



St. Modwen Developments Limited

Coed Darcy

Crymlyn Tip - Environmental Monitoring Annual Report

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I Introduction

I.1 Overview

This report has been prepared to satisfy Condition 4.2.2 (a) of Environmental Permit Crymlyn Tip Environmental Permit EPR/AP3990LR and subsequent variations (the Permit), which states:

'4.2.2 A report or reports on the performance of the activities over the previous year shall be submitted to the Environment Agency [now Natural Resources Wales] by 31 January (or other date agreed in writing by [NRW] each year. The report(s) shall include as a minimum:

a) A review of the results of the monitoring and assessment carried out in accordance with this permit against the relevant assumptions, parameters and results in the risk assessments submitted in relation to this site and any agreed amendments thereto.'

This report covers monitoring period January 1st, 2019 to December 31st, 2019.

I.2 Background

St Modwen Developments Limited (St Modwen) acquired responsibility of the Tip area in 2008, when they purchased the site from former site owners BP. For the Tip area to enter 'definitive' closure NRW must be satisfied that a Closure and Aftercare Management Plan has been produced.

In January 2018 Atkins were appointed, by St Modwen, to undertake an environmental monitoring programme in line with the requirements of the above permit and to assist in the production of the Closure and Aftercare Management Plan.

I.3 Summary of Works

The environmental monitoring programme was initially undertaken by Atkins between January 2018 and March 2019. As of April 2019, PJA took over responsibilities for the monitoring and reporting of the findings.

GeoEnvironmental Applications Ltd (GAL) have been contracted to manage the recovery of local free phase oil within the Tip area and its peripheries. Alongside the oil recovery, GAL carry out groundwater monitoring within boreholes/sumps and obtain monthly gas readings from available boreholes within/surrounding the Tip area as part of the monitoring programme. The oil recovery and monitoring works carried out by GAL are overseen by PJA, who also collect groundwater and surface water samples on a monthly basis as part of the monitoring programme.



I.4 Supporting Documents

A PJA technical note was issued to NRW in November 2019, documenting works undertaken between April and September 2019. Details regarding the technical note can be seen below:

- Coed Darcy – Crymlyn Tip Factual Summary Report, April – September 2019. Ref: 4020-PJA-19-XX TN-R-005. Dated 22/10/2019.

Additional information relating to the history, operation, previous assessments and risk assessments of the Tip area are presented in the following reports:

- Atkins (2013) Coed Darcy – Hydrogeological Risk Assessment Crymlyn Tip.
- Atkins (2013) – Coed Darcy – Landfill Gas Risk Assessment and Gas Management Plan.
- Atkins (2017)- Coed Darcy Crymlyn Tip- Partial Surrender of Coed Darcy Wetlands. EPR/AP3990LR/S003 Site Condition Report. Ref 5041216-RAP-RPT-0001788
- Atkins (2019) – Coed Darcy Crymlyn Tip – Environmental Permit Monitoring. Ref: 5041216. Dated: 31/01/2019.
- Natural Resources Wales (2019) – Compliance Assessment Report. Ref: CAR_NRW0034811. Dated: 13/03/2019.

It is assumed the reader has access to the above documentation and is familiar with previous assessments undertaken. This report is not intended to repeat or reproduce findings of previous assessments in any great detail.

I.5 Limitations

This report has been prepared by PJA, on behalf of St Modwen, for submission to NRW. This report shall not be relied upon or transferred to any other parties. If an unauthorised third party comes into possession of this report, they rely on its contents at their own risk.

The findings within the report are based upon information gained from a variety of sources and field measurements as detailed within this report and which PJA believes are reliable. Nevertheless, PJA cannot guarantee the authenticity or reliability of third-party information.

The conclusions made within this report are based on the guidance available at the time of writing.



2 Site Setting

2.1 Site Location and Description

The Tip is located within the historic 'Containment Area' in the western section of the wider Coed Darcy development. The 'Containment Area' includes the licenced landfill and the lagoons and wetlands. The containment area is shown in Appendix A on PJA drawing 04020-A-0110-P1: Notable Areas & NRW Discharge Consent Points.

The Permitted area to which this report relates is shown on drawing 04020-A-SK201-P1 and consists of the 'lower tip' in the west and the 'main tip' in the east. To the north is the Crymlyn Bog SSSI and to the south of the permitted area is the 'Coed Darcy wetlands' which were removed from the permitted area in 2017.

2.2 Brief Site History

When the refinery opened in the early 1920s the 'Containment Area' comprised a series of lagoons and wetlands, congruent with Crymlyn Bog. The lagoons were initially constructed during the operational years of the refinery and were intended to intercept oil, preventing it from entering Crymlyn Bog. There are three lagoons within the Containment Area: Crymlyn Bog Lagoon (approx. 10,500m³), South Bay (approx. 4,450m³) and West Bay (approx. 1,500m³).

Prior to the Second World War an ash bund was constructed around the Containment Area to provide a containment area for oil, which may have flowed into Crymlyn Bog, if the area had been struck by bombs during the war. The ash bund also contained drainage systems, serving the southern half of the former refinery.

In 1977 a waste disposal license was granted for the Containment Area. The permit granted the deposition of refinery waste, including both inert and potentially hazardous materials. Waste was filled in the 'Tip Areas' north of the wetlands. No waste has been accepted since 1999 and the landfill has been non-operational since July 2001.

Remedial works have taken place within the wetland lagoons (South Bay, West Bay and Crymlyn Bog Lagoon) between 2011 and 2015. These works were summarised as part of the submission for the partial surrender of the waterbodies from the permitted area. The partial surrender report (Atkins report reference- 5041216-RAP-RPT-0001788) was submitted to NRW and the Coed Darcy wetlands removed from the permitted area in 2017:

The remaining permitted area is shown on 04020-A-SK201.



3 Environmental Setting

3.1 Geology

The British Geological Survey (BGS) record the Tip area to be underlain by Peat in the northern and central section and Devensian Till in the southern area. Peat and Devensian Till overlie Pennant Sandstone Formation.

Based on historic borehole logs Made Ground/waste depths are variable but extend to depths in excess of 12mbgl locally. Made Ground generally comprises grey, brown and black sandy, gravelly clay, with sand, gravels and cobbles consisting of bricks, concrete, timber, metal, and ash. Much of the infill material is consistent with waste derived from refinery operations. There are areas where asbestos waste is known to have been deposited as well as tank sludges, other industrial waste by-products, oil and tar residues.

Available borehole logs are presented in Appendix B.

3.2 Hydrogeology

Superficial deposits (Peat and Devensian Till) are classified as Unproductive Strata and bedrock beneath is classified as a Secondary A Aquifer.

Following a site wide investigation, URS produced Groundwater Contour Maps for the bedrock and superficial hydrogeology for the wider Coed Darcy development site (URS Report: 39991-044-785: Final Factual Report Whole Site Investigation BP LLANDARCY REFINERY 12th August 2005). These maps indicate groundwater in the bedrock beneath the tip flows from south to north across the Permitted area. Artesian and sub-artesian conditions in the bedrock may be present around the at the border between the site and Crymlyn Bog. Monitoring of shallow groundwater beneath the tip indicates possible local radial flow although this may be distorted by the presence of oil residues.

For reference these groundwater maps have been taken from the original URS document and are presented in Appendix C.

3.3 Hydrology

A peripheral trench separates the Permitted area from Crymlyn Bog SSI to the north. This is a narrow channel that intercepts the groundwater flowing north from the tip into the bog. A plywood wall in the trench prevents the flow of free phase oil into the bog. Oil is collected from the trench (and from sumps and boreholes within the tip) and sent for offsite disposal.

As mentioned in section 2.1 above there are three water bodies within the Containment area but were removed from the Permitted area in 2017: South Bay, West Bay and Crymlyn Bog Lagoon.



3.3.1 South Bay

South Bay is approximately 4,450m³ and is located south of the former landfill area. The water body was originally installed uncontrolled discharge of free product from the refinery entering Crymlyn Bog.

3.3.2 West Bay

West Bay is approximately 1,500m³ and lies to the south west of the former landfill area. Similar to South Bay, West Bay was installed to intercept uncontrolled discharge of free product from the western section of southern tank farm from entering Crymlyn Bog.

3.3.3 Crymlyn Bog Lagoon

Outfalls from both South Bay and West Bay enter the Crymlyn Bog Lagoon prior to discharging into Crymlyn Bog. Discharge to the Bog is via a siphon valve and a historical oil-water interceptor located within the ash bund. This valve is an NRW discharge consent point, W3 (BP0279201) held by SMD.



4 Ongoing Sampling / Monitoring

4.1 Sampling Locations

Positions currently sampled and monitored are shown on PJA drawing: PJA drawing: 04020-A-SK201-P1 in Appendix A and summarised in Table 1.

Table 1: Summary of Sampling/Monitoring Locations

Location	Monitoring type	Added to Monitoring in 2019	Response zone
MSMW27	Gas & groundwater		Glacial Till
MSMW155D	Gas & groundwater		Coal Measures
MSMW155S	Gas & groundwater		Glacial Till
CARW008	Gas & groundwater		Made Ground
CARW009	Gas & groundwater		Made Ground
CARW034	Gas & groundwater		Coal Measures
BHXI	Groundwater	✓	*TBC N.B added in December 2019
BH20	Gas & groundwater		Made Ground
BH30	Groundwater	✓	Made Ground
BH32	Gas		Made Ground
BH49	Gas		Made Ground
BH51	Gas & groundwater		Made Ground
BH52	Gas & Groundwater		Made Ground
BH57	Gas & groundwater		Made Ground
BH62	groundwater		*TBC N.B added in December 2019
SW1 –S W6	Surface water		Surface water
Sumps 14 – 21 & 23-28	Oil recovery	✓	Made Ground
BH23	groundwater	✓	*TBC N.B added in Oct 2019
BH19	groundwater	✓	*TBC N.B added in Oct 2019
BH13	groundwater	✓	*TBC N.B added in Nov 2019
BH2	groundwater	✓	*TBC N.B added in Nov 2019
BH31	groundwater	✓	*TBC N.B added in April 2019
BH48	groundwater	✓	*TBC N.B added in November 2019
BH64	groundwater	✓	*TBC N.B added in December 2019
BH46	groundwater	✓	*TBC N.B added in November 2019
BH29	groundwater	✓	*TBC N.B added in April 2019

GAL carry out field measurements, monitoring of the groundwater levels and taking gas readings from locations installed with a gas bung and tap. PJA carry out groundwater and surface water sampling once a month.



Groundwater and surface water samples are scheduled for the following laboratory analysis:

- Ammoniacal Nitrogen as N
- Dissolved metals
- Total Petroleum Hydrocarbons (TPHs)
- BTEX compounds (Benzene, Toluene, Ethylbenzene and Xylenes)
- Polyaromatic Hydrocarbons (PAHs)

Table 2 shows when each of the groundwater locations have been monitored over the course of the year. A '✖' illustrates when a sample was unobtainable, either due to a lack of water in the ground (1), technical difficulty with the equipment(2), interference from free phase oil (3) or no access/blocked (4), mis-sampled (5), not sampled (6). A '✓' shows where a sample was successfully taken.

Table 2: Groundwater Sampling

Sampling location	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
CARW008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CARW009	✖6	✖6	✖6	✓	✓	✓	✓	✓	✓	✓	✓	✓
BH20	✖6	✖6	✖6	✖1	✓	✓	✓	✓	✓	✓	✓	✓
BH32	✖6	✖6	✖6	✖3	✖3	✖3	✖3	✖3	✖3	✓	✓	✖3
BH51	✖6	✖3	✖3	✖3	✓	✓	✓	✖3	✖3	✓	✓	✖3
BH52	✖6	✖6	✖6	✓	✖3	✖3	✓	✖3	✓	✓	✓	✓
BH57	✖6	✖6	✖6	✓	✓	✓	✓	✓	✓	✓	✓	✓
MSMW155S	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MSMW27	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✖5
MSMW155D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CARW034	✖6	✖6	✖6	✓	✓	✓	✓	✓	✓	✓	✓	✓
BH30	✖6	✖4	✖4	✖4	✖4	✖4	✖4	✖4	✖3	✖4	✖4	✓
BHXI	6	✖6	✖6	✓	✓	✓	✓	✓	✓	✓	✓	✓

The findings from the field data and lab data from the sampling are discussed in the following sections.



5 Groundwater Monitoring Results

A total of 22 borehole locations were monitored over the last year as part of the current monitoring programme. Some of these borehole locations were found during the course of the year so monitoring data for these locations is partial for 2019. A plan showing all monitoring locations (PJA drawing: 04020-A-SK201-P1) is presented in Appendix A.

Borehole logs have been reviewed to identify response zones for each of the monitoring locations, with logs presented in Appendix B. Response zones lie within waste material, superficial deposits and bedrock. A summary of the groundwater levels recorded over the year 2019 are provided in Table 3 below.



5.1 Groundwater Levels

Table 3: Groundwater Levels

Monitoring Locations	Response Zone	Minimum		Maximum		Average	Variability
		Depth	Month	Depth	Month		
CARW008	Waste/Made Ground	0.53mbgl 10.55mAOD	June	0.42mbgl 10.65mAOD	September	0.50mbgl 10.58mAOD	0.11m
CARW009	Waste/Made Ground	0.16mbgl 10.43mAOD	October	0.00mbgl 10.59mAOD	November	0.09mbgl 10.50mAOD	0.16m
BH2	Waste/Made Ground	2.92mbgl 10.38mAOD	November	2.62mbgl 10.68mAOD	December	2.77mbgl 10.53mAOD	0.30m
BH13	Waste/Made Ground	9.11mbgl 5.59mAOD	September	6.91mbgl 8.08mAOD	November	7.68mbgl 7.31mAOD	2.20m
BH19	Waste/Made Ground	8.59mbgl 7.00mAOD	October	6.90mbgl 8.69mAOD	November	7.63mbgl 7.69mAOD	1.69m
BH20	Waste/Made Ground	7.01mbgl 8.31mAOD	July	5.75mbgl 9.57mAOD	December	6.36mbgl 8.96mAOD	1.26m
BH23	Waste/Made Ground	5.12mbgl 9.48mAOD	November	4.71mbgl 9.89mAOD	December	4.86mbgl 9.74mAOD	0.41m
BH29	Waste/Made Ground	6.77mbgl 7.75mAOD	September	5.64mbgl 8.88mAOD	December	6.14mbgl 8.38mAOD	1.13m
BH30	Waste/Made Ground	5.54mbgl 9.01mAOD	September	4.50m 10.05mAOD	December	4.98mbgl 9.57mAOD	1.04m
BH31	Waste/Made Ground	3.96mbgl 10.35mAOD	November	3.93mbgl 10.38mAOD	December	3.94mbgl 10.37mAOD	0.03m
BH32	Waste/Made Ground	9.71mbgl 6.52mAOD	April	7.97mbgl 8.26mAOD	December	8.79mbgl 7.44mAOD	1.74m
BH49	Waste/Made Ground	2.57mbgl 11.23mAOD	December	2.57mbgl 11.23mAOD	December	2.57mbgl 11.23mAOD	-
BH51	Waste/Made Ground	7.65mbgl	September	5.55mbgl	October	6.52mbgl	2.1m



Monitoring Locations	Response Zone	Minimum		Maximum		Average	Variability
		6.99mAOD		9.09mAOD		8.12mAOD	
BH52	Waste/Made Ground	6.46mbgl 8.37mAOD	February	1.12mbgl 13.71mAOD	November	4.05mbgl 10.79mAOD	5.34m
BH57	Waste/Made Ground	7.15mbgl 8.54mAOD	June	5.76mbgl 9.93mAOD	December	6.54mbgl 9.15mAOD	1.39m
MSMW155S	Drift Deposits	0.72mbgl 8.30mAOD	July	0.18mbgl 8.84mAOD	December	0.55mbgl 8.47mAOD	0.54m
MSMW27	Drift Deposits	2.22mbgl 7.12mAOD	June	0.87mbgl 8.47mAOD	December	1.53mbgl 7.81mAOD	1.35
MSMW155D	Bedrock	0.56mbgl 8.66mAOD	December	0.20mbgl 9.02mAOD	February	0.34mbgl 8.88mAOD	0.36
CARW034	CARW034	0.56mbgl 10.60mAOD	July	0.00mbgl 11.15mAOD	October – December	0.06mbgl 11.09mAOD	0.55m
BH48	TBC	2.57mbgl 11.24mAOD	December	2.57mbgl 11.24mAOD	December	2.57mbgl 11.24mAOD	*only data for Dec 19
BH29	TBC	5.97mbgl 7.75mAOD	September	7.1mbgl 8.88mAOD	December	6.47mbgl 8.83mAOD	1.13m



5.2 Non-Aqueous Phase Liquid Levels (NAPL)

Both light and dense non-aqueous phase liquids (LNAPLs & DNAPLs) have been detected in all borehole locations and within some sumps at least once during the monitoring period. LNAPL and DNAPL thicknesses recorded in boreholes are presented in Table 4 & Table 5 Respectively. LNAPL thicknesses detected in sumps are presented in Table 6 below. Plans visually displaying 'snapshots' of product thickness for months, January, March., June, September and December are provided in Appendix D.

Table 4: LNAPL Thickness in boreholes

Borehole ID	Response Zone	Number of occurrences	LNAPL thickness		Average thickness
			Minimum	Maximum (date)	
CARW008	Waste/Made Ground	3/12	0.00m	0.03m (September 2019)	0.003m
CARW009	Waste/Made Ground	5/12	0.00m	0.03m (September 2019)	0.005m
BH20	Waste/Made Ground	4/12	0.00m	0.68m (June 2019)	0.27m
BH32	Waste/Made Ground	12/12	0.07m	2.41m (March 2019)	0.78m
BH51	Waste/Made Ground	12/12	0.10m	0.59m (October 2019)	0.22m
BH52	Waste/Made Ground	8/9	0.00m	1.73m (March 2019))	0.36m
BH57	Waste/Made Ground	3/12	0.00m	0.12m (September 2019)	0.68m
MSMW155S	Drift Deposits	1/11	0.00m	0.002m (August 2019)	0.00m
MSMW27	Drift Deposits	4/10	0.00m	0.05m (June 2019)	0.06m
MSMW155D	Bedrock	3/11	0.00m	0.02m (June & December 2019)	0.00m
CARW034	Bedrock	2/12	0.00m	0.002m (July & August)	0.28m
BH29* partial data due to oil recovery from well Aug/Sept/Oct	Unknown	6/6	0.62 (July 2019)	0.86m (May 2019)	0.69m
BH30* as Above	Unknown	3/3	0.05 (December 2019)	0.62 (July)	0.29m
BH31* As above	Unknown	5/6	0.00m	0.19 (April)	0.1m
BH49	Unknown	12/12	0.16 (august 2019)	1.02 (April 2019)	0.49m



Borehole ID	Response Zone	Number of occurrences	LNAPL thickness		Average thickness
			Minimum	Maximum (date)	
BH19	Unknown	3/3	0.4 (December 2019)	0.88 (October 2019)	0.56m
BH2	Unknown	2/2	0.3 December 2019	0.4 (November)	0.35m
BH13	Unknown	2/2	0.25 (November)	0.65 December	0.45m
BH46	Unknown	2/2	0.2 December	0.32 (November)	0.26m
BH48	Unknown	2/2	0.29 December	0.46 November	0.38m

Table 5: DNAPL Thickness in boreholes

Borehole ID	Response Zone	Number of occurrences	DNAPL thickness		Average thickness
			Minimum	Maximum (date)	
CARW008	Waste/Made Ground	3/12	0.00m	0.89m (March 2019)	0.003m
CARW009	Waste/Made Ground	3/12	0.00m	0.1.4m (Jan 2019)	0.005m
BH20	Waste/Made Ground	3/12	0.00m	0.86m (Jan 2019)	0.27m
BH57	Waste/Made Ground	3/12	0.00m	2.99m (January 2019)	0.68m
CARW034	Bedrock	3/12	0.00m	1.59m (January 2019)	0.28m

Table 6: NAPL Thickness in sumps

Sump ID	Response Zone	Number of occurrences	NAPL thickness		Average thickness
			Minimum	Maximum (date)	
18	Waste/Made Ground	6/9	0.00m	0.41m (November)	0.13m
19	Waste/Made Ground	8/9	0.00m	0.37m (July 2019)	0.13m
20	Waste/Made Ground	5/9	0.00m	0.44m (September/ October)	0.14m
21	Waste/Made Ground	9/9	0.09m (April 2019)	0.75m (September)	0.17m
23	Waste/Made Ground	2/2	0.24 (June 2019)	0.26 (may)	0.25m
24	Waste/Made Ground	2/9	0.00m	1.15m (July)	0.10m



Sump ID	Response Zone	Number of occurrences	NAPL thickness		Average thickness
			Minimum	Maximum (date)	
25	Waste/Made Ground	8/9	0.00m	1.26m (September)	0.24m
27	Waste/Made Ground	7/9	0.00m	0.32m (November)	0.12m
28	Waste/Made Ground	1/9	0.00m	0.11m (October)	0.01m

Only sumps where NAPL was detected are shown in the above table.

5.3 Groundwater and NAPL Levels Discussion

5.3.1 Groundwater Levels

The average level of groundwater recorded over the year is shown on PJA drawing: 04020-A-SK202-P1: Crymlyn Tip Monitoring: Ground Water Contours. Although the contours are restricted by the spread of available data, the drawing suggests the shallow groundwater follows the topography, generally as indicated by historic URS data.

As expected along the northern extent of the data set, the contours indicate a radial flow in shallow groundwater towards the various waterbodies within/surrounding Crymlyn Tip. This isn't shown on the URS maps, although the recently collected data is likely to be more detailed than those used to produce the URS plans. It is also worth noting that this interpretation is made from a relatively limited data set with restricted distribution.

Looking over groundwater level data collected over the last 12 months, generally the lowest levels were recorded between months April to September, and the highest levels between October and February. This would be expected from the change in the amount of precipitation between the summer months and the winter months.

There is an average variability of 1.36m between the lowest and highest recorded water level in any one location.

Borehole BH52 has the largest variability in ground water levels, where there was a 5.34m difference between the highest and lowest recorded water levels. Note: this well is located in the central area of the tip where it would be expected that there would be a high degree of local heterogeneity in material properties. Borehole CARW008 has the smallest variability in recorded groundwater levels of just 0.1m. This location is on the southern margin of the landfill and outside the 'waste' proper and in an area where saturated ash deposits are prevalent.

5.3.2 Non Aqueous Phase Liquid (NAPL) Levels and Distribution

Light NAPL have been detected in all but two borehole locations BH 23 and 64- (both of these locations were found towards the end of 2019 and so limited monitoring data available).

Locations BH32 and BH51 have LNAPL recorded most consistently, where it has been detected during all 12 monitoring rounds. The LNAPL is recorded thickest in those wells installed in the Waste/ Made ground (CARW008, CARW009, BH20, BH32, BH51, BH52, & BH57). In these locations the average thickness of LNAPL across the year was 0.33m. By contrast, the wells installed in drift deposits and bedrock, (MSMW155S, MSMW155D, MSMW27, CARW034), have LNAPL detected infrequently at an average thickness of 0.027m.

Suspected Dense NAPLs have been recorded in CARW008, CARW009, BH20, BH57, CARW034. All of these locations are installed in Waste/Made Ground, with the exception of CARW 034 which is installed in the bedrock. DNAPL was detected in all these locations during 3 monitoring rounds (January, February & March 2019). Thickness in these locations have been recorded to range from nil, to 2.99m (BH57 Jan 2019). Within BH57 suspected DNAPL was measured on three occasions out of 12. The other readings were 2.47m (February 2019) and 2.53m (March 2019) indicating variability or measurement error. This could be down to a difference in the equipment or the operational use of the equipment, or errors made during data recording. Clarification of DNAPL presence and distribution will continue in future monitoring rounds.

Further assessment of DNAPLs is proposed as the differentiation during measurement was difficult to achieve therefore the values should be viewed with caution at present.

The NAPL records for January, March, September and December are plotted on the site plan in Appendix D. This visually shows the spatial distribution and thickness of the LNAPL across the site. The eastern area of the tip (main tip area) is most impacted by LNAPL. The sumps and boreholes in the western half, (the lower tip) record lower thicknesses, and more infrequent levels of LNAPL.

6 Groundwater and Surface Water Quality Assessment

6.1 Threshold Values

Laboratory results from groundwater and surface water samples obtained during 2019 have been screened against Environmental Quality Standards (EQS), Natural Resources Wales (NRW) threshold values, and World Health Organisation (WHO) water quality standards. NRW threshold values have been obtained from NRW discharge permit EPR/LB3293HN, which relates to water discharges from NRW sampling locations W2 and W3 within/around the Tip. Screened laboratory results are presented in Appendix E.

Based on laboratory results, the number of exceedances recorded appears to decline during wetter winter months. This is likely due to a dilution factor as a result of increased rainfall. Screened laboratory results are presented in Appendix E.

Over the twelve-month monitoring period 12 metal exceedances were recorded, 15 TPH exceedances and 48 PAH exceedances. Sampling point W1 was recorded as having the highest number of exceedances (31) and sampling location W2 recorded the lowest number of exceedances (1).

As hydrocarbons are the major contaminants within the Tip area and to attempt to identify trends, graphs 1 - 4 in Appendix E show total TPH concentrations within groundwater and surface water against average monthly rainfall and average monthly temperatures. Total TPH concentrations have been compared with threshold value reported in NRW discharge permit EPR/LB3293HN, relating to 'visible oil and grease' which is 5,000µg/l.

6.2 Groundwater

Graphs 1 & 2 in Appendix E shows TPH concentrations in boreholes. It should be noted that results from BH51 in May (3,820,000µg/l) and October (2,540,000µg/l), and BH 30 in December (172000 µg/l) have been omitted from the graph to improve visual representation of the other data.

Overall, TPH concentrations in most locations are relatively stable and generally less than 20,000 µg/l. The data from wells, CARW008, CARW009, BH20, BH51, BH52 is sporadic, with concentrations of TPH fluctuating over time. Based on the data set to date, there appears to be no obvious correlation between TPH concentration and rainfall/temperature data. All three of these locations are screened in waste / Made Ground.

Data from CARW034 (screened in the bedrock) is also variable but shows some correlation between rainfall data and TPH concentrations whereby the TPH concentrations drop with increased rainfall and vice versa. This could suggest that water may be entering the monitoring well from the surface.

This is verified by the engineers notes which indicate the headworks are damaged at that monitoring location.

However, in BH20 the opposite effect appears to be happening, where TPH concentrations appear to increase with increased rainfall.

Note: in some sample's interference through cross contamination with oily residues cannot be ruled out. Ruling out this error will be a focus of future works.

6.3 Surface Waters

Over the past year, two instances where concentrations of TPH were recorded in excess of the NRW Discharge Permit threshold of 5,000µg/l. Both instances occurred at SW1 in May (10,200µg/l) and July (21,300µg/l).

Graphs 3 & 4 in Appendix E show TPH concentrations against average monthly rainfall and average monthly temperature data. An increase in TPH concentrations at sampling location SW1 occurred in warmer temperatures during drier periods and a decrease during periods of increased rainfall.

7 Landfill Gas

7.1 Landfill Gas Monitoring

Landfill gas monitoring was undertaken at 12 locations within and around the Tip area, using a GA5000 gas analyser. Of the 12 locations monitored 8 lie within the former landfill and 4 lie outside the former landfill area to the south-east and south-west, as shown in Table 7.

Table 7: Landfill Gas Monitoring Location Information

Monitoring locations within the former landfill area	Monitoring locations outside the former landfill area
CARW008	CARW034
CARW009	MSMW155S
BH20	MSMW155D
BH32	MSMW027
BH49	
BH51	
BH52	
BH57	

7.2 Landfill Gas Concentrations

Landfill gas readings were recorded by Atkins from January – March 2019 and from April 2019 GAL have undertaken landfill gas monitoring. The minimum atmospheric pressure reading was recorded as 982mb in November 2019, whilst the highest atmospheric pressure was recorded as 1035 in March 2019.

Methane (CH₄)

Based on the graphs below (figures 1&2), methane concentrations appear to show some variability. Generally, methane concentrations within the tip are below 20%. The highest methane concentration for every monitoring round was detected in BH20, with concentrations ranging between 42.9% (February) and 71.2% (October). The lowest methane concentration (<0.1%), within the former landfill area, was recorded across several monitoring locations throughout the year.

Outside the former landfill area, the maximum CH₄ concentration (7.2%) was detected in MSMW155S (screened in Glacial Till) in March. The minimum CH₄ concentration (0%), outside the former landfill area was detected across all three monitoring locations during multiple monitoring rounds.

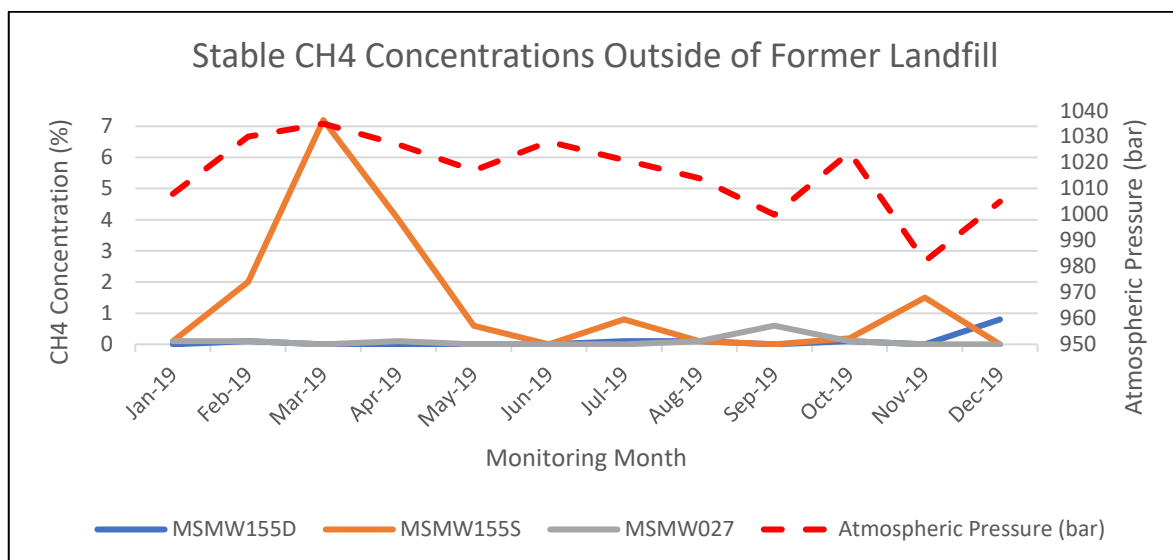


Figure 1: Methane Concentrations in boreholes outside the landfill

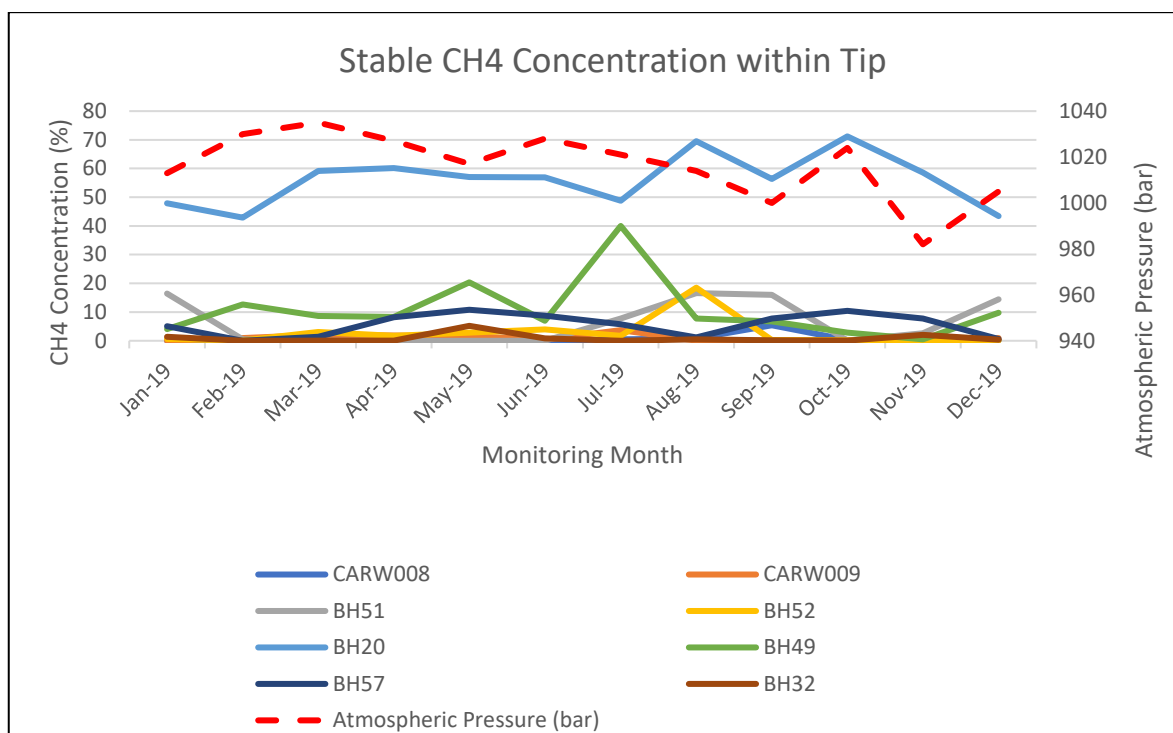


Figure 2: Methane concentrations in boreholes within the landfill

Carbon Dioxide (CO₂)

Based on monitoring data presented in the graphs below (figures 3 & 4) stable CO₂ concentrations within the former landfill area range between <0.1% and 13.6%. The maximum concentration (13.6%), was detected in BH20 in August and the lowest concentration (0%) detected in BH51 across April – June.

The maximum CO₂ concentration (13.4%) recorded outside of the former landfill area was detected in MSMW27 (screened in drift deposits) in July and the lowest concentrations recorded (0.1%) in MSMW155S and MSMW27 during January and August respectively.

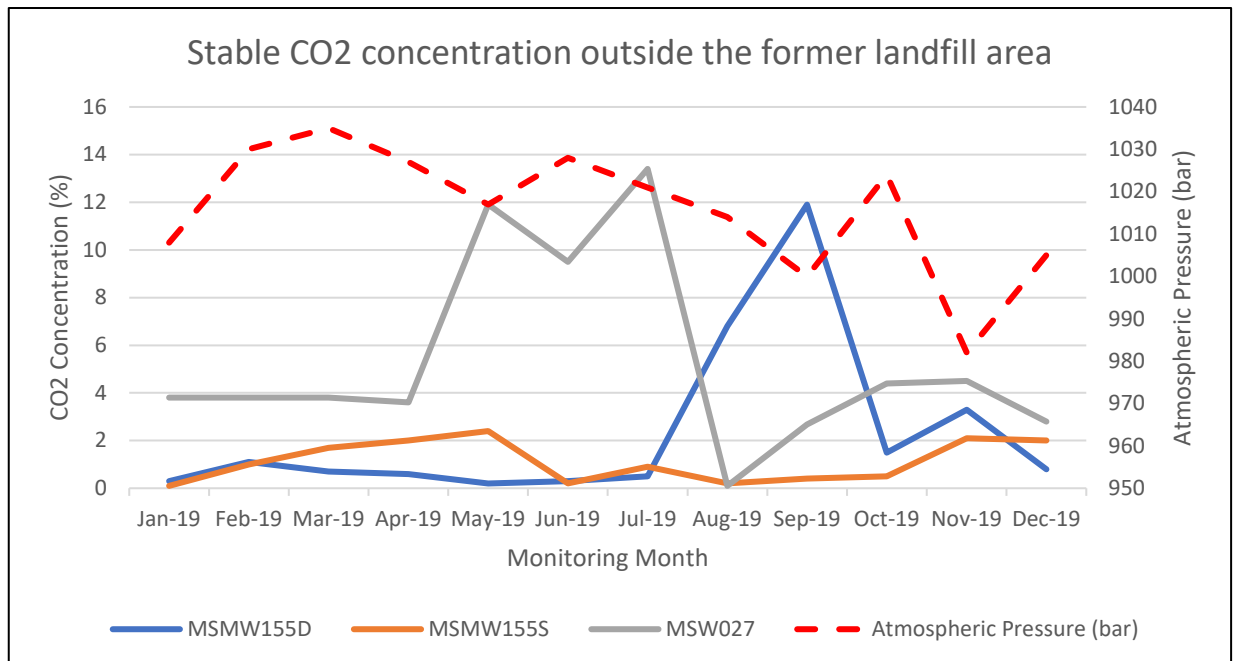


Figure 3: Carbon Dioxide concentrations outside landfill area

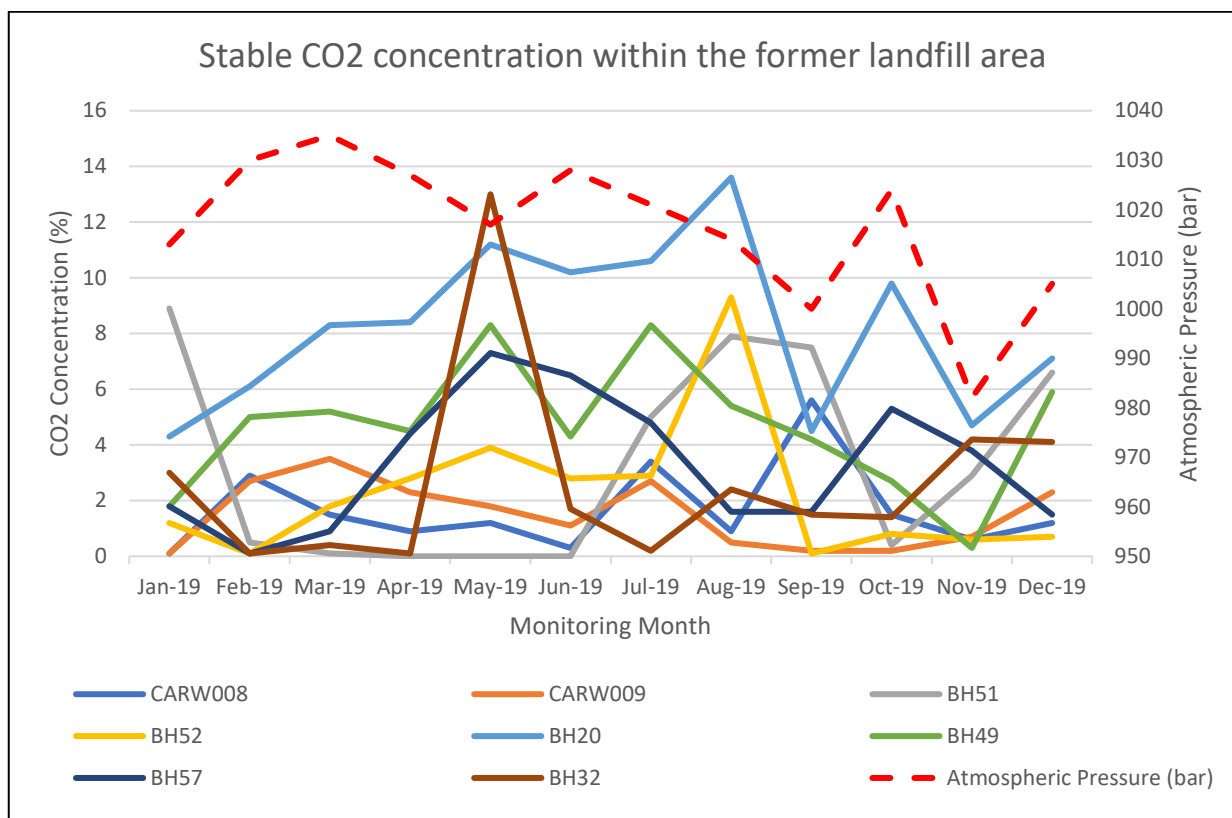


Figure 4: Carbon dioxide concentrations within the landfill

Oxygen (O2)

O2 concentrations (shown on figures 5 & 6) within the former landfill area range between 0.1% and 22.3%, with the lowest concentration recorded in BH20 during May and the maximum detected in CARW009 during January. Oxygen concentrations are stable in BH20, consistently below 1%.

Outside of the former landfill area O2 concentrations range between 4% and 21.2%. The minimum concentration (4%) was recorded in MSMW027 in July and the maximum concentration (21.2%) recorded in MSMW155D in January.

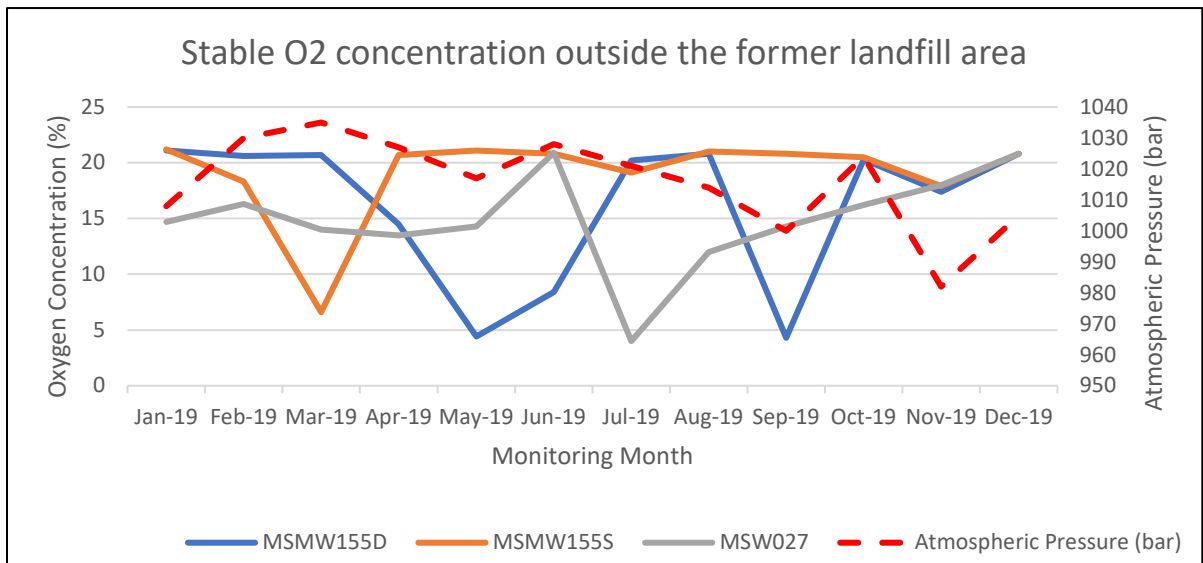


Figure 5: Oxygen concentrations in boreholes outside the landfill

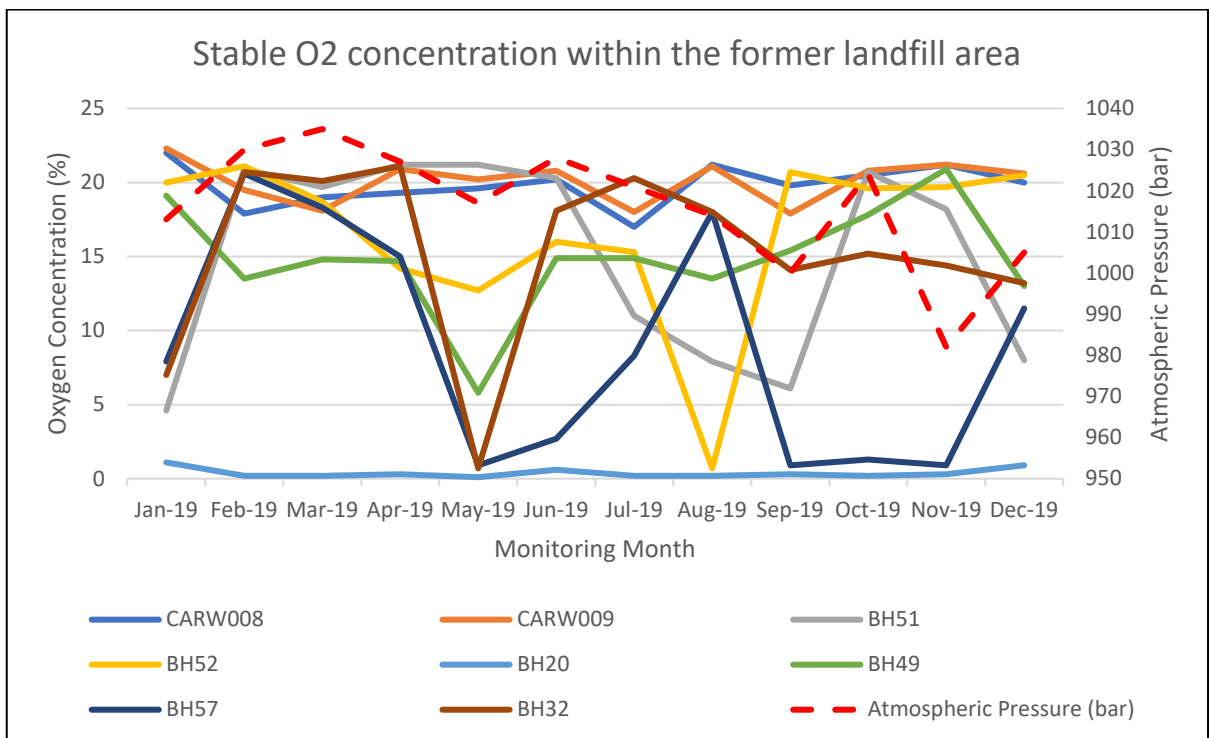


Figure 6: Oxygen concentrations in boreholes within the landfill

Landfill gas monitoring results recorded between January 1st – December 31st, 2019 are summarised in Table 8 below.

Based on the data collected during 2019, there does not appear to be an obvious link between boreholes with greater thicknesses of product and elevated gas concentrations. Monitoring locations where elevated gas concentrations were detected generally have none to minor amounts of oil present.



Table 8: Landfill Gas Concentration Summary

Monitoring location	Location	Methane (%)		Carbon dioxide (%)		Oxygen (%)	
		Min	Max	Min	Max	Min	Max
CARW008	In waste on SE boundary	<0.1	5.4	0.1	5.6	17.0	22
CARW009	In waste on SE boundary	<0.1	3.7	0.1	3.5	17.9	22.3
BH20	In waste within central section	42.9	71.2	4.3	13.6	0.1	1.1
BH32	In waste within central section	<0.1	5.2	0.1	13	0.7	21.1
BH49	In waste within central section	0.5	40	0.3	8.3	5.8	20.9
BH51	In waste within central section	<0.1	16.6	<0.1	8.9	4.6	21.2
BH52	In waste within central section	0.1	18.5	0.1	9.3	0.7	21.1
BH57	In waste within central section	<0.1	10.8	0.1	7.3	0.9	20.6
MSMW155S	Beyond W boundary of landfill area	<0.1	7.2	0.1	2.4	6.6	21.2
MSMW27	Beyond W boundary of landfill area	<0.1	0.6	0.1	13.4	4	20.9
MSMW155D	Beyond W boundary of landfill area	<0.1	0.8	0.2	11.9	4.3	21.1

8 Commentary

LNAPL continues to be monitored within boreholes and sumps within the tip. Generally, more consistent and thicker instances of LNAPL appear at the eastern part of the tip, the areas to the west (the lower tip) has fewer recorded instances of LNAPL in boreholes and sumps.

Suspected DNAPL was measured locally during January, February and March 2019, during the time Atkins were responsible for collecting the data. Since GAL took over the monitoring, there have been no records of DNAPL in any of the locations. This could be down to a difference in the equipment or the operational use of the equipment, or errors made during data recording. GAL have been audited on their use of the equipment and reading of NAPL and groundwater levels remain relatively consistent. Clarification of DNAPL presence and distribution will continue in future monitoring rounds.

The groundwater levels in the shallow aquifer are broadly in line with what would be expected, i.e. following topography. However, the groundwater plot produced as part of this report is limited due to the spread of available boreholes. Eleven additional boreholes are proposed and are shown on PJA drawing 04020-1006-P0- Proposed Boreholes. These will provide more information to better understand model groundwater flow in the tip and provide a more evenly distributed monitoring network.

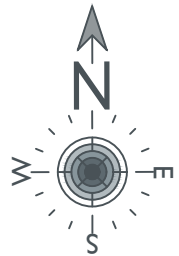
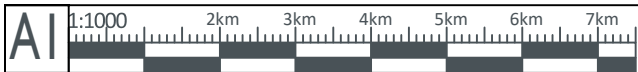
During 2018 and early 2019 there was only a sampling success of 19% from 9 monitoring locations screened in the Made Ground, this has increased over 2019 to 56% from 9 monitoring wells screened in the Made Ground. A number of additional wells have been 'found' during the course of the year, and where possible these have been monitored. Locating, identify and assessing the condition of historic wells is an ongoing process and it is planned to take additional samples from these recently found wells in the coming year.

Oil recovery will continue from the external trench and become more consistent from sumps and wells where LNAPL is repeatedly detected. Continued monitoring will show what impact this is having on the NAPL distribution and thickness.

Monitoring will continue into 2020 to build up the data set to determine compliance and control limits to be used in the production of a closure and aftercare management plan.



Appendix A - Site Plans

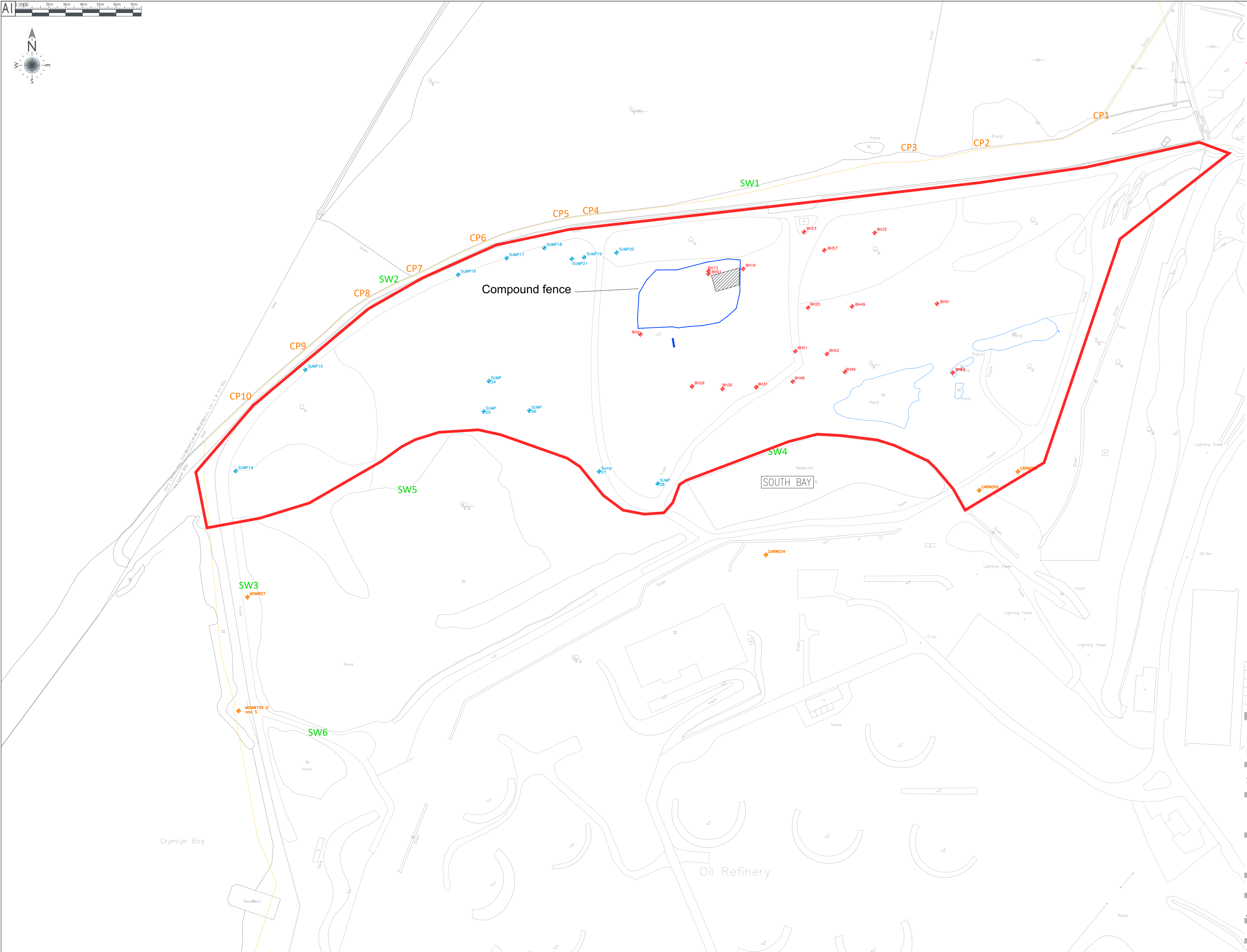


NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

KEY

- Permit area
- SW1 Surface water sampling locations
- Groundwater monitoring/sampling locations
- Sump locations
- CP7 Collection point



PI	13.02.20	Added more boreholes to location plan	JP
REV	DATE	REVISION NOTE	BY

Seven House - High Street
Longbridge - Birmingham
B31 2UQ - Tel: 0121 475 0234
Birmingham - Bristol
Exeter - London - Reading
pja.co.uk

CLIENT
St Modwen Development Ltd

PROJECT
Coed Darcy

DRAWING TITLE
Crymlyn Tip
Monitoring Location Plan

DRAWING ISSUE STATUS
PJA JOB No. SUB-CODE DRAWING NO. REVISION
04020 - A - SK201 - PI
Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction
BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE
A1@1:1000 JP LC 30.10.19



Appendix B - Borehole Logs

Design and Construct Remediation

Date: 27 Jan 2009

Easting: 270302.000

Project No: C1296

Engineer: MS

Northing: 195534.000

Site Location: BP Former Llandarcy

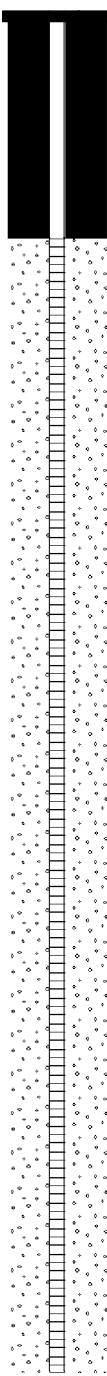
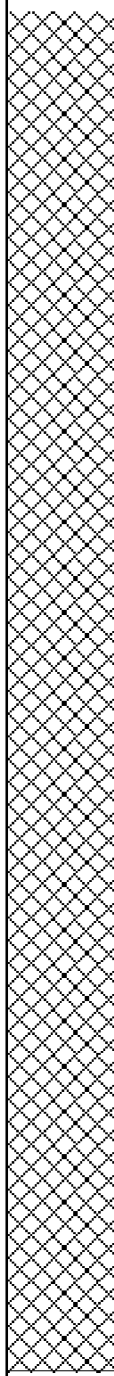
Method: ODEX

Datum: -

Client: St. Modwen

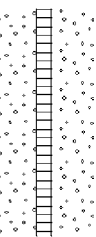
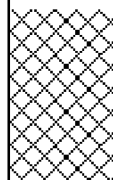
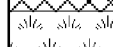
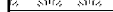
Hole Diameter: 200mm

Screen Position: 1.50 - 10.50m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
▽ 3.50m					MADE GROUND: Waste Tip Fill.			
Continued next sheet								

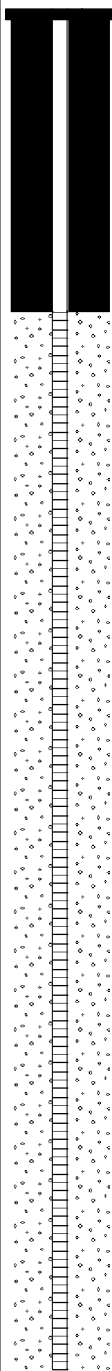
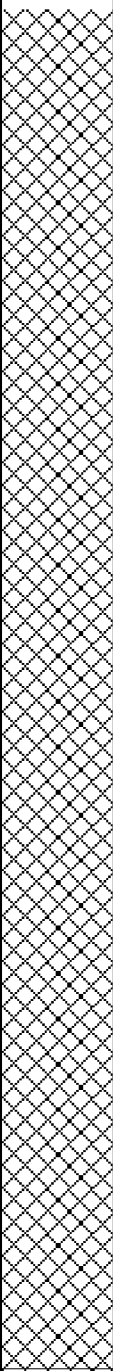
Comments:

Project No: C1296	Date: 27 Jan 2009	Easting: 270302.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195534.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.50 - 10.50m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9 10 11 12 13 14 15 16 17 18					MADE GROUND: Waste Tip Fill.			
					PEAT:	10.20		
					End of Borehole	10.50		

Comments:

Project No: C1296	Date: 29 Jan 2009	Easting: 270343.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195572.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 2.00 - 12.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste Tip Fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
Continued next sheet								

Comments:

Design and Construct Remediation

Date: 29 Jan 2009

Easting: 270343.000

Project No: C1296

Engineer: MS

Northing: 195572.000

Site Location: BP Former Llandarcy

Method: ODEX

Datum: -

Client: St. Modwen

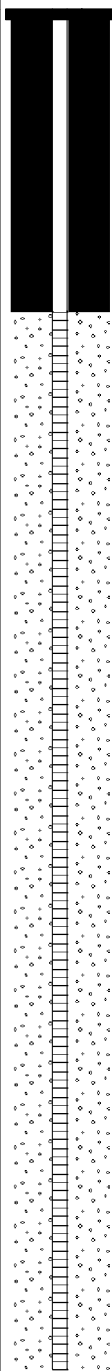
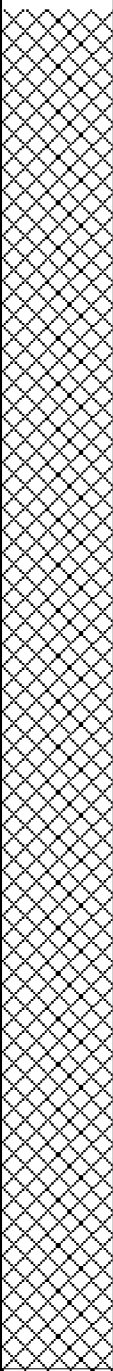
Hole Diameter: 200mm

Screen Position: 2.00 - 12.00m

[illegible]

Comments:

Project No: C1296	Date: 29 Jan 2009	Easting: 270362.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195572.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 2.00 - 12.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste tip Fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
Continued next sheet								

Comments:

Design and Construct Remediation

Date: 29 Jan 2009

Easting: 270362.000

Project No: C1296

Engineer: MS

Northing: 195572.000

Site Location: BP Former Llandarcy

Method: ODEX

Datum: -

Client: St. Modwen

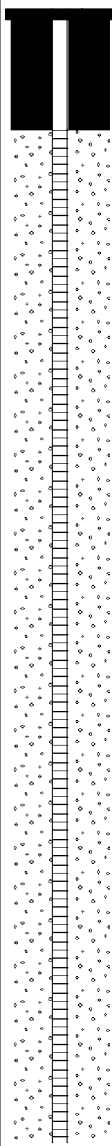
Hole Diameter: 200mm

Screen Position: 2.00 - 12.00m

[illegible]

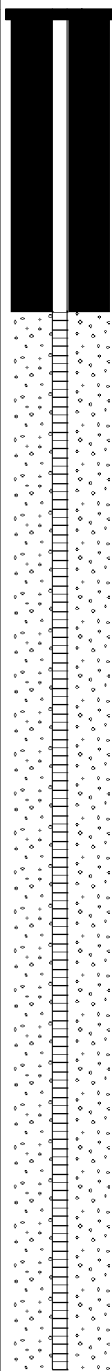
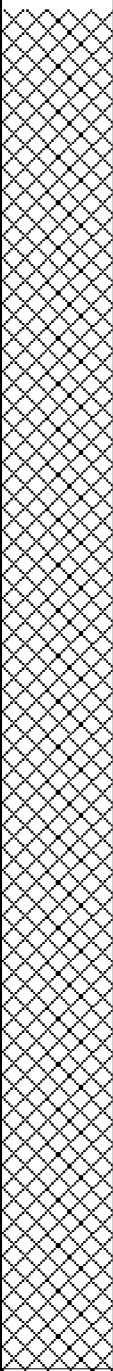
Comments:

Project No: C1296	Date: 27 Jan 2009	Easting: 270832.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195553.000
Client: St. Modwen	Method: CP	Datum: -
	Hole Diameter: 200mm	Screen Position: 0.80 - 7.50m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: mixture of compacted grey to black clay, gravels and cobbles (up to 10 cm)			
					MADE GROUND: Mixture of black ash, brick fragments, gravel and brown clay.	2.50		
					End of Borehole	7.50		

Comments:

Project No: C1296	Date: 6 Feb 2009	Easting: 270421.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195573.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 2.00 - 12.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste tip Fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
Continued next sheet								

Comments:

Design and Construct Remediation

Date: 6 Feb 2009

Easting: 270421.000

Project No: C1296

Engineer: MS

Northing: 195573.000

Site Location: BP Former Llandarcy

Method: ODEX

Datum: -

Client: St. Modwen

Hole Diameter: 200mm

Screen Position: 2.00 - 12.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9.00m					MADE GROUND: Waste tip Fill. End of Borehole	12.00		

Comments:

Design and Construct Remediation

Date: 30 Jan 2009

Easting: 270422.000

Project No: C1296

Engineer: MS

Northing: 195553.000

Site Location: BP Former Llandarcy

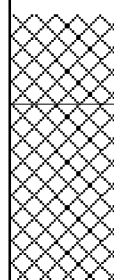
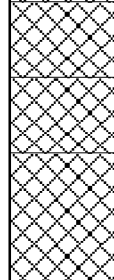
Method: CP

Datum: -

Client: St. Modwen

Hole Diameter: 200mm

Screen Position: 1.80 - 9.50m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE				
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)	
0					MADE GROUND: Brown gravelly clay	0.60			
1					MADE GROUND: Grey gravelly clay with bricks fragments				
2									
3									
4									
5					MADE GROUND: Brown gravelly clay with bricks fragments	3.50			
6	MADE GROUND: Concrete fragments	4.00							
7	MADE GROUND: Black clay with bricks and timbers fragments. Very hard object at the bottom of the hole	4.50							
8									
9									
					Continued next sheet				

Comments:

Design and Construct Remediation

Date: 30 Jan 2009

Easting: 270422.000

Project No: C1296

Engineer: MS

Northing: 195553.000

Site Location: BP Former Llandarcy

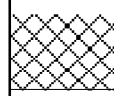
Method: CP

Datum: -

Client: St. Modwen

Hole Diameter: 200mm

Screen Position: 1.80 - 9.50m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					MADE GROUND: Black clay with bricks and timbers fragments. Very hard object at the bottom of the hole	9.50		
					End of Borehole			
10								
11								
12								
13								
14								
15								
16								
17								
18								

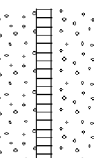
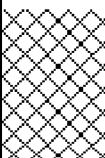
Comments:

Project No: C1296	Date: 30 Jan 2009	Easting: 270422.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195533.000
Client: St. Modwen	Method: CP	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.80 - 10.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Clay with bricks and concrete fragments			
					MADE GROUND: Soft grey to brown clay with bricks fragments	2.30		
					MADE GROUND: Clayay peat with ash, bricks, steel and timbers fragments.	8.30		
					Continued next sheet			

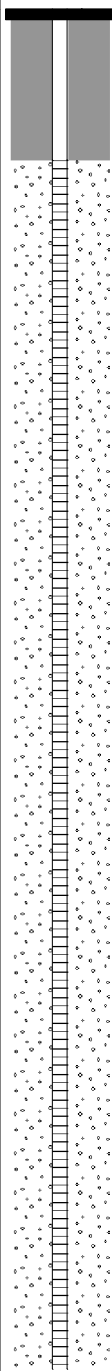
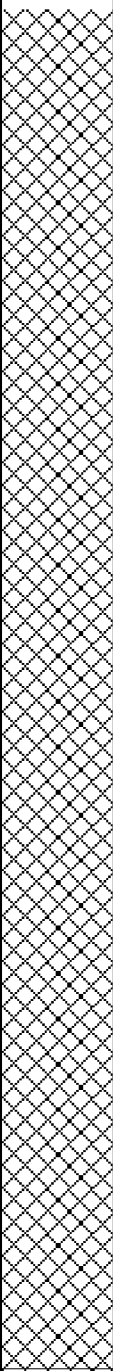
Comments:

Project No: C1296	Date: 30 Jan 2009	Easting: 270422.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195533.000
Client: St. Modwen	Method: CP	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.80 - 10.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					MADE GROUND: Clayay peat with ash, bricks, steel and timbers fragments.	10.00		
10					End of Borehole			
11								
12								
13								
14								
15								
16								
17								
18								

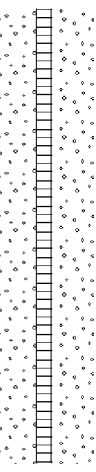
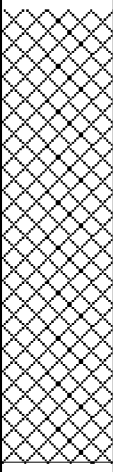
Comments:

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Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195595.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 12.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste tip Fill.			
					Continued next sheet			

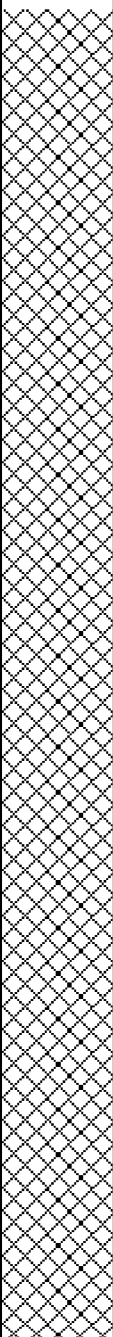
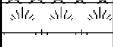
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Project No: C1296	Date: 4 Feb 0009	Easting: 270442.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195595.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 12.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					MADE GROUND: Waste tip Fill.			
10								
11								
12								
13								
14								
15								
16								
17								
18								
					End of Borehole	12.00		

Comments:

Project No: C1296	Date: 23 Jul 2009	Easting: 270394.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195502.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 9.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste Tip fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9						8.80		
Continued next sheet								

Comments:

Project No: C1296	Date: 23 Jul 2009	Easting: 270394.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195502.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 9.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					PEAT: End of Borehole	9.00		
10								
11								
12								
13								
14								
15								
16								
17								
18								

Comments:

Design and Construct Remediation

Date: 23 Jul 2009

Easting: 270415.000

Project No: C1296

Engineer: MS

Northing: 195501.000

Site Location: BP Former Llandarcy

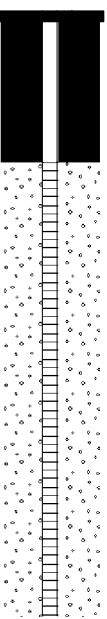
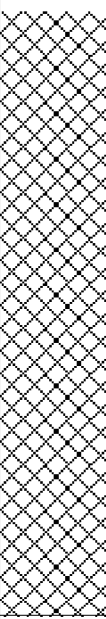
Method: ODEX

Datum: -

Client: St. Modwen

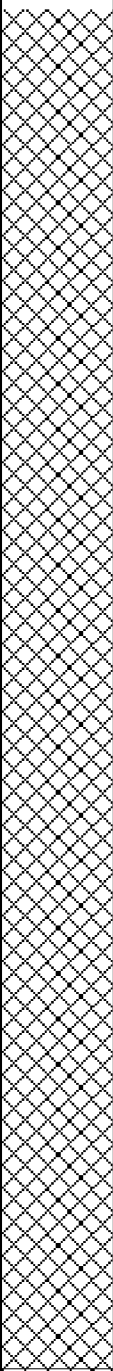
Hole Diameter: 200mm

Screen Position: 1.00 - 4.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
0					MADE GROUND: Waste tip Fill. Obstruction at 4 metres	4.00		
1								
2								
3								
4					End of Borehole			
5								
6								
7								
8								
9								

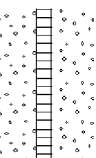
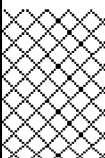
Comments:

Project No: C1296	Date: 22 Jul 2009	Easting: 270393.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195523.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 10.00m

WATER		WELL		SAMPLING/TESTING		SUBSURFACE PROFILE		
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste Tip fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
Continued next sheet								

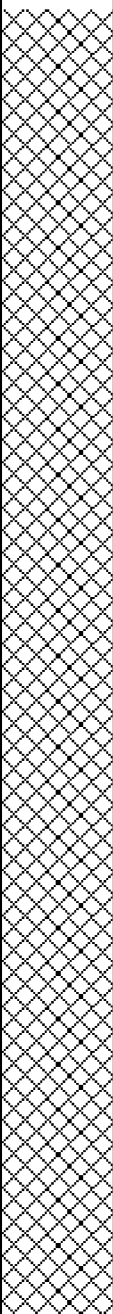
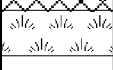
Comments:

Project No: C1296	Date: 22 Jul 2009	Easting: 270393.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195523.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 10.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					MADE GROUND: Waste Tip fill.			
10					End of Borehole	10.00		
11								
12								
13								
14								
15								
16								
17								
18								

Comments:

Project No: C1296	Date: 22 Jul 2009	Easting: 270415.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195525.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 9.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste Tip fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9						8.70		
Continued next sheet								

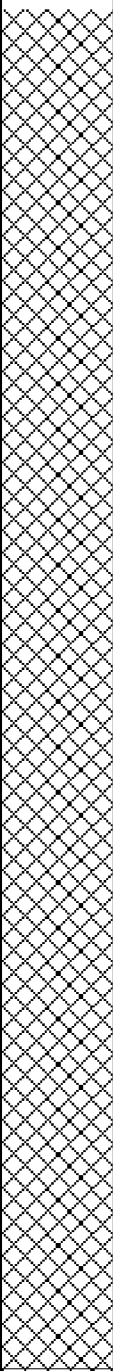
Comments:

Project No: C1296	Date: 22 Jul 2009	Easting: 270415.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195525.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 9.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					PEAT: End of Borehole	9.00		
10								
11								
12								
13								
14								
15								
16								
17								
18								

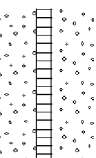
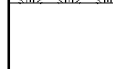
Comments:

Project No: C1296	Date: 24 Jul 2009	Easting: 270410.000
Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195585.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 10.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
					MADE GROUND: Waste Tip fill.			
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
Continued next sheet								

Comments:

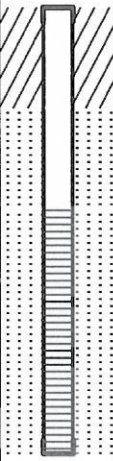
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Site Location: BP Former Llandarcy	Engineer: MS	Northing: 195585.000
Client: St. Modwen	Method: ODEX	Datum: -
	Hole Diameter: 200mm	Screen Position: 1.00 - 10.00m

WATER	WELL	SAMPLING/TESTING			SUBSURFACE PROFILE			
Water Strike	Well Data	N Value	Sample Type	Sample Ref	DESCRIPTION OF STRATA	Depth (m bgl)	Legend	Level (m AOD)
9					MADE GROUND: Waste Tip fill.			
					PEAT:	9.60		
					End of Borehole	10.00		
10								
11								
12								
13								
14								
15								
16								
17								
18								

Comments:

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: CARW008		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/01/01		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : ~100mm	
							LOGGED BY : URS		SCREEN TYPE & DIAM: UPVC 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0		DESCRIPTION	COMMENTS	0.0	
					0.5		Loose, black, sandy, fine GRAVEL comprising Ash. MADE GROUND	Dry, NVO		
			*47.6		0.5		Sticky, black sandy GRAVEL, some grease. (MADE GROUND)	Sticky product. Mod odour	0.5	
			*37.4		1.0		As above but fine-medium GRAVEL. (MADE GROUND)	Damp from 0.85m, wet from 1.0m. Mod odour	1.0	
					1.5				1.5	
			*237		2.0				2.0	
					2.5		Soft, brown, silty CLAY	Dry, NVC, slight odour	2.5	
			*3.5		3.0		Soft, very light brown CLAY. Drilled to 3.0m, collapsed to 2.0m	Dry-moist. NVO	3.0	
					3.5		End of Borehole		3.5	
					4.0				4.0	
				4.5				4.5		
				5.0				5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Containment Area Investigation Location: Llandarcy Refinery Client: BP Llandarcy Refinery URS App'd: _____ Date: 05/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG	

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: CARW034		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 20/06/01		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : ~100mm	
							LOGGED BY : NL		SCREEN TYPE & DIAM: UPVC 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0		DESCRIPTION		COMMENTS	0.0
					0.5		Soft, brown, silty PEAT		Strong odour	0.5
					1.0	SAMPLE LOST DUE TO HIGH WATER CONTENT		1.0		
					1.5		Mottled orange/grey sandy SILT with some clay and occasional gravel.		Sheen and odour. Some free phase product. Heavy staining throughout.	1.5
					2.0	Gravel concentration increasing with depth, resulting in harder drilling.		2.0		
				2.5		End of Borehole			2.5	
					3.0					3.0
					3.5					3.5
					4.0					4.0
					4.5					4.5
					5.0					5.0
					5.5					5.5
					6.0					6.0

LOCATION / NOTES: NVO = No visual or olfactory evidence	LEGEND  Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	BOREHOLE LOG Job Title: Containment Area Investigation Location: Llandarcy Refinery Client: BP Llandarcy Refinery	
			App'd: _____ Date: 04/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW27d		PAGE 1 of 2	
	NUMBER	TYPE					START DATE: 05/06/98		DRILLING METHOD: Cable Percussion	
							FINISH DATE: 08/06/98		BOREHOLE DIAMETER: 200/150mm	
							DRILLER: CP1		SCREEN TYPE & DIAMETER: HDPE 50mm	
							LOGGED BY: SG APPRD BY:		SCREEN SLOT SIZE: 0.5mm	
						DESCRIPTION	COMMENTS			
						0	Loose red-brown and grey COBBLES with sand and fine to coarse gravel with some concrete (MADE GROUND)	Moderate hydrocarbon odour	0	
						1.0	Loose black / dark brown coarse SAND with ash, clinker, burnt coal and brick (MADE GROUND)		1.0	
						2.0	becoming coarse sand and gravel at 2.5m		2.0	
						3.0			3.0	
						4.0	blowing ash at 4m		4.0	
						5.0			5.0	
						6.0			6.0	
						7.0			7.0	
						8.0			8.0	
						9.0	Spongy light yellow-brown PEAT	No odour	9.0	
10	becomes dark brown at 9.7 mbgl	No odour	10							

LOCATION / NOTES: 1. All measurements in m below ground level (mbgl) 2. Water strike at 2.0m		LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	<table border="1"> <tr> <th colspan="2">BOREHOLE LOG</th> </tr> <tr> <td>Job Title</td> <td>SOIL & GROUNDWATER INVESTIGATION</td> </tr> <tr> <td>Location</td> <td>LLANDARCY REFINERY</td> </tr> <tr> <td>Client</td> <td>BP LLANDARCY</td> </tr> <tr> <td>App'd</td> <td>DRAFT</td> </tr> <tr> <td>Ref.</td> <td>MC/CR/BR5</td> </tr> <tr> <td>Date</td> <td>JUL 98</td> </tr> <tr> <td>Job No.</td> <td>39991-001-401</td> </tr> </table> DAMES & MOORE GROUP	BOREHOLE LOG		Job Title	SOIL & GROUNDWATER INVESTIGATION	Location	LLANDARCY REFINERY	Client	BP LLANDARCY	App'd	DRAFT	Ref.	MC/CR/BR5	Date	JUL 98	Job No.	39991-001-401
BOREHOLE LOG																			
Job Title	SOIL & GROUNDWATER INVESTIGATION																		
Location	LLANDARCY REFINERY																		
Client	BP LLANDARCY																		
App'd	DRAFT																		
Ref.	MC/CR/BR5																		
Date	JUL 98																		
Job No.	39991-001-401																		

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW27d		PAGE 2 of 2	
	NUMBER	TYPE					START DATE: 05/06/98		DRILLING METHOD: Cable Percussion	
							FINISH DATE: 08/06/98		BOREHOLE DIAMETER: 200/150mm	
							DRILLER: CP1		SCREEN TYPE & DIAMETER: HDPE 50mm	
							LOGGED BY: SG APPD BY:		SCREEN SLOT SIZE: 0.5mm	
							DESCRIPTION	COMMENTS		
					10		Spongy dark brown PEAT	No dour	10	
					11		Soft grey-brown slightly silty and sandy CLAY	No odour	11	
							Soft to very soft light grey silty and sandy CLAY	No odour		
					12		Dense blue-grey GRAVEL with fragments of angular blue-grey medium grained sandstone	No odour	12	
					13		Borehole terminated at 12.5 mbgl		13	
					14				14	
					15				15	
					16				16	
					17				17	
					18				18	
					19				19	
					20				20	

LOCATION / NOTES: 1. All measurements in m below ground level (mbgl) 2. 200mm casing sealed and bentonited and boring reduced to 150 mm at 11.5 mbgl		LEGEND ☒ Disturbed Sample ☐ Undisturbed Sample ☐ Headspace Analysis ☐ Down Borehole Analysis ☐ Groundwater Table ☐ Perched Water Table		BOREHOLE LOG Job Title SOIL & GROUNDWATER INVESTIGATION Location LLANDARCY REFINERY Client BP LLANDARCY Appd DRAFT Ref. MC/CR/BR Date JUL 98 Job No. 39991-001-401  DAMES & MOORE GROUP	
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Appendix C - URS groundwater drawings



LEGEND

- Shallow Wells (Typically 10m to 15m deep)
- Deep Wells (Typically 20m to 30m deep)
- Interpolated Groundwater Contours (Typically 1m Contour Interval)
- Test

Contours based on groundwater elevation C data collected in September 2003

REVISE	DATE	CHK	APPD
1 - INITIAL DRAFT	MAY 04	SS	

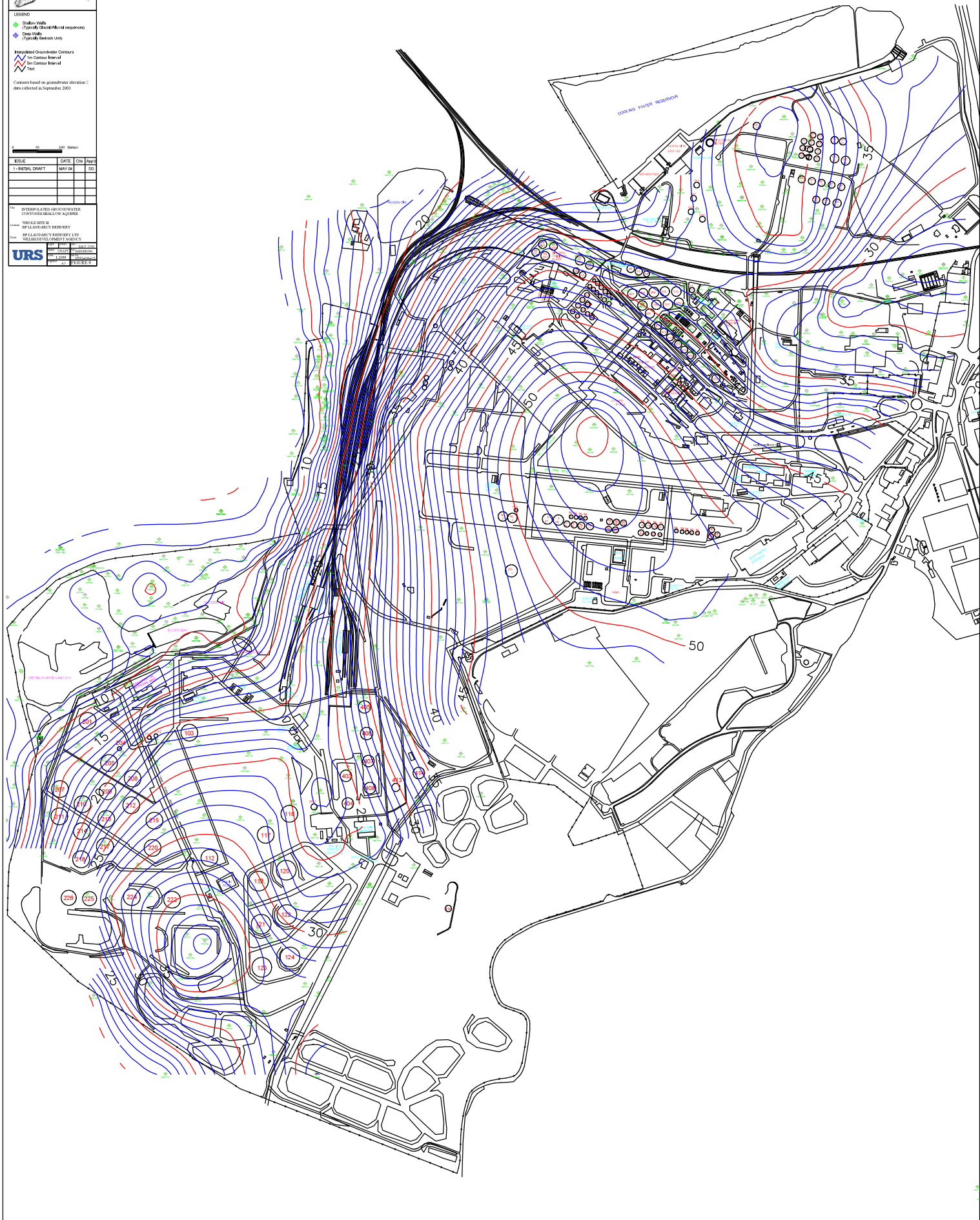
INTERPOLATED GROUNDWATER CONTOUR MAP FOR THE SITE

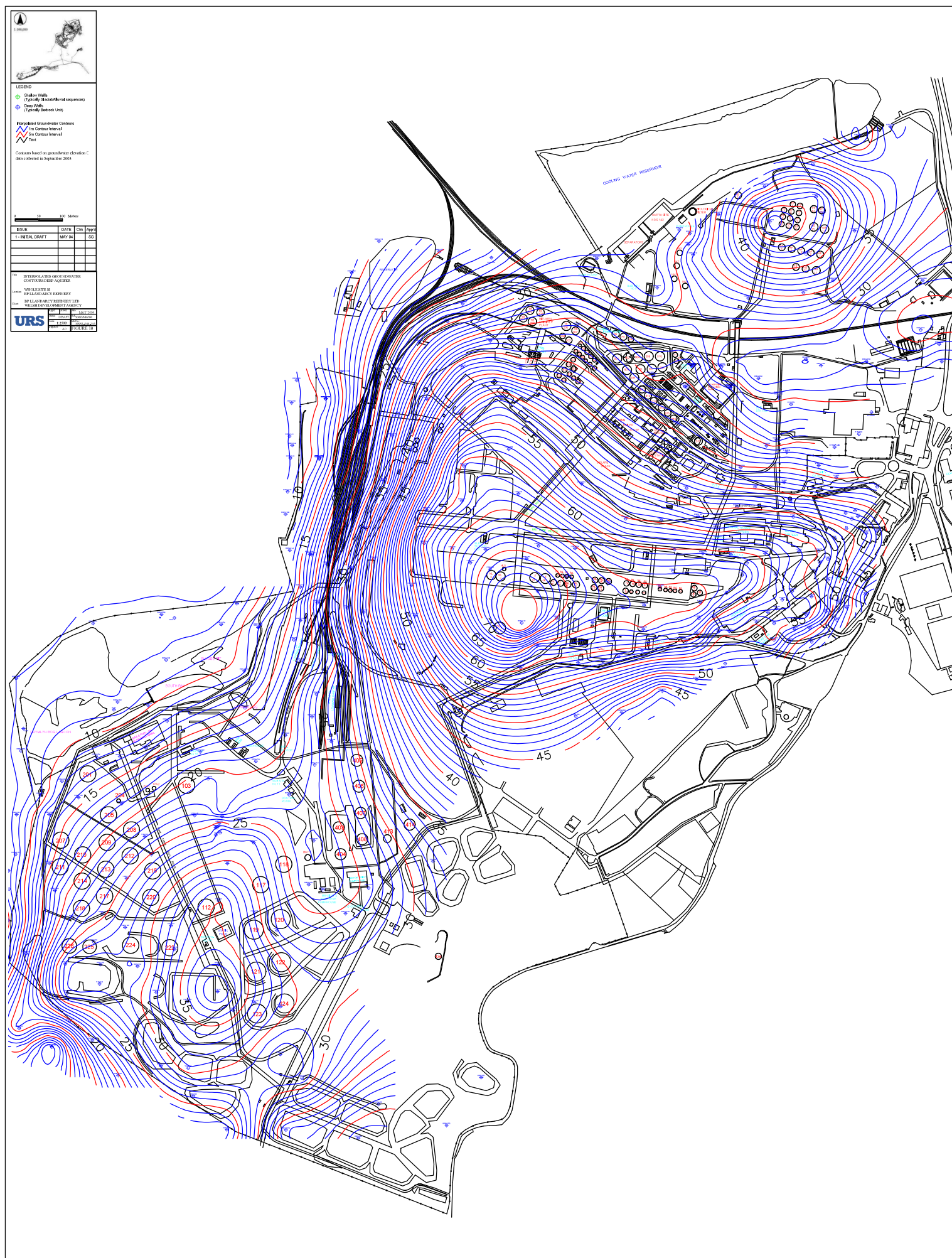
WELL SITE IS

OF LANDSCAPE RECOVERY LTD

WELL SITE IS

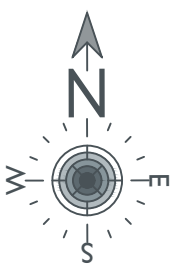
URS







Appendix D - NAPL thickness and distribution



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

KEY

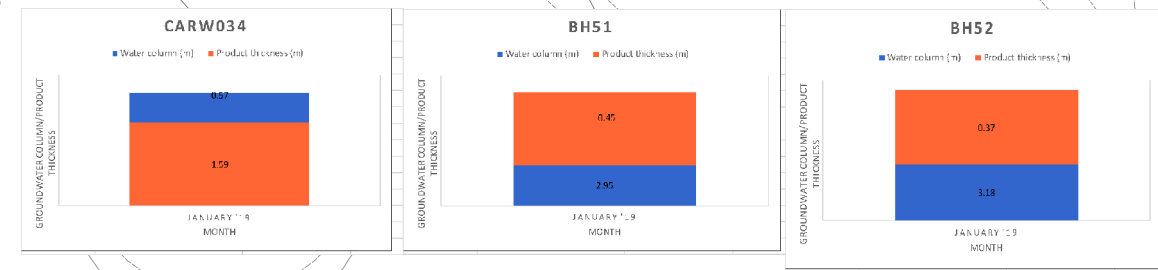
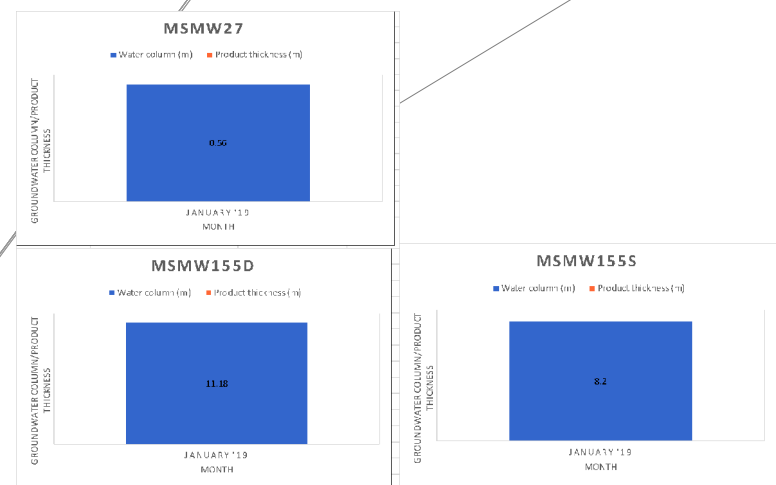
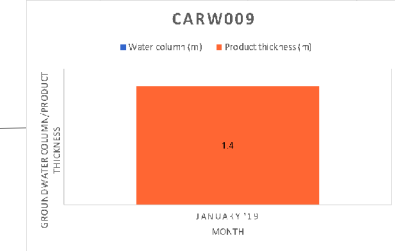
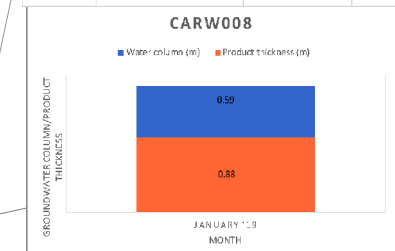
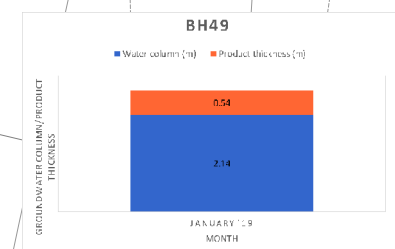
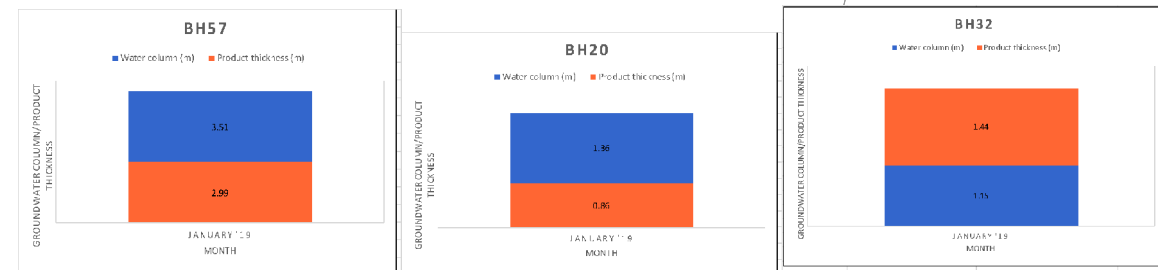
Permit area

SW1 Surface water sampling locations

Groundwater monitoring/sampling locations

Sump locations

Collection point



REV	DATE	REVISION NOTE	BY
1	15/01/24	Initial design	JP
2	15/01/25	Final design	JP

CLIENT
St Modwen Development Ltd

PROJECT
Coed Darcy

DRAWING TITLE
Crymlyn Tip
Monitoring Location Plan
January

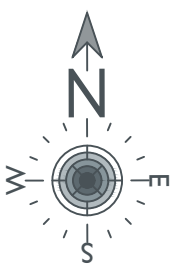
DRAWING ISSUE STATUS
INFORMATION

PJA JOB No: SUB CODE DRAWING NO: REVISION
04020 - A - SK205 - P0

Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction
BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE
AI@1:1000 JP LC 03.02.20

Crymlyn Tip Monitoring Location Plan January 2025



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

KEY

Permit area

SW1 Surface water sampling locations

Groundwater monitoring/sampling locations

Sump locations

CP7 Collection point

Compound fence

SOUTH BAY

Oil Refinery

Crymlyn Bog

Reservoir

SW6

SW4

SW5

SW2

SW1

CP1

CP3

CP2

CP5

CP4

CP6

CP7

CP8

CP9

CP10

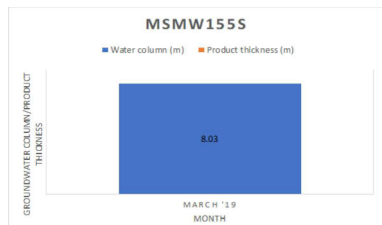
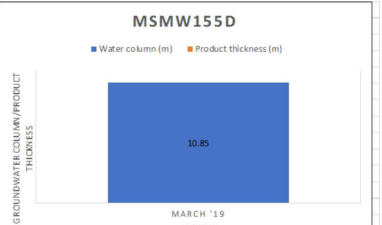
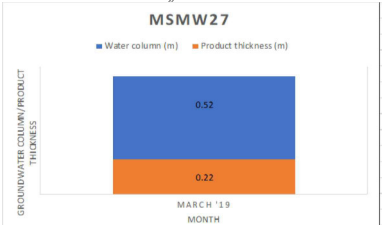
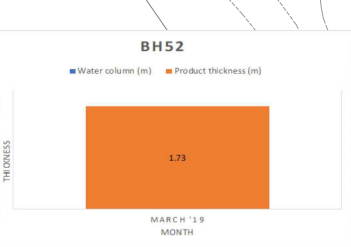
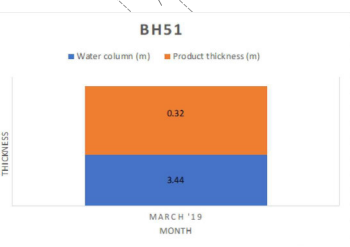
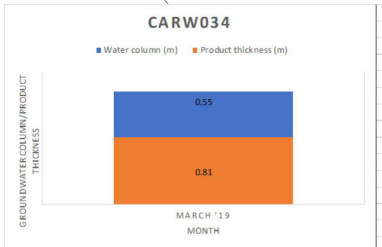
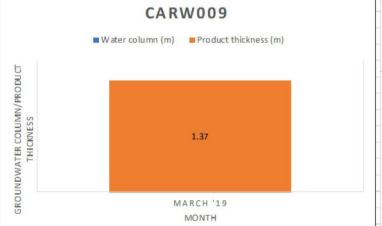
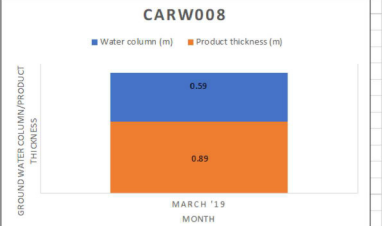
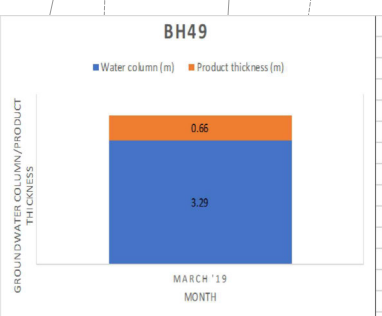
SW3

MSMW155 D and S

MSMW155

MSMW155D

MSMW27



REV	DATE	REVISION NOTE	BY
1	2023-02-03	Issue for information	JP

PJA

CLIENT

St Modwen Development Ltd

PROJECT

Coed Darcy

DRAWING TITLE

Crymlyn Tip

Monitoring Location Plan

March

DRAWING ISSUE STATUS

INFORMATION

PJA/JOB No: SUB-CODE DRAWING NO: REVISION

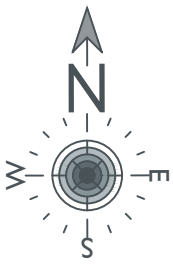
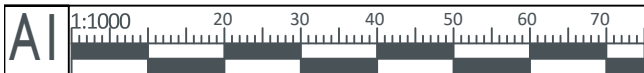
04020 - A - SK206 - P0

Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction

BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE

A1@1:1000 JP LC 03.02.20



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

KEY

Permit area

SW1 Surface water sampling locations

Groundwater monitoring/sampling locations

Sump locations

CP7 Collection point

Compound fence

SOUTH BAY

Oil Refinery

Crymlyn Bog

REV DATE REVISION NOTE BY

PJA

CLIENT

St Modwen Development Ltd

PROJECT

Coed Darcy

DRAWING TITLE

Crymlyn Tip
Monitoring Location Plan
June

DRAWING ISSUE STATUS

INFORMATION

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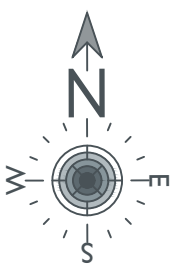
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Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction

BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE

A1@1:1000 JP LC 04.02.20



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

KEY

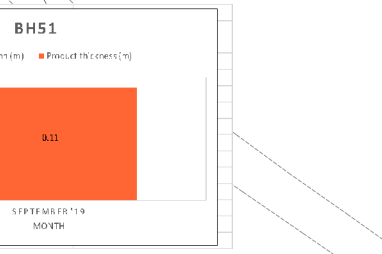
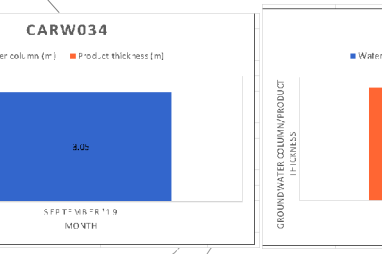
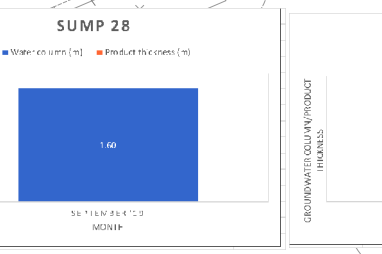
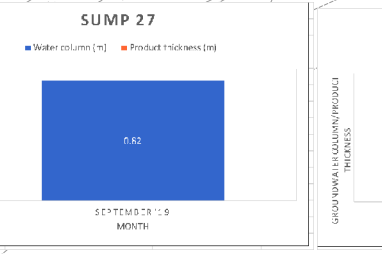
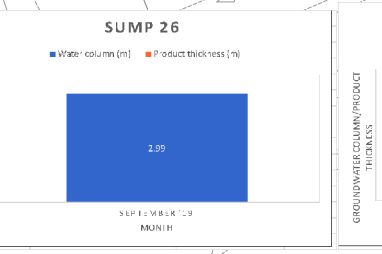
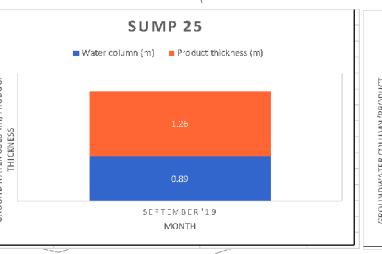
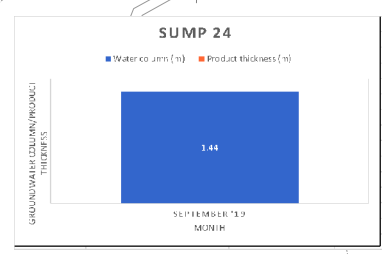
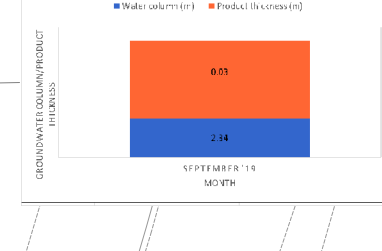
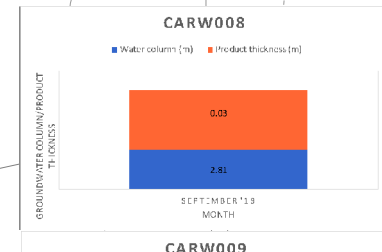
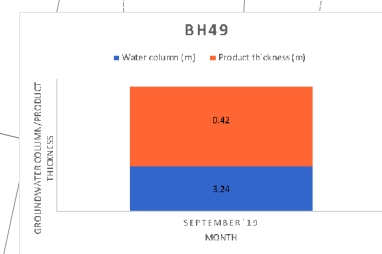
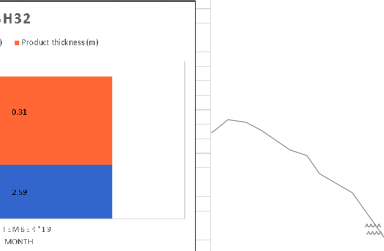
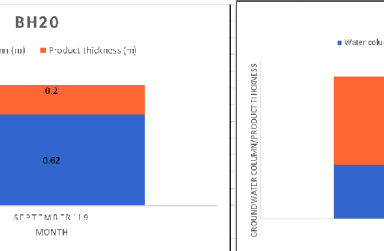
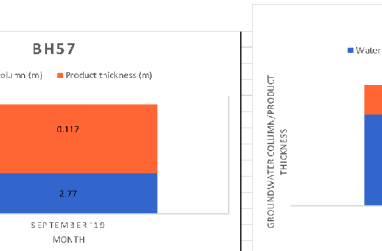
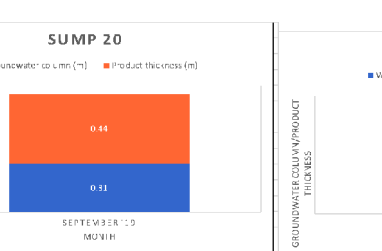
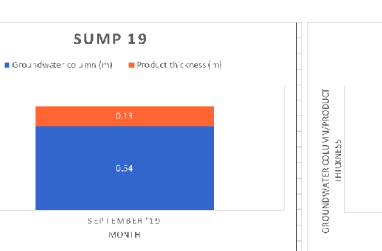
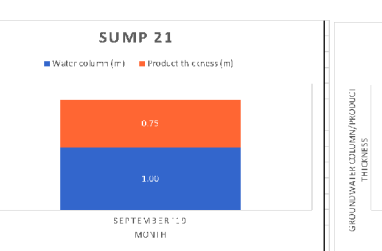
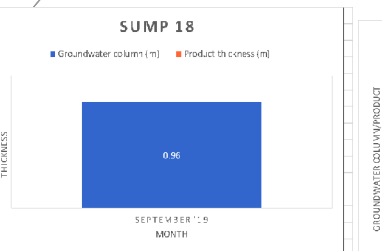
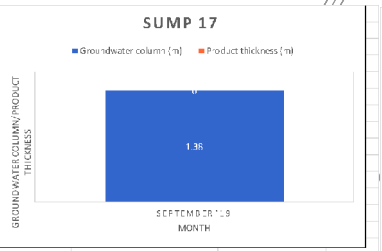
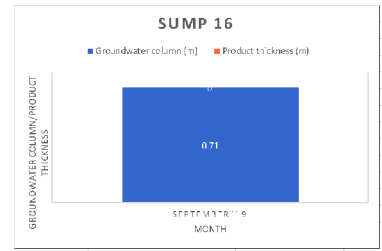
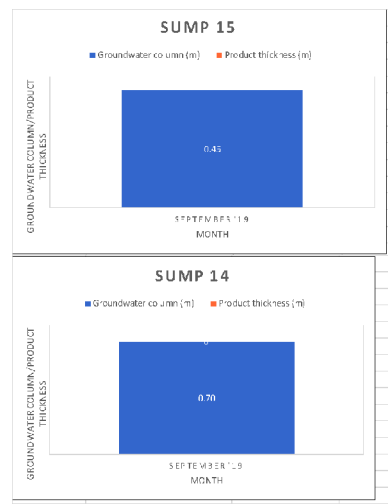
Permit area

SW1 Surface water sampling locations

Groundwater monitoring/sampling locations

Sump locations

Collection point



Crymlyn Bog

Oil Refinery

REV	DATE	REVISION NOTE	BY
1	04.02.20	Issue for information	JP

CLIENT
PJA

PROJECT
St Modwen Development Ltd

Coed Darcy

DRAWING TITLE
**Crymlyn Tip
Monitoring Location Plan
September**

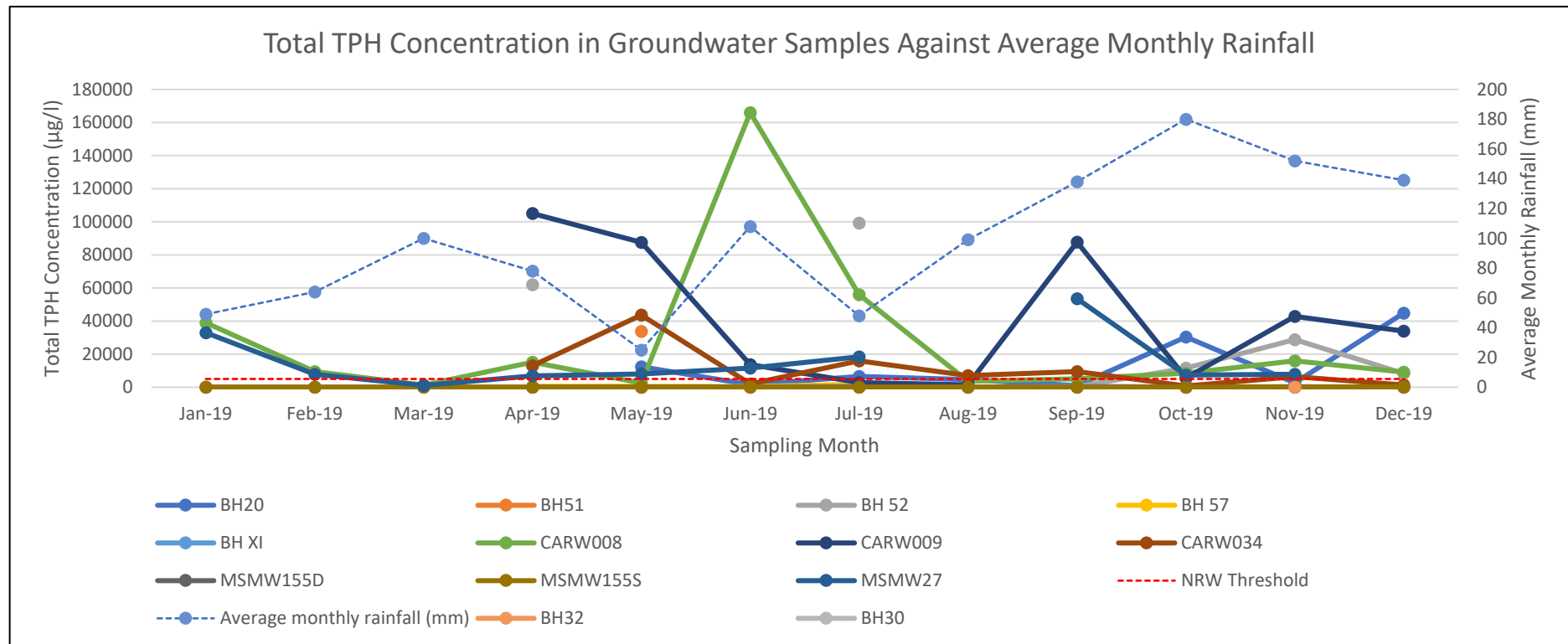
DRAWING ISSUE STATUS
INFORMATION
PJA/JOB No: SUB-CODE DRAWING NO. REVISION
04020 - A - SK208 - P0
Revision Letter: P - Prelim / A - Approval / T - Tender / C - Construction
BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE
AI@1:1000 JP LC 04.02.20

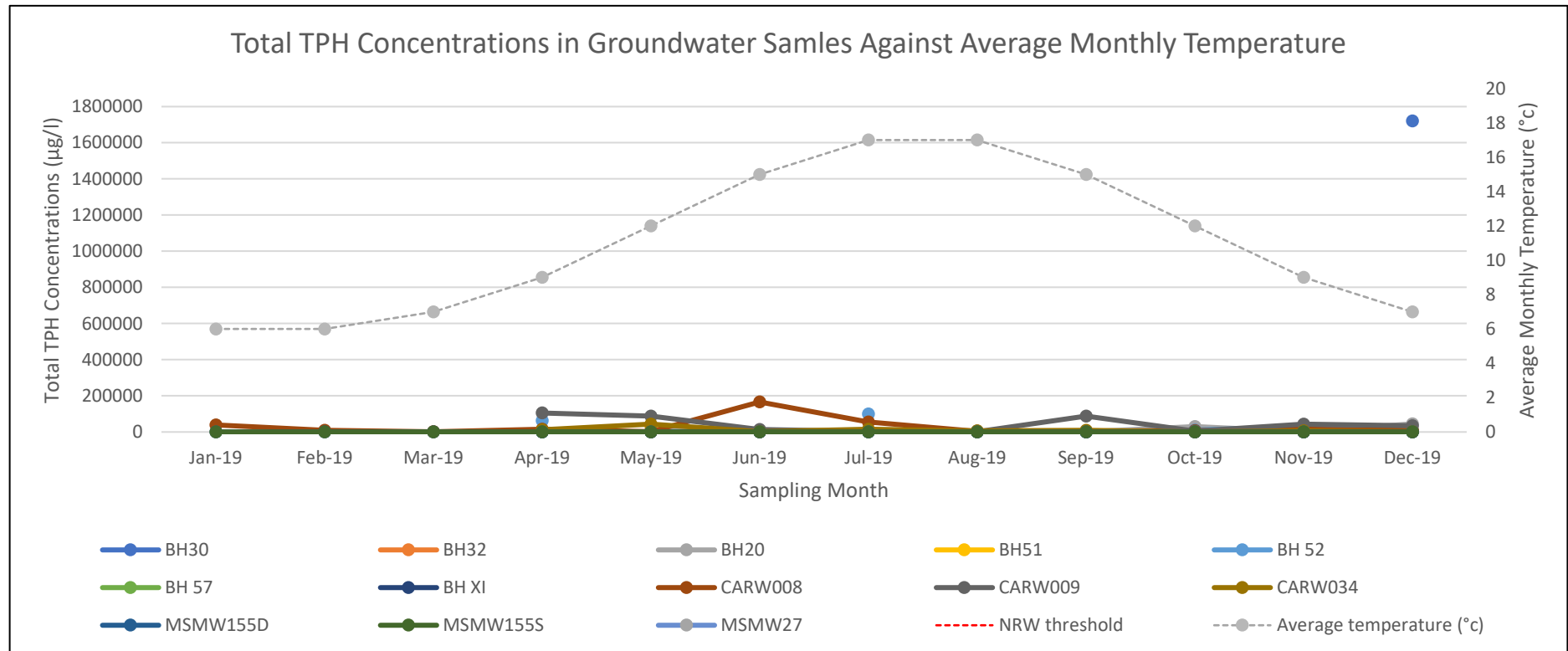


Appendix E - Groundwater & Surface Water Laboratory Results

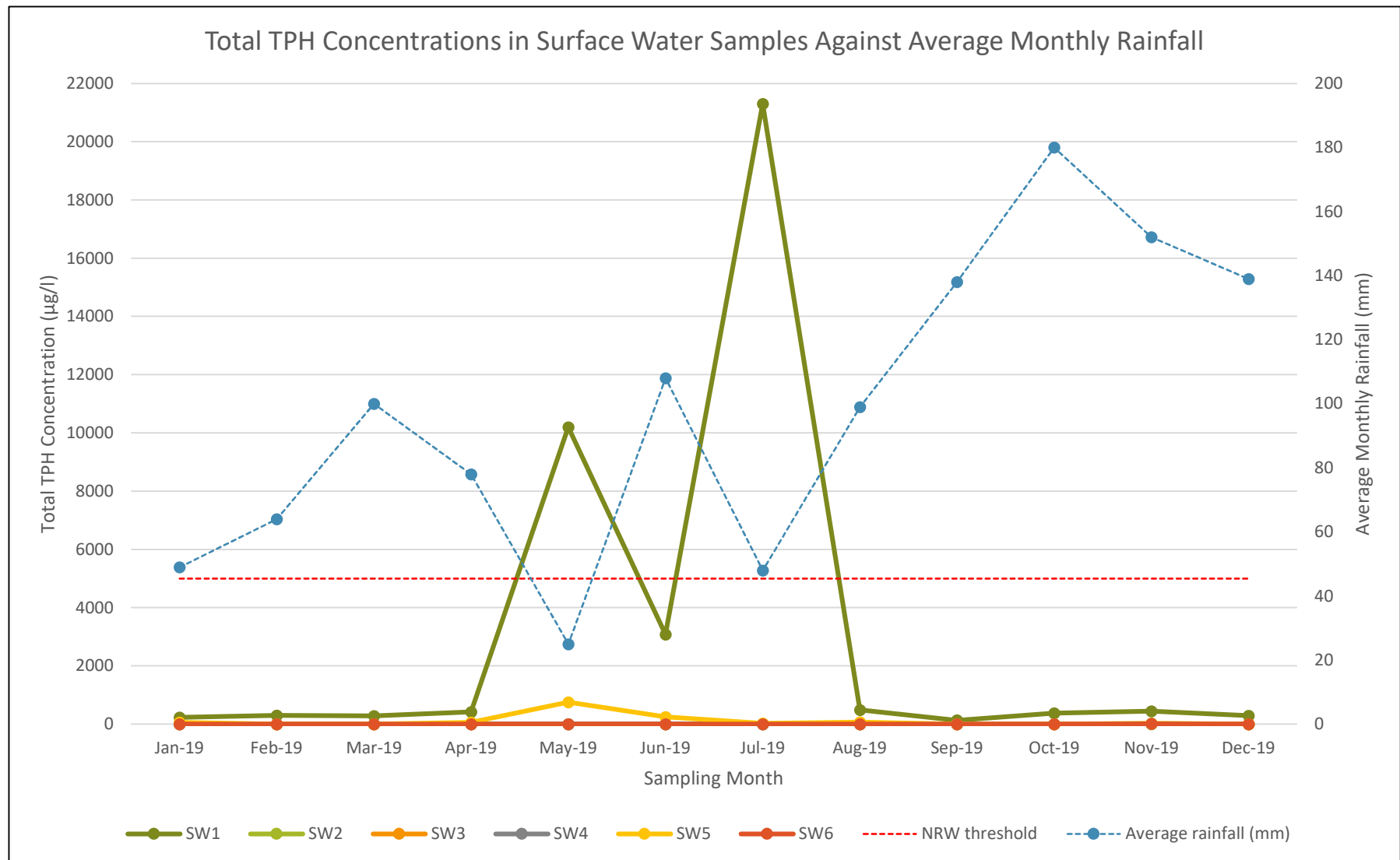
Graph 1



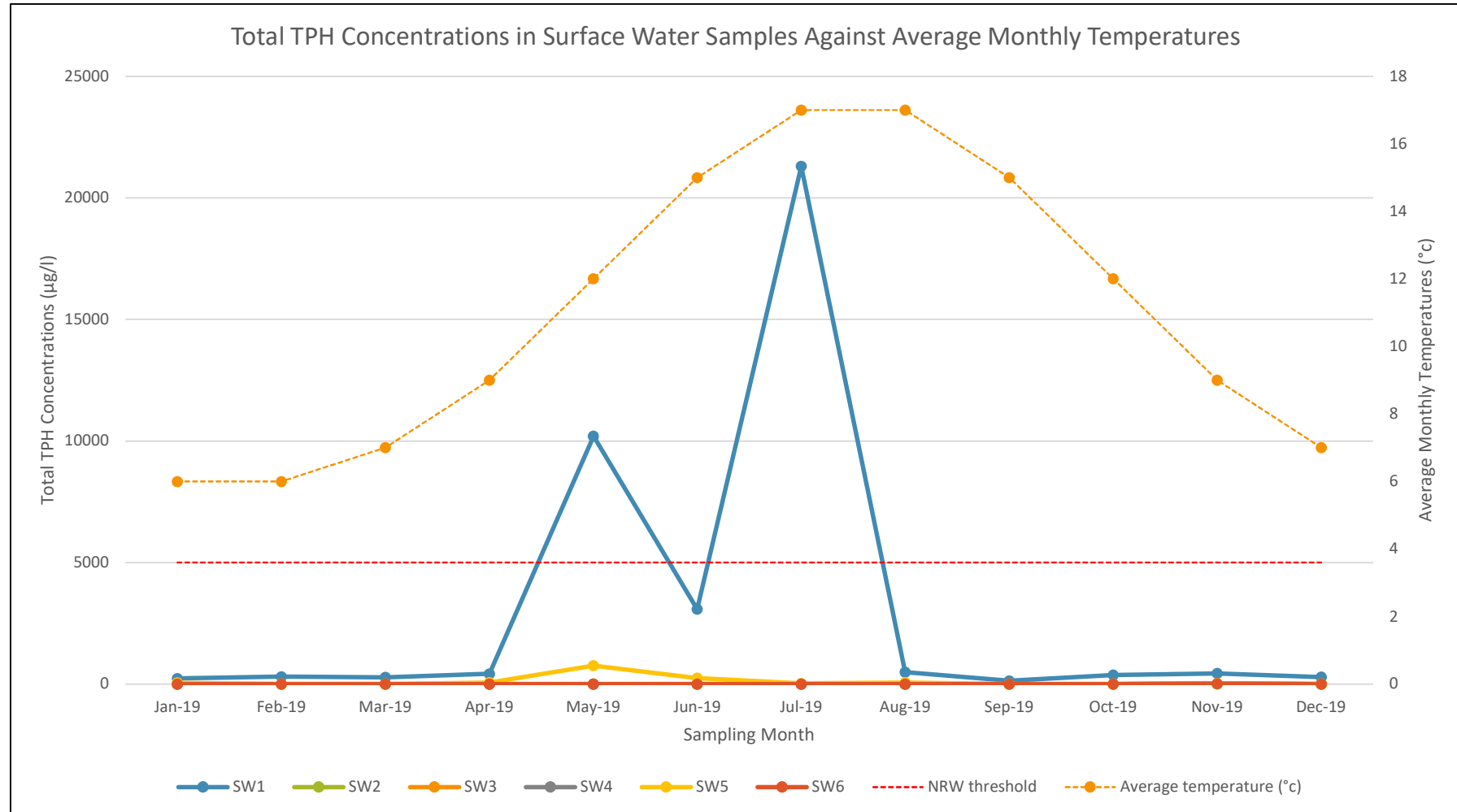
Graph 2



GRAPH 3

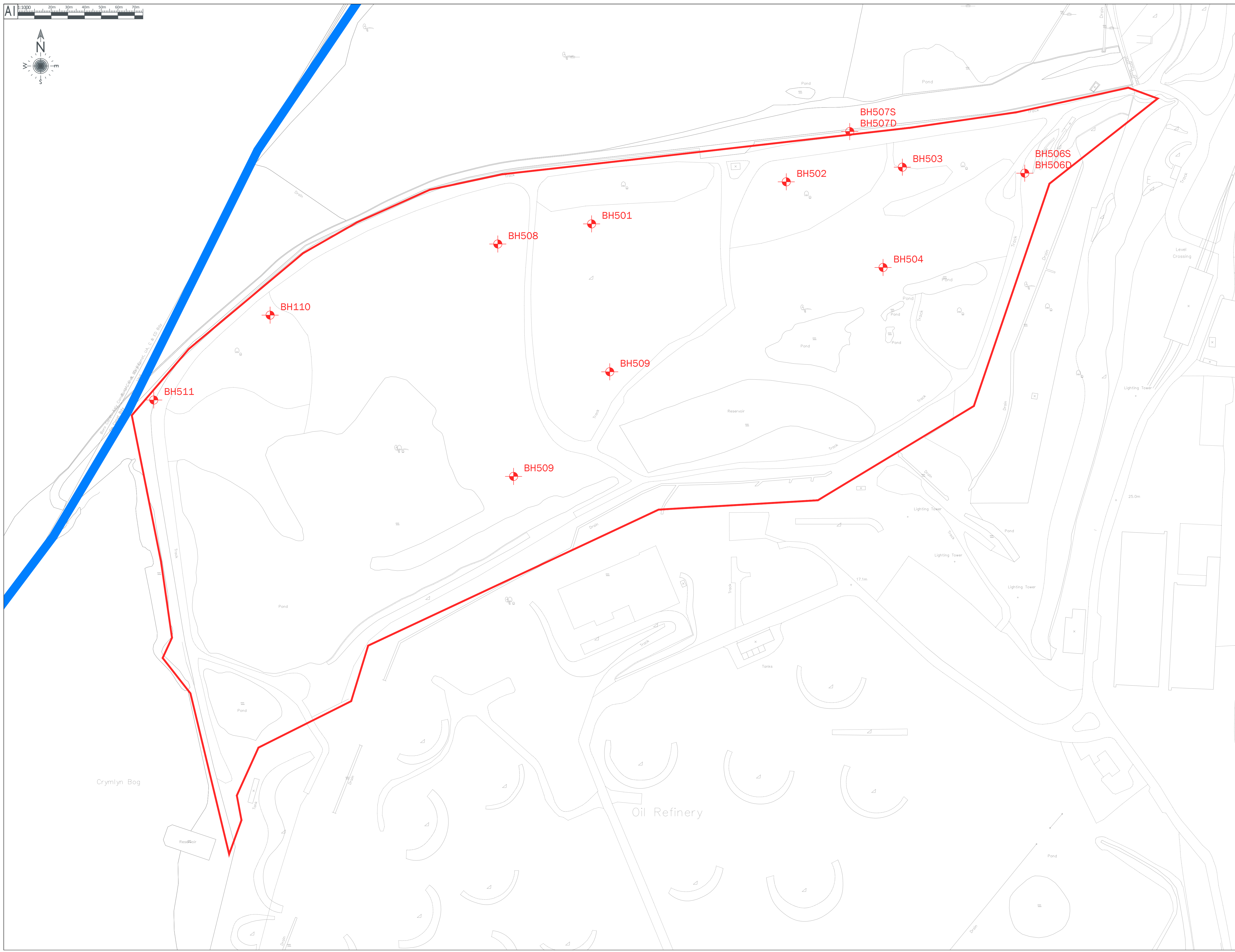


GRAPH 4





Appendix F - Proposed Borehole Location Plan



These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

 Site Ownership Boundary
 Environmental permit boundary
 Proposed boreholes

f			

REV	DATE	REVISION NOTE	BY
		 Seven House - High Street Longbridge - Birmingham B31 2UQ - Tel: 0121 475 0234 Birmingham - Bristol Exeter - London - Reading pja.co.uk	

St Modwen Development Ltd

PROJECT

Coed Darcy

DRAWING TITLE

Proposed boreholes

INFORMATION

PJA JOB No.	SUB-CODE	DRAWING NO.	REVISION
04020	- A -	1006	- P0

Revision Letter : P - Prelim / A - Approval / T - Tender / C - Construction

SCALE	DRAWN	REVIEWED	DATE
AI@1:1000	JP	LC	23.10.19