

Technical Note

To:	Cyfoeth Naturiol Cymru – Natural Resources Wales	
From:	May Chan / Richard Mitchener	Atkins Limited
Date:	Aug 2015	
Ref:	5041216-RAP-MEMO-0001399	
Subject:	Coed Darcy Crymlyn Tip Gas Monitoring Audit	

1. Introduction

1.1. Background

An environmental permit (EPR/AP3990LR/V002) is held by St. Modwen Developments Ltd (SMD) for the Crymlyn Tip in Coed Darcy, Llandarcy, Neath. The permit boundary and the approximate area of historical landfill are shown on Drawings 5041216-RAP-DWG-1906 and 1907. The deposition of waste before 1974 was unknown but the landfill was licenced to accept refinery wastes including demolition materials, asbestos, boiler cleanings, oily sludge, bitumen, waxes and pyrophoric materials between 1974 and 1999. The approximate distribution of the various waste types within the landfilled area is shown on Drawing 5041216-RAP-DWG-1907. The landfill ceased accepting landfill materials in 1999 and the former Environment Agency Wales recorded the site as closed in July 2001. (Ref. 1, ESID, Section 2.1)

An Environmental Setting & Installation Design (ESID) Report¹ and a Landfill Gas Risk Assessment & Gas Management Plan (LfGRA)² were submitted to Cyfoeth Naturiol Cymru – Natural Resources Wales (CNC-NRW, formerly Environment Agency Wales) in June 2013 for compliance with the permit. These previous ESID and LfGRA provided a conceptual site model and reviewed the ground gas monitoring data between October 2010 and May 2013.

CNC-NRW provided some interim comments related to gas monitoring in a letter and a Compliance Assessment Report in October 2013, and a meeting was held between CNC-NRW and Atkins on 30 January 2014 to discuss the Crymlyn Tip including the issues related to gas monitoring. (The CNC-NRW/Atkins correspondence and meeting minutes are included in Appendix A)

1.2. Environmental Assessment Levels (EALs)

The Environmental Assessment Levels (EALs) for methane and carbon dioxide used to screen ground gas monitoring data in the previous ESID and LfGRA are summarised in Table 1. These are default limits stated in the Environment Agency's Guidance on the Management of Landfill Gas 2004³ and do not take account of the setting of the site within an extensive area of peat deposits.

Table 1. Summary of Environmental Assessment Levels

Emission	EAL (% v/v)	
	Lower level	Higher level
Methane	0.5%	1.0%
Carbon Dioxide	1.0%	1.5%

¹ Atkins Ltd, June 2013. Coed Darcy, Environmental Setting & Installation Design (ESID) Report. Prepared for St Modwen Developments Ltd.

² Atkins Ltd, June 2013. Crymlyn Tip, Coed Darcy, Llandarcy, Landfill Gas Risk Assessment & Gas Management Plan. Prepared for St Modwen Developments Ltd.

³Environment Agency., 2004. Guidance on the management of landfill gas. Bristol: The Environment Agency.

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1.3. Previous Gas Monitoring Data

The previous ESID and LfGRA reviewed the ground gas monitoring data gathered between October 2010 and May 2013 by screening them against the EALs for methane (1% v/v) and carbon dioxide (1.5% v/v) stated in Section 1.2. These previous gas monitoring data, highlighting exceedances of the EALs, are included in Appendix B.

Gas monitoring was undertaken between October 2010 and May 2013 to determine the following parameters. However, no screening levels have been established for the other parameters.

- Methane – peak concentration as %v/v;
- Carbon Dioxide – peak concentration as %v/v;
- Oxygen – peak concentration as %v/v;
- Carbon Monoxide in ppm;
- Hydrogen sulphide in ppm;
- Relative Pressure;
- Flow in the borehole in l/ hr;
- Atmospheric Pressure in atm; and
- Observations, e.g. weather conditions or conditions of the monitoring installations.

The following conclusions were derived and reported in the previous LfGRA:

- The landfilled area is actively producing carbon dioxide and methane, thought to be from the degradation of waste.
- Several monitoring boreholes installed in the peat deposits and located in the non-landfilled area to the west of the landfill, exhibited similar trends of elevated gas concentrations. This could potentially be linked to the peat deposits and also potentially to hydrocarbons associated with historical oil spillage from the former Southern Tank Farm.
- There is little evidence to suggest that gas migration from the waste mass is occurring or is responsible for elevated concentrations detected away from the landfilled area.

1.4. Objectives

Atkins Limited (Atkins) has been commissioned by the permit holder, St. Modwen Developments (SMD), to prepare this Gas Monitoring Audit for the following objectives:

- To review the ground gas data collected after the submission of the previous ESID and LfGRA in 2013, i.e. the recent data between Oct 2013 and May 2014;
- To review the potential methods for distinguishing the landfill gas from more general hydrocarbon-based or peat-derived vapours; and
- To support the Closure and Aftercare Management Plan and propose a gas monitoring plan from present through the closure process to definite closure and into the aftercare phase for approval by CNC-NRW.

1.5. Recent Gas Monitoring Data

This Audit reviews the data collected during the five rounds of ground gas monitoring undertaken between October 2013 and May 2014.

The parameters measured are the same as those listed in Section 1.3 and the data are screened against the EALs of methane (1%) and carbon dioxide (1.5%) stated in Section 1.2. Exceedances of the EALs, based on recent monitoring, are highlighted in Appendix C.

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2. Data Review

This section reviews the gas monitoring data collected between October 2010 and May 2014 from within and in the vicinity of the permit area (Data included in Appendix B and C, and graphs in Appendix D).

The permit area has been divided into the following four areas and they are shown on Drawing 5041216-RAP-DWG-1907.

- The formally landfilled area located in the east of the permit area;
- The non-landfill area which is an approximate area of mixed soils and materials called "Site 1";
- The non-landfill area in the west within the permit boundary but outside Site 1 or the water bodies; and
- The three water bodies, Crymlyn Bog Lagoon, West bay, both located in the south-west of the permit area, and the South Bay located to south of the landfilled area.

2.1. Landfilled Area

Monitoring rounds between October 2010 and October 2013 recorded frequent exceedances of methane in MSMW235, MSMW236 and MSMW238 which are all located in the west of the landfilled area. Concentrations in MSMW235 exceeded the methane EAL every time it was monitored, the peak reading within this borehole being 29.9% v/v recorded in October 2013.

The steady values that exceed the methane EAL within this borehole ranges from 13% v/v in October 2010 to 29.9% v/v in October 2013. The highest steady value of methane of 44.6% within the site was recorded at borehole MSMW236 in October 2010, since then methane concentrations in MSMW236 have not been recorded above 22.2% v/v within this borehole.

The steady methane concentrations in MSMW238 were between 0.7% v/v and 5.2% v/v in 2010 but the values increased significantly to between 34.8% v/v and 39.4% v/v in 2013. The exceedances of methane were generally accompanied by exceedances of carbon dioxide. These three monitoring boreholes were not monitored after October 2013 monitoring rounds.

Methane exceedances were also frequently recorded in the centre of the landfilled area, predominantly in boreholes CBH26, CBH31, CBH48, CBH49, CBH51, CBH52 and MSMW231. The steady methane concentrations were generally above 10% v/v with a maximum value of 45.8% v/v recorded in CBH31 in May 2013. The methane exceedances were generally associated with carbon dioxide exceedances in these boreholes in the centre of the landfilled area. The maximum carbon dioxide exceedance was 10.6 % v/v recorded in CBH26 in May 2014.

The boreholes near the northern permit boundary, i.e. MSMW033d, MSMW228, CBH28, CBH32, CBH36, CBH37, CBH57, CBH58 and CBH63, generally recorded exceedances in carbon dioxide but the methane concentrations were generally below the EAL. The exceptions were the elevated values recorded for CBH36 in April 2013 and for CBH28 in January 2014 of which the steady concentrations of carbon dioxide were around 10% v/v but the corresponding steady methane concentrations were only around 3.0% v/v.

Detectable concentrations of carbon monoxide and hydrogen sulphide were recorded at several locations sporadically found across the landfilled area but were generally below 10ppm. The exceptions were two extremely high concentrations of hydrogen sulphide, 211ppm and 368ppm, recorded in CBH31 in April and May 2013 respectively. These high concentrations of hydrogen sulphide were accompanied by the very high methane concentrations (33.2% v/v and 45.8% v/v).

2.2. Non-landfill Site 1 Area

Steady methane concentrations in CARW015, CARW025 and CARW029b frequently exceeded the EAL with the maximum value of 99.9% v/v recorded in CARW025 in December 2011.

Exceedances of steady carbon dioxide concentrations were also frequently found in the boreholes, in Site 1, i.e. CARW015, CARW025 and CARW029b. There does not appear to be a clear link between carbon dioxide and methane peaks. For example, the steady methane concentrations in CARW025 exceeded 90% v/v on

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28/11/2011, 15/12/2011 and 03/01/2012, and was 73% v/v on 06/12/2011. In contrast the corresponding carbon dioxide concentrations for these occasions were lower than the EAL (1.5% v/v of CO₂).

Carbon monoxide has only been detected twice within the Site 1 Area, both times within borehole CARW025. These were in November 2013 and February 2014 at 1ppm and 7ppm respectively.

Hydrogen sulphide has only been detected three times within Site 1 Area, again these were in borehole CARW025. Hydrogen sulphide was detected in November 2011, December 2011 and January 2012 at values of 7ppm, 2ppm, and 8ppm respectively.

2.3. Non-landfill area outside Site 1 within the permit boundary

Borehole MSMW156 (in both installations MSMW156s1 in made ground & peat and MSMW156s2 in peat) regularly exceeded both the methane and carbon dioxide EALs. This borehole lies within the non-landfill area located to the west of the landfilled area and to the south of Site 1. The highest steady concentration of methane from this borehole was 67.1% v/v in MSMW156s1 in November 2013.

MSMW027 (in made ground & peat), MSMW155s (missing borehole record) and GA7s (in made ground & peat) are located near the west boundary. Data from these boreholes occasionally exceeded the methane EALs but more frequently exceeded the carbon dioxide EAL. The highest steady value of methane from this boreholes was 13.5% v/v recorded in MSMW155s in January 2014 and the highest steady value of carbon dioxide was 12.3% v/v recorded in GA7s in October 2013.

Methane and carbon dioxide exceedances were also noted on rare occasions in other boreholes CARW007, CARW008, CARW009, CARW033 and CARW034 along the east and south-east permit boundary but there were no more than 2.5% v/v of methane (in CARW008) and 3.1% v/v of carbon dioxide (in CARW007) both in January 2014.

Hydrogen sulphide was also frequently detected in MSMW156s1 with a maximum reading of 9ppm in October 2013 but rarely detected and generally not more than 2ppm in other boreholes outside the landfilled area or Site 1.

Carbon monoxide was frequently detected in the boreholes along the eastern and southern permit boundary and the south of the permit area, i.e. CARW002, CARW007, CARW008, CARW009, CARW033, CARW034, MSMW029b, MSMW154 and MSMW156. The highest carbon monoxide concentrations outside the landfilled area but within the permit boundary were detected in CARW009 (11ppm) in May 2014. CARW007, CARW008, CARW009, CARW033, CARW034, MSMW029b, MSMW154 and MSMW156 are within the permit area whereas CARW002 and MSMW154 are outside but close to the permit boundary.

2.4. Outside of Permit Boundary

Ground gas monitoring for five boreholes outside the permit boundary have been reviewed. CARW002 and CARW005 (to the north-west) and MSMW154 (to the south-east) are close to the permit boundary (see Drawing 5041216-RAP-DWG-1908) whereas RFSW018 and CBH20 which are located more than 380m and 1km to the east and north-east to the permit area respectively (outside the extent of Drawing 5041216-RAP-DWG-1908).

Exceedances of methane and carbon dioxide were not found in the upstream boreholes CARW002 and CARW005. High exceedances were frequently found in MSMW154, i.e. 67% v/v of methane in January 2014 and 13.9% v/v carbon dioxide in November 2011 in MSMW154s.

Carbon monoxide and hydrogen sulphide were rarely detectable in CARW002 and CARW005 and MSMW154.

Exceedances of methane and carbon dioxide were recorded in RFSW018 and CBH20 which are far away from the permit area, with much higher concentrations in CBH20 (highest concentrations 39.1% v/v of methane and 9.4% v/v of carbon dioxide) than in RFSW018 (3.9% v/v of methane and 2.7% v/v of carbon dioxide in only one monitoring round in February 2014).

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2.5. Summary of data

In summary:

- The methane and carbon dioxide exceedances in the landfilled area suggests there is a source of landfill gases in the landfilled area.
- The extremely high concentrations of methane found in Site 1 and the fact that they were not correlated with the carbon dioxide concentrations suggests there is a source of ground gases, e.g. hydrocarbon-based vapours, which was wrongly detected as methane.
- The exceedances of methane and carbon dioxide recorded in installations within peat suggested another potential source of ground gases generated from the decomposition of peat.
- There may be other sources of ground gases in other parts of the wider Coed Darcy site outside the permit boundary.

2.6. Potential Sources of Gas Emissions

There are three potential sources of ground gas emissions within the permit area at the Crymlyn Tip in Coed Darcy.

- **Peat:** Microbial decomposition of organic matter in the peat generates carbon dioxide (CO₂), nitrous oxide (N₂O) and methane (CH₄). (Couwenberg, 2009)⁴ The concentrations of gases generated depend on the site conditions including the groundwater table in particular. When the peat is saturated with water, CH₄ emission is high. When the peat is exposed to the air, CO₂ and N₂O emissions are high. (Dinsmore, et al., 2009)⁵ The conceptual site model in the previous ESID (shown on ESID Drawing 5041216-RAP-DWG-0001521) clearly indicated that underlying the landfilled waste, made ground or the ash bund fill, there is a layer of peat soil and groundwater is known to be shallow.
- **Landfill gas from the landfilled area:** Microbial decomposition of organic matter in the landfilled waste generates methane (typical concentrations up to 60% v/v) and carbon dioxide (typical concentrations up to 40% v/v).
- **The mixed materials in Site 1 of the non-landfilled area:** A large proportion of the gas recorded is likely to be hydrocarbon-based vapours (e.g. ethane, propane, butane, etc.) which a GA2000 metre, which has been used in taking the gas readings presented in this document, will record as methane.

With the existing site information including the ground gas monitoring data undertaken in October 2010 to May 2014, there is not sufficient evidence to prove or disprove the presence of any of these potential sources.

The methane concentrations in borehole CARW025 exceeded 90% by volume (% v/v) as recorded in the monitoring on 28/11/2011, 15/12/2011 and 03/01/2012, and is 73% v/v on 06/12/2011. In contrast the corresponding carbon dioxide concentrations for these occasions were lower than the EAL (1.5% v/v of carbon dioxide). These methane concentrations were much higher than the typical landfill gas levels (methane up to 60% v/v) but the corresponding carbon dioxide concentrations were low. Given the borehole location is outside the landfilled area but within Site 1, i.e. the approximate area of mixed materials, these unusually high readings of methane concentrations suggest the presence of other hydrocarbon-based vapours (e.g. ethane, propane, butane, etc.) rather than methane.

Elevated methane (above 1% v/v) and carbon dioxide (above 1.5% v/v) concentrations were recorded in borehole MSMW156 (in monitoring installations MSMW156s1 within made ground & peat and MSMW156s2 within peat) in most of the monitoring occasions between November 2011 and May 2014. The maximum methane concentrations recorded in this borehole were 67.1% v/v with a groundwater level of 0.4m below ground level (bgl) on 19/11/2013 for MSMW156s1 and 34.2% v/v on 06/12/2011 for MSMW156s2 with an unknown groundwater level. Given the borehole installations are in made ground & peat (MSMW156s1) or

⁴ Couwenberg, John, 2009, Methane emissions from peat soils (organic soils, histosols) Facts, MRV-ability, emission factors, Paper for the United Nations Framework Convention on Climate Change (UN-FCCC) meetings in Bonn, August 2009, Wetlands International, www.wetlands.org.

⁵ Dinsmore, Kerry J.; Skiba, Ute M.; Billett, Michael F.; Rees, Robert M.. 2009 Effect of water table on greenhouse gas emissions from peatland mesocosms. *Plant and Soil*, 318 (1-2). 229-242, published by Natural Environment Research Council (NERC), nora.nerc.ac.uk/5459.

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peat (MSMW156s2) and its location is outside the landfilled area or Site 1, these data could suggest the decomposition of organic matter in the peat. However, the potential for migration of landfill gases from the landfilled area or hydrocarbon-based vapours from Site 1 cannot not be eliminated without further investigations.

The instrument used to measure ground gas between October 2010 and May 2014 is a portable GA-2000 gas analyser. This instrument measures methane and carbon dioxide concentrations using dual beam infra-red absorption. The infra-red meter cannot distinguish methane from other hydrocarbon-based vapours and can only correctly determine methane concentrations provided no other hydrocarbon-based vapours are present. However, given the known presence of hydrocarbons within Crymlyn Tip, it is possible that the high methane concentrations could relate to hydrocarbon-based vapours and thus an infra-red meter is of limited use at some areas of the tip. Some more detailed analysis is therefore recommended.

3. Gas Monitoring Strategy

The following sampling and detection methods are selected from CIRIA C682 (2009)⁶, *The VOCs Handbook, Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination*, and BS 8567 (2013)⁷, *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)* and are proposed for future monitoring of ground gas emissions within and in the vicinity of the Crymlyn Tip. Different methods should be applied at various stages and to various areas of the Crymlyn Tip as summarized in Table 2.

Table 2. Summary of proposed gas detection methods

Applicable to areas	Gas sampling and/or detection methods	Examples of equipment
Initial gas monitoring: Only for the first and second rounds of gas monitoring		
All the proposed gas monitoring locations within and in the vicinity of the Crymlyn Tip	Sampling of gases with bags or sorbent tubes and analysis of the gas sample with Gas chromatography–mass spectrometry (GC-MS) in the laboratory to identify and quantify the individual gases including CH ₄ , CO ₂ , petroleum hydrocarbons and VOCs.	Widely used sampling bags are Tedlar⁸ products. Widely used sorbent tubes are Tenax and Carboxen⁹ products. A pump may be required for sampling.
Long-term gas monitoring: From the third round and through the closure process to the aftercare phase		

⁶ CIRIA C682, 2009, *The VOCs Handbook, Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination*

⁷ BS 8567, 2013, *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*

⁸ Adtech, Tedlar Bags Datasheet, www.adtech.co.uk

⁹ Sigma-Aldrich, Tenax and Carboxen Tubes Datasheet, www.sigmaaldrich.com

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Applicable to areas	Gas sampling and/or detection methods	Examples of equipment
Only the proposed gas monitoring locations that have been identified with emissions from the peat i.e. majorly N ₂ O, CO ₂ and CH ₄ emissions	Portable infra-red (IR) meter to measure CH₄ and CO₂ concentrations. • Oxygen, carbon monoxide and hydrogen concentrations; • Relative pressure; • Flow in the borehole; and • Atmospheric pressure should also be measured. Alternatives to IR meters are laser diodes. Each type of diode will be specific for detection of only one compound in gas.	Widely used portable IR meter is GA-2000¹⁰. A pump may be required for sampling but there is no requirement of sampling bags or tubes.
Only the proposed gas monitoring locations that have been identified with landfill gas emissions, i.e. majorly CH ₄ and CO ₂ emissions	Portable infra-red (IR) meter to measure CH₄ and CO₂ concentrations. • Oxygen, carbon monoxide and hydrogen concentrations; • Relative pressure; • Flow in the borehole; and • Atmospheric pressure should also be measured. Alternatives to IR meters are laser diodes. Each type of diode will be specific for detection of only one compound in gas.	Widely used portable IR meter is GA-2000. A pump may be required for sampling but there is no requirement of sampling bags or tubes.
Only the proposed gas monitoring locations that have been identified with hydrocarbon-based vapours.	Portable photoionization detector (PID) to measure volatile organic compounds (VOCs) including total petroleum hydrocarbons (TPH). • Oxygen, carbon monoxide and hydrogen concentrations; • Relative pressure; • Flow in the borehole; and • Atmospheric pressure should also be measured.	Widely used portable PID is miniRAE-3000¹¹. A pump may be required for sampling but there is no requirement of sampling bags or tubes.

¹⁰ Geotech, GA-2000 Portable Gas Analyser Datasheet, www.geotechuk.com

¹¹ RAE Systems, MiniRAE 3000 Portable Handheld VOC Monitor Datasheet, www.raesystems.com

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Measurements of groundwater or leachate levels in the boreholes should be undertaken on all the gas monitoring occasions and locations.

3.1. Initial Gas Monitoring

It is proposed that, following CNC-NRW's approval of this proposed gas monitoring strategy, including the gas detection methods above, the first and second rounds of gas monitoring will require sampling of gases with bags or tubes and analysis with gas chromatography-mass spectrometry (GC-MS).

The gas sampling bags (Tedlar bags or equivalent) should have fitting valves and should be made of materials which are tough and chemically inert to the gas compounds contained. Sampling can either be diffusive (i.e. passive and without a pump) if the gas flow rate is high or alternatively a low flow sampling pump may be required to draw gases from the borehole into the bag. An appropriate type of bag, the pump flow rate and the sampling time period (and thus the sampling volume) will need to be established by trial and error during the first round of gas monitoring. An established and consistent method of sampling should be adopted for the second round of gas monitoring.

The sorbent tubes (Tenax, Carboxen tubes or equivalent), sometimes called thermal desorption tubes, should have seal caps and contain a selected adsorbent such as porous polymer or activated carbon. Sampling can either be diffusive (i.e. passive sampling without a pump) if the gas flow rate is high or alternatively the sorbent tube may be connected to the borehole via a low flow sampling pump to accelerate the sampling. The concentrations of individual gases are calculated according to their known diffusive uptake rates over a given time period which may be up to several days (passive sampling without a pump) or over a shorter time period using a sampling pump. An appropriate type of sorbent tube, the pump flow rate and the sampling time period (and thus the sampling volume) will need to be established by trial and error during the first round of gas monitoring. An established and consistent method of sampling should be adopted for the second round of gas monitoring. The sorbent tube will be thermally desorbed to recover a gas sample for analysis in the laboratory.

The gas samples in the bags or sorbent tubes will be sent to the laboratory for analysis with gas chromatography-mass spectrometry (GC-MS) to identify and quantify the individual gases including CH₄, CO₂, petroleum hydrocarbons and VOCs present in each sample.

3.2. Long-term Gas Monitoring

Once the initial gas monitoring results have identified the individual gases generated from the various monitoring locations, the detection methods for long-term gas monitoring will vary according to the three potential sources of emissions, i.e. decomposition of peat, landfill gases and hydrocarbon-based vapours.

Peat occurs naturally and the CO₂, N₂O and CH₄ emissions from microbial decomposition of organic matter in the peat are considered as the background emissions which do not require remediation. It is proposed that CO₂ and CH₄ will continued to be monitored with portable IR meter (GA-2000 or equivalent) in the locations that have been identified with emissions from the peat through the closure process to the aftercare phase but long-term monitoring for N₂O is not proposed.

It is proposed that the gas monitoring locations that have been identified with landfill gas emissions, i.e. majorly CH₄ and CO₂ emissions will continued to be monitored with portable IR meter (GA-2000 or equivalent) through the closure process to the aftercare phase.

It is proposed that the gas monitoring locations that have been identified with hydrocarbon-based vapours will continued to be monitored with portable PID (miniRAE-3000 or equivalent) through the closure process to the aftercare phase. The PID should be fitted with a ultra-violet (UV) lamp (e.g. ionisation energy of 10.6eV) to determine for the presence of VOCs. It should be noted that due to the ionisation energy of hydrogen sulphide (10.5eV which is lower than that of the UV lamp) and that of methane (12.6eV which is higher than that of the UV lamp), the PID measurement will include the hydrogen sulphide concentration (if present) but will exclude the methane concentration.

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3.3. Gas Monitoring Plan

It is proposed that gas monitoring should be carried out monthly for a continuous period of 12 months. The locations of the boreholes and the frequency of monitoring are summarised in Table 3. The boreholes are to be monitored in line with the detection methods and parameters stated in Table 2.

Table 3. Proposed monitoring programme

Location	Boreholes		Monitoring frequency
	Current serviceable boreholes	Proposed new boreholes	
Within the landfilled area	CARW023, MSMW228, MSMW231, MSMW233, MSMW235 and MSMW238.	None.	Monthly.
Within Site 1		BH501, BH502, BH503, BH504 and BH505.	Monthly.
Non-landfill area outside Site 1 within the permit boundary	CARW008, CARW009, MSMW034, MSMW154d, MSMW154s, MSMW155d and MSMW155s. (MSMW154 is outside but close to at the boundary)	BH506s, and BH508.	Monthly.

4. Conclusion

In conclusion, the review of the data collected during the monitoring rounds from October 2010 to May 2014 indicates the presence of methane and carbon dioxide within the landfilled area as well as the non-landfill area within the environmental permit boundary.

Unfortunately the existing site information does not provide sufficient evidence to prove or disprove the presence of the following potential sources; peat, landfill gas from the landfilled area and the mixed materials located in Site 1 area. The installation of additional gas monitoring boreholes and a detailed gas monitoring strategy with appropriate detection methods have been proposed in order to attempt to confirm potential sources of gases at each location.

Drawings



List of Drawings

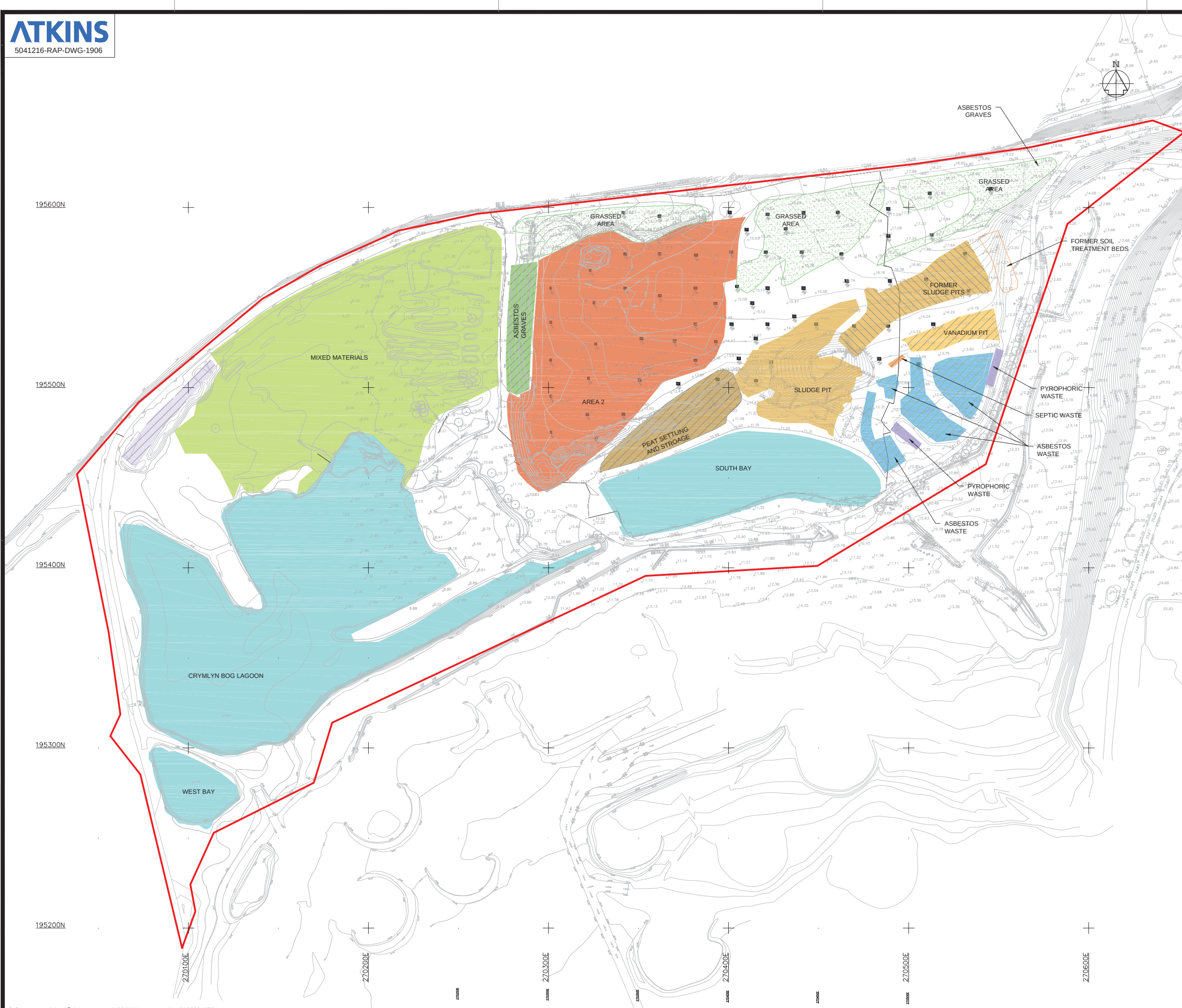
5041216-RAP-DWG-1906 - Historical Waste Deposition

5041216-RAP-DWG-1907 - Proposed Strategy

5041216-RAP-DWG-1908 - Previous Gas Monitoring Locations

5041216-RAP-DWG-1521 - ESID 12 – Hydrogeological Cross Section

5041216-RAP-DWG-1529 - ESID 1 – Location



- NOTES
1. DO NOT SCALE.
 2. TOPOGRAPHY DATA TAKEN FROM SURVEY DATA PROVIDED BY PLANNED VISION ON DATE 21/05/2013 AND 22/05/2013 AND 10/06/2013.
 3. CONTOURS SHOWN ARE IN mAD.
 4. TIP FEATURES ARE TAKEN FROM URS DRAWING REF. 44382624-FIGURE 2, FEB 2006.

- KEY
- ENVIRONMENTAL PERMIT BOUNDARY
 - GRASSED AREA
 - SITE 1 MIXED MATERIALS
 - AREA 2
 - SITE 3 SLUDGE PIT
 - SITE 3 FORMER SLUDGE PITS
 - SITE 4 PYROPHORIC WASTE
 - SITE 5 ASBESTOS WASTE
 - SITE 5 VANADIUM PIT
 - SITE 6 SEPTIC WASTE
 - SITE 7 - ASBESTOS GRAVES
 - DRUM BURIAL MOUND
 - FORMER SOIL TREATMENT BEDS
 - PEAT SETTING AND STORAGE
 - CRYMLYN BOG LAGOON, SOUTH & WEST BAY

REVISIONS	Drawn By	Checked By	Date

PURPOSE OF ISSUE

Rev.

Authorised for issue

Date

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THIS DRAWING IS NOT TO BE SCALED

CLIENT

ST.MODWEN

PROJECT

COED DARCY

DRAWING TITLE

HISTORICAL WASTE DEPOSITION

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5041216-RAP-DWG-1906				-

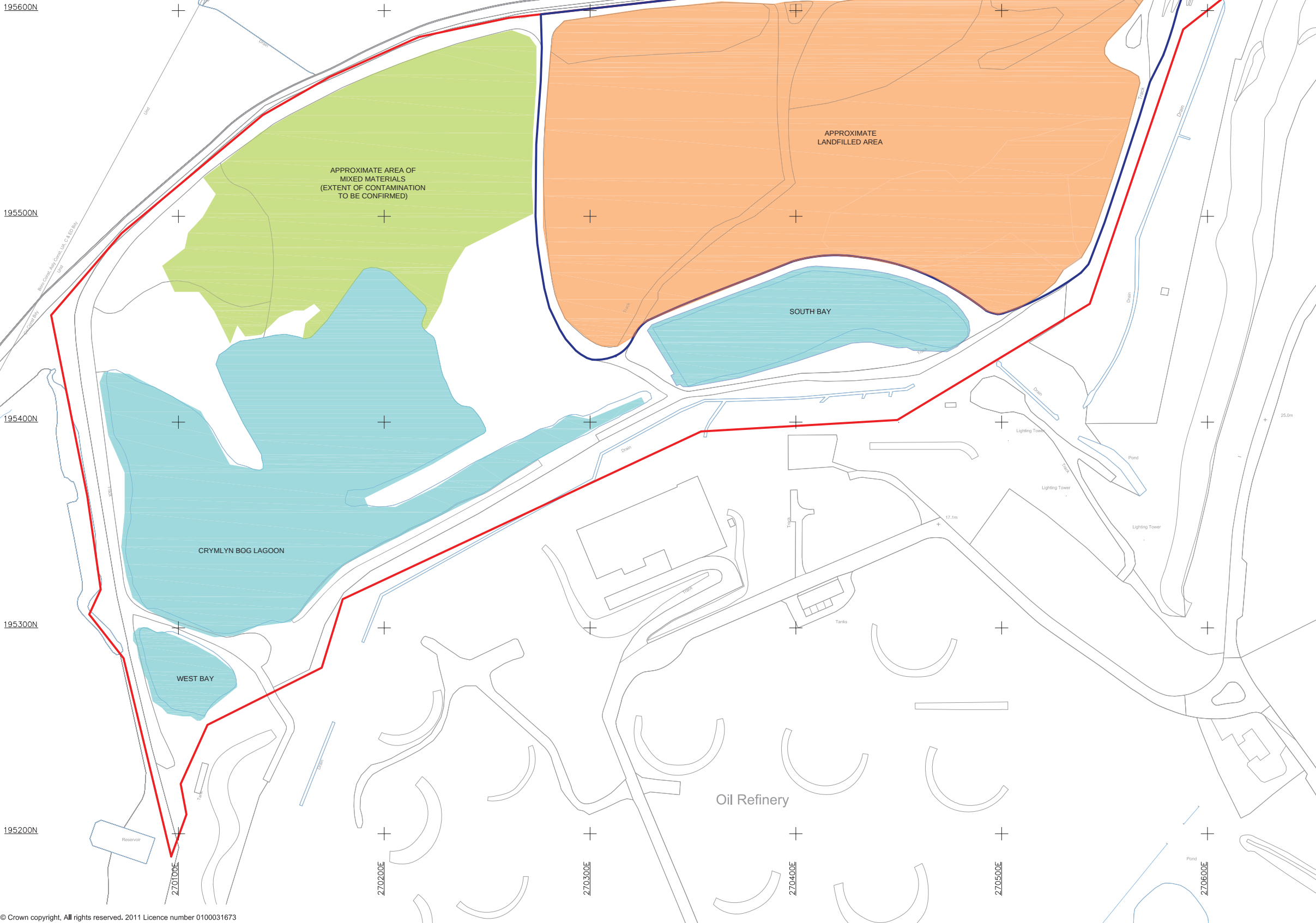
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- KEY
- ENVIRONMENTAL PERMIT BOUNDARY
 - APPROXIMATE AREA TO BE CAPPED (FUTURE)
 - PROPOSED PARTIAL SURRENDER (FUTURE)
 - APPROXIMATE LANDFILLED AREA
 - APPROXIMATE AREA OF MIXED MATERIALS

REVISIONS		Drawn By	Checked By	Date
PURPOSE OF ISSUE		Rev.	Authorised for issue	Date
Atkins Limited Birmingham Office The Axis, 10 Holiday Street Birmingham West Midlands B1 1TF Tel 0121 483 5000 Fax 0121 483 5252 © THIS DRAWING IS NOT TO BE SCALED				
CLIENT ST.MODWEN				
PROJECT COED DARCY				
DRAWING TITLE PROPOSED STRATEGY				
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NOTES

- DO NOTE SCALE
- BOREHOLE LOCATIONS ARE INDICATIVE AND COORDINATES ARE APPROXIMATE ONLY.

KEY

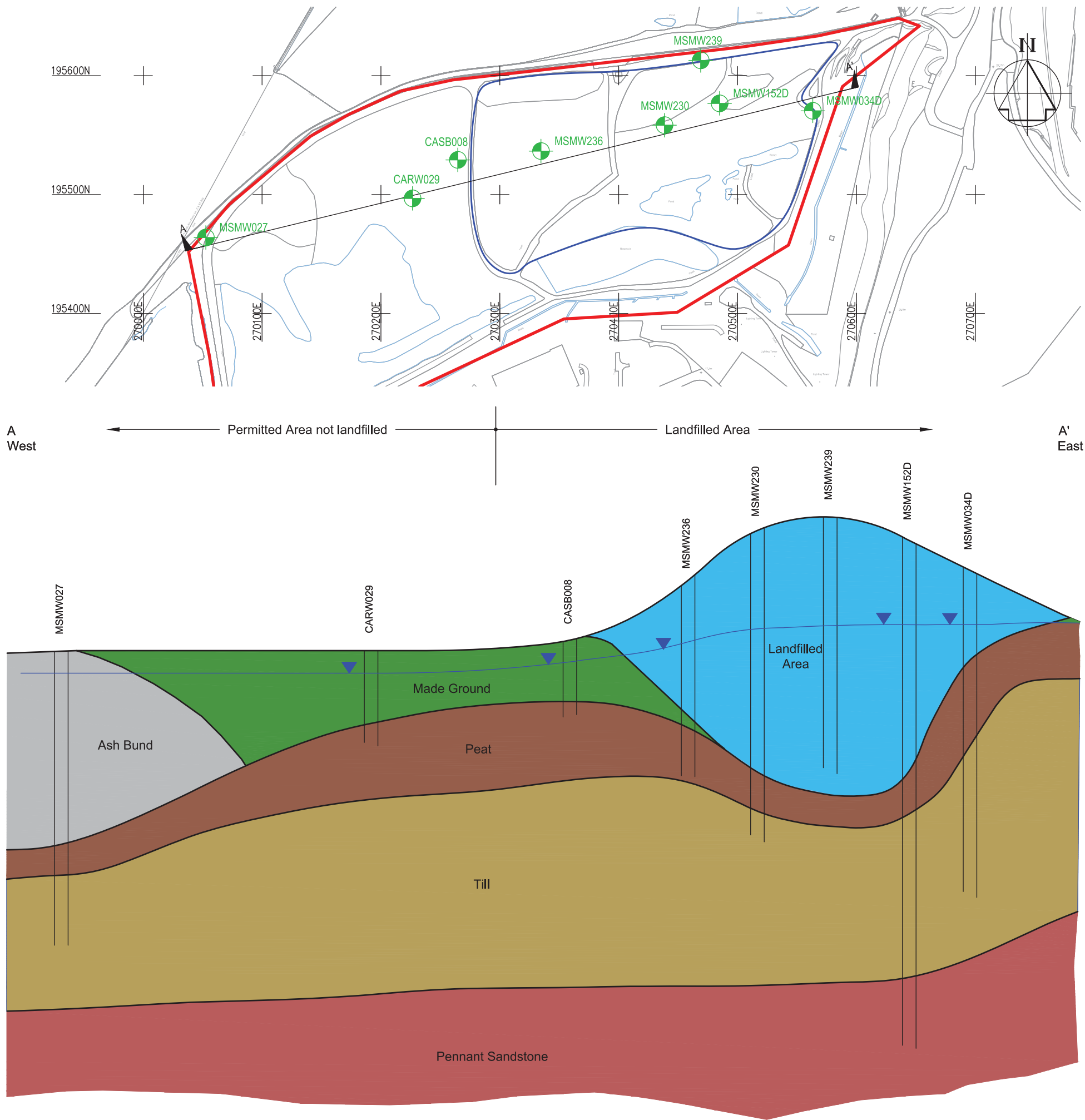
- ENVIRONMENTAL PERMIT BOUNDARY
- PROPOSED PARTIAL SURRENDER (FUTURE)
- APPROXIMATE LANDFILLED AREA
- APPROXIMATE AREA OF MIXED MATERIALS - SITE AREA 1
- GAS MONITORING LOCATIONS

Previous Gas Monitoring Locations in Oct 2010 to May 2014				
Borehole ID	Easting (mE)	Northing (mN)	Gas Monitoring Data	Serviceable/Unrecoverable
CARW002	270601	195588	Oct2010-May2013	TBC
CARW005	270562	195508	Oct2010-May2013	Unrecoverable
CARW007	270545	195466	Oct2013-May2014	Unrecoverable
CARW008	270527	195453	Oct2013-May2014	Serviceable
CARW009	270504	195441	Oct2013-May2014	Serviceable
CARW015	270191	195568	Oct2010-May2013	Unrecoverable
CARW024	270300	195444	Oct2010-May2013	Unrecoverable
CARW025	270207	195551	Oct2010-May2014	Unrecoverable
CARW029b	270227	195497	Oct2010-May2014	Unrecoverable
CARW033	270471	195418	Oct2013-May2014	Unrecoverable
CARW034	270378	195403	Oct2013-May2014	Unrecoverable
CBH02	270302	195534	Oct2010-May2013	Unrecoverable
CBH04	270302	195493	Oct2010-May2013	Unrecoverable
CBH20	270832	195553	Oct2010-May2014	Unrecoverable
CBH26	270402	195533	Oct2013-May2014	Unrecoverable
CBH28	270422	195594	Oct2013-May2014	Unrecoverable
CBH31	270422	195533	Oct2010-May2013	Unrecoverable
CBH32	270442	195595	Oct2013-May2014	Unrecoverable
CBH33	270441	195573	Oct2010-May2013	Unrecoverable
CBH36	270461	195595	Oct2010-May2013	Unrecoverable
CBH37	270463	195572	Oct2010-May2013	Unrecoverable
CBH41	270490	195557	Oct2010-May2013	Unrecoverable
CBH42	270490	195533	Oct2010-May2013	Unrecoverable
CBH48	270394	195502	Oct2010-May2014	Unrecoverable
CBH49	270415	195501	Oct2013-May2014	Unrecoverable
CBH51	270393	195523	Oct2013-May2014	Unrecoverable

Previous Gas Monitoring Locations in Oct 2010 to May 2014				
Borehole ID	Easting (mE)	Northing (mN)	Gas Monitoring Data	Serviceable/Unrecoverable
CBH52	270415	195525	Oct2013-May2014	Unrecoverable
CBH57	270410	195585	Oct2013-May2014	Unrecoverable
CBH58	270432	195585	Oct2010-May2013	Unrecoverable
CBH63	270545	195608	Oct2010-May2013	Unrecoverable
GA7	270068	195363	Oct2010-May2014	TBC
MSMW027	270053	195463	Oct2010-May2014	TBC
MSMW029	270426	195432	Oct2013-May2014	Unrecoverable
MSMW033	270518	195620	Oct2010-May2014	TBC
MSMW034	270563	195573	Oct2010-May2014	Serviceable
MSMW035	270532	195479	Oct2010-May2014	TBC
MSMW152	270485	195577	Oct2010-May2013	TBC
MSMW154	270104	195217	Oct2010-May2014	Serviceable
MSMW155	270063	195310	Oct2010-May2014	Serviceable
MSMW156	270267	195413	Oct2010-May2014	Unrecoverable
MSMW226	270455	195592	Oct2013-May2014	Unrecoverable
MSMW228	270441	195577	Oct2010-May2013	Serviceable
MSMW231	270405	195546	Oct2013-May2014	Serviceable
MSMW235	270336	195548	Oct2010-May2014	Serviceable
MSMW236	270335	195537	Oct2010-May2013	Unrecoverable
MSMW238	270334	195503	Oct2010-May2013	Serviceable
MSMW239	270469	195613	Oct2010-May2013	TBC
RFSW018	271846	196169	Oct2013-May2014	Unrecoverable

THE FOLLOWING LOCATIONS ARE NOT SHOWN ON THE DRAWING
*CBH20 is located approximately 250m to the east of the permit boundary
*RFSW018 is located approximately 1000m to the north east of the permit boundary

REVISIONS	Drawn By	Checked By	Date
PURPOSE OF ISSUE			
	Rev.	Authorised for issue	Date
Atkins Limited Birmingham Office The Axis, 10 Holliday Street Birmingham West Midlands B1 1TF Tel 0121 483 5000 Fax 0121 483 5252			
THIS DRAWING IS NOT TO BE SCALED			
CLIENT ST.MODWEN			
PROJECT COED DARCY			
DRAWING TITLE PREVIOUS GAS MONITORING LOCATIONS			
Scales 1:1000	DRAWN JSD	CHECKED TC	CO-ORD CHECK MC
DATE 14/05/15	DATE 14/05/15	DATE 14/05/15	DATE 14/05/15
0		SHEET A1	PLOT DATE 21.07.15
DRAWING NO 5041216-RAP-DWG-1908			REV -



NOTES:

1. SECTION & GROUND WATER LEVELS ARE SCHEMATIC & INDICATIVE ONLY.

KEY:

- ENVIRONMENTAL PERMIT BOUNDARY
- LANDFILLED AREA
- MONITORING WELLS
- GROUND WATER LEVEL

REVISIONS	Drawn By	Checked By	Date

PURPOSE OF ISSUE	Rev.	Authorised for Issue	Date

Atkins Ltd
Consulting Engineers
The Axis, 10 Holliday Street
Birmingham West Midlands B1 1TF

Tel 0121 483 5000
Fax 0121 483 5252

THIS DRAWING IS NOT TO BE SCALED

CLIENT: ST.MODWEN

PROJECT: CRYMLYN TIP

DRAWING TITLE: ESID 12 HYDROGEOLOGICAL CROSS SECTION

SCALES	DRAWN	CHECKED	CO-ORD CHECK
N:T.S.	JH	YM	—
DATE	14/05/13	DATE	14/05/13
DATE	—	DATE	—

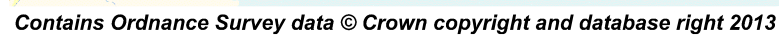
0 100m

DRAWING NO: 5041216-RAP-DWG-0001521

REV: -

PLOT DATE: 28/05/13

SHEET: A2



— ENVIRONMENTAL PERMIT
BOUNDARY

DRABET

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
<i>Atkins Ltd</i> Consulting Engineers The Axis, 10 Holliday Street Birmingham West Midlands B1 1TF	Tel	0121 483 5000	
	Fax	0121 483 5252	

Appendices



Appendix A



Dr Richard Mitchener
Principal Hydrologist, Water and Environment
Atkins
The Axis
10 Holiday Street
Birmingham
B1 1TF

Ein cyf/Our ref: EPR/AP3990LR

Eich cyf/Your ref:

Dyddiad/Date: 2 October 2013

Dear Dr Mitchener

Interim Comments on Landfill Gas Risk Assessment and Gas Management Plan

Following receipt of the Crymlyn Tip, Coed Darcy, Llandarcy – Landfill Gas Risk Assessment and Gas Management Plan (LfGRA), in accordance with Improvement Programme 1 of Table S1.3 Improvement programme requirements, please find our comments below. These comments are based on the information that has been provided in the LfGRA and the Environmental Settings and Installation Design Report (ESID).

It is acknowledged that the operator (St Modwen Developments Limited) have been restricted due to poor historic background gas data. In recent years the operator has made efforts to improve the data by the installation and monitoring of new gas wells. We agree with the comments that further monitoring is required on site. Due to the complexity of the site the increased monitoring needs to be undertaken so that a more detailed risk assessment can be developed. This risk assessment should also include attempts to quantify the dispersion of landfill gas outside of the permitted area. The further monitoring and revised risk assessment will facilitate the preparation of a gas management plan.

We would welcome attempts to quantify the fugitive release of methane from the surface of the landfilled area. This should ideally be done prior to and post the capping works proposed as part of the Capping of Crymlyn Tip – Construction Quality Assurance Plan. It is also noted that the submission has largely concentrated on the traditional bulk gases and there is limited examination of the potential emissions from other trace gases. This is particularly relevant due to the waste types that were accepted historically. Subsequently, further work should be

Natural Resources Wales/Cyfoeth Naturiol Cymru
Maes Newydd, Llandarcy, Neath Port Talbot, SA10 6JQ.
Llinell gwasanaethau cwsmeriaid/Customer services line: 0300 065 3000
www.cyfoethnaturiolcymru.gov.uk / www.naturalresourceswales.gov.uk

Croesewir gohebiaeth yn y Gymraeg a'r Saesneg

Correspondence welcomed in Welsh and English

undertaken to identify whether there are other trace gases present in the landfill gas that require assessment e.g. VOC's.

As part of the qualitative risk assessment, certain scenarios have been scored incorrectly: for example the "likelihood" of "loss of containment" should be "probable" as there is currently no containment at the facility. The risk assessment should therefore be re-examined once the additional investigative works are completed.

Have attempts been made to identify whether there are landfill gas indicator compounds present in the landfill gas that are not present in other sources. It is accepted that this could be problematic due to off-site contamination, but we would welcome discussions on this, as this will be helpful when the operator eventually aims to apply for full surrender.

Please could you provide further information on the method used to collect the gas flow readings.

Taking the above points into consideration, at this point we cannot accept and provide written approval for the Landfill Gas Risk Assessment submission. Subsequently, we require further monitoring before the risk assessment is then re-examined. Once this work is undertaken the operator should be in the position to then develop the landfill gas management plan in line with Landfill Directive requirements.

Further to this, it is recommended that attempts are made to start formalising the monitoring schedule as part of a Closure and Aftercare Management Plan required under IP2 of Table S1.3 Improvement programme requirements. The landfill gas monitoring proposals in section 3.2 seem appropriate, but we would request that the additional monitoring outlined above is included.

Once a monitoring schedule has been agreed as part of the Closure and Aftercare Management Plan, it can be amended or reduced in due course as more information is gathered and a better understanding of the site is achieved. The monitoring review can be undertaken annually and recommendations made by the operator as part of submissions made under condition 4.2.3.

We also wish to highlight our concern that the eventual housing development could potentially be sited directly adjacent to the landfill and therefore an appropriate understanding of the risks will be critical before this happens.

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Correspondence welcomed in Welsh and English

Whilst the above comments relate to the risks from the landfill, it should be noted that there are also other sources of gas as outlined in the report. The developer must consider these when the development progresses to this area.

If you have any questions or wish to discuss any of the points raised above, then please do not hesitate to contact me via the details below.

Yours sincerely



Gareth M Davies

Senior Environment Officer
Neath Port Talbot Bridgend Environment Management Team

Deialu uniongyrchol/Direct dial 01792 325653

Ffacs uniongyrchol/Direct fax 01792 325511

E-bost uniongyrchol/Direct e-mail

gareth.davies@naturalresourceswales.gov.uk / gareth.davies@cyfoethnaturiolcymru.gov.uk

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Croesewir gohebiaeth yn y Gymraeg a'r Saesneg

Correspondence welcomed in Welsh and English

	EPR Compliance Assessment Report	Report ID: 1131010/ EAWML34003
This form will report compliance with your permit as determined by an NRW officer		
Site	Crymlyn Tip, Former BP Llandarcy Site	Permit Ref EAWML 34001
Operator/ Permit holder	St Modwen Developments Limited	
Date	10 October 2013	Time in 10:00 Out 12:45
What parts of the permit were assessed	Compliance visit of landfill, random surface emission check, visual inspection of some gas monitoring points and general permit compliance	
Assessment	Site Inspection/ Check Monitoring EPR Activity: Installation Waste Op x Water Discharge	
Recipient's name/position	Neil Williams – Construction Manager, St Modwen Properties Limited	
Officer's name	Gareth Davies and Neil Herbert	Date issued 15 October 2013

Section 1 - Compliance Assessment Summary			
This is based on the requirements of the permit under the Environmental Permitting Regulations. A detailed explanation and any action you may need to take are given in the "Detailed Assessment of Compliance" (section 3). This summary details where we believe any non-compliance with the permit has occurred, the relevant condition and how the non-compliance has been categorised using our Compliance Classification Scheme (CCS). CCS scores can be consolidated or suspended, where appropriate, to reflect the impact of some non-compliances more accurately. For more details of our CCS scheme, contact your local office.			
Permit Conditions and Compliance Summary			Condition(s) breached
a) Permitted activities	1. Specified by permit	N	
b) Infrastructure	1. Engineering for prevention & control of pollution	3	2.8.1
	2. Closure & decommissioning	A	
	3. Site drainage engineering (clean & foul)	N	
	4. Containment of stored materials	N	
	5. Plant and equipment	N	
c) General management	1. Staff competency/ training	N	
	2. Management system & operating procedures	3	1.1.1 (a) & (b)
	3. Materials acceptance	N	
	4. Storage handling, labelling, segregation	N	
d) Incident management	1. Site security	N	
	2. Accident, emergency & incident planning	N	
e) Emissions	1. Air	A	
	2. Land & Groundwater	N	
	3. Surface water	N	
	4. Sewer	N	
	5. Waste	N	
f) Amenity	1. Odour	N	
	2. Noise	N	
	3. Dust/fibres/particulates	N	
	4. Pests, birds & scavengers	N	
	5. Deposits on road	N	
g) Monitoring and records, maintenance and reporting	1. Monitoring of emissions & environment	N	
	2. Records of activity, site diary, journal & events	N	
	3. Maintenance records	N	
	4. Reporting & notification	N	
h) Resource efficiency	1. Efficient use of raw materials	N	
	2. Energy	N	
KEY: C1, C2, C3, C4 = CCS breach category (*suspended scores are marked with an asterisk), A = Assessed or assessed in part (no evidence of non-compliance), N = Not assessed, NA = Not Applicable			

Number of breaches recorded	2	Total compliance score (see section 5 for scoring scheme)	8
If the Total No Breaches is greater than zero, then please see Section 3 for details of our proposed enforcement response			

Section 2 – Compliance Assessment Report Detail

This section contains a report of our findings and will usually include information on:

- the part(s) of the permit that were assessed (e.g. maintenance, training, combustion plant, etc)
- where the type of assessment was 'Data Review' details of the report/results triggering the assessment
- any non-compliances identified
- any non-compliances with directly applicable legislation
- details of any multiple non-compliances
- information on the compliance score accrued inc. details of suspended or consolidated scores.
- details of advice given
- any other areas of concern
- all actions requested
- any examples of good practice.
- a reference to photos taken

The purpose of the onsite compliance visit was to gain an understanding of the current landfill gas management on site and the condition of the gas infrastructure. The opportunity has also been taken to assess compliance with all other aspects of the permit, including documents that require submission to Natural Resources Wales.

Gas Surface Survey

As part of the visit we undertook a limited survey of the landfill area, a copy of this report has been provided with this Compliance Assessment Report. We used a *Gazomat* methane analyser to undertake the work, however it transpired that it was not possible to undertake any meaningful survey due to: obstruction such as presence of various stockpiles; limited access was restricted due to vegetation; some areas had been heavily compacted by vehicular traffic, and other areas were waterlogged. The findings from the survey are therefore limited although they suggest that methane surface emissions (in most of the areas checked) is not an issue presently. Two areas had elevated levels, one on the flank and one in the area where gas levels is known to be elevated. In time as restoration works progress more detailed surveys of surface emissions will be required to fully assess methane surface emissions.

Gas Monitoring Infrastructure

A random inspection of some of the site's gas monitoring infrastructure was undertaken.

A table showing well specific actions are listed below; however we have also included general actions that need to be undertaken for all wells. The operator needs to undertake an infrastructure check for all the gas monitoring points at the facility to ensure that they provide an effective means of monitoring gas.

Monitoring Point	Action required
GW37	Plastic screw type end caps are not air tight and should be replaced. 
Unidentified well at SS 70515 95539	It is unclear whether this is a gas monitoring point but the slotted section of the casing extends beyond the ground surface. This is not suitable for gas monitoring.
General (all)	Gas taps should be checked to ensure that they remain gas tight when turned off.
General (all)	A number of wells which we believe could be gas monitoring points were damaged. e.g. some wells were snapped in half etc. If these are gas monitoring points they need to be repaired.
General (all)	All gas monitoring infrastructure should be clearly labelled.

General (all)	Need to consider installing protective, lockable headworks on designated landfill gas monitoring point. At some points (e.g. where vehicular traffic is likely) then additional protection should be considered to prevent the loss of infrastructure.
---------------	--

We also observed that the sampling tap had been left open at one well. At another well we found the gas tap/bung arrangement had been left on the floor. This is indicative of poor sampling practice. Monitoring boreholes must remain sealed at all times to avoid the dilution of landfill gas with air.

The importance of collecting a good quality data set is paramount to the management of this closed landfill and will underpin the operator's risk assessments and eventual surrender application. NRW must have confidence in the quality of the data collected at the facility and in that regard we suggest a review of staff competence is now undertaken to ensure sampling staff are familiar and suitably trained in the site's sampling procedures. Whilst the deficiencies we noted in this report relate to gas we would suggest that this would be a good time to review the sampling procedures and training for all media monitored at the site.

Photograph showing monitoring point 41, with gas tap left open.



The failure we have noted in this report is considered a breach of condition 1.1.1 a) and b) and 2.8.1 of your permit. We have attributed a Compliance Classification Score of 3 for this breach against the b1 and c2 compliance headings. You have been given advice and guidance against this breach. CCS Reference 203720.

Leachate/ contamination remediation

The remediation works to mitigate the hydrocarbon contamination is ongoing and we observed several locations where this work was underway. We also observed that the interception trench has recently been subject to some maintenance with the improvement of the ply-board trench boundary.

General Permit Compliance

A review of the permit was undertaken in order to assess compliance with all conditions within the permit. The following table highlights those areas of the permit that require action or submissions to be made to Natural Resources Wales.

As per condition 4.2.1, please send correspondence to Natural Resources Wales, Maes Newydd, Britannic Way West, Llandarcy, SA10 6JQ and include permit number EPR/AP3990LR and EAWML 34003 as the reference.

Permit Condition Number	Permit Condition	Action Required
1.1.1 (a) and (b)	The operator shall manage and operate the activities in accordance with a written management system that identifies and minimises risks of pollution, including those arising from operations, maintenance, accidents, incidents, non-conformances, closure and those drawn to the operators as a result of complaints.	A written management system shall be submitted to Natural Resources Wales. Please provide a timescale for submission of a written management system by 6 November 2013
1.1.4	The operator shall comply with the requirements of an approved competence scheme.	Please provide details of the competent person on site, this should include their name and the qualification that they have obtained. Please provide these details by 6 November 2013.
1.2.1 (a)	The operator shall maintain an accident management plan.	An accident management plan shall be submitted to Natural Resources Wales. Please provide a timescale for submission of an accident management plan by 6 November 2013.
2.3.1 – linked to Schedule 1 – Operations, Table S1.2 Operating techniques and Table S1.3 Improvement programme requirements – IP2.	The operator shall, subject to the conditions of the permit, be operated using the techniques and in the manner described in the documentation specified in schedule 1, table S1.2, unless otherwise agreed in writing by the Environment Agency (now Natural Resources Wales)	A Closure and aftercare management plan shall be submitted to Natural Resources Wales for written approval. Please provide a timescale for submission of a Closure and Aftercare Management Plan by 6 November 2013.
2.4.1	The operator shall complete the improvements specified in schedule 1 table S1.3 by the date specified in that table unless otherwise agreed in writing by the Environment Agency (Natural Resources Wales).	It is noted that the Hydrogeological Risk Assessment, Stability Risk Assessment and Gas Risk Assessment have been submitted to Natural Resources Wales for review and comments have been provided to Atkins, consultants acting on behalf of St Modwen Developments Limited.
2.7.1	The operator shall maintain a closure and aftercare management plan.	As per condition 2.3.1 a Closure and Aftercare Management Plan shall be submitted to Natural Resources Wales for written approval.
2.8.1	The operator shall take appropriate measures, including, but not limited to, those specified in any approved closure and aftercare management plan, to control the migration of landfill gas.	The findings and recommendations from the gas survey shall be implemented alongside the comments made in response to the Gas Risk Assessment.
3.1	Emissions to water, air or land	The emissions to water, air or land shall be review as part of the Closure and Aftercare Management Plan. The Closure and Aftercare Management Plan shall have consideration of conditions of 3.1.1, 3.1.2, 3.1.3, 3.1.5 and 3.1.6.
3.5.1	The operator shall, unless otherwise agreed in writing by the Environment Agency (Natural Resources Wales), undertake the monitoring and any other actions specified in the agreed closure and aftercare management plan including (a) leachate; (b) point source emissions; (c) Groundwater; (d) Landfill gas; and (e) Surface water.	As per condition 2.3.1 and 2.7.1 a Closure and Aftercare Management Plan shall be submitted to Natural Resources Wales. The Closure and Aftercare Management Plan shall have consideration for the monitoring required under condition 3.5.1 and conditions 3.5.2, 3.5.3, 3.5.4 and 3.5.5.

Site	Crymlyn Tip, Former BP Llandarcy Site	Permit	EAWML 34003
Operator/ Permit	St. Modwen Developments Limited	Date	10 October 2013

We will now consider what enforcement action is appropriate and notify you, referencing this form.

Section 5 - Compliance notes for the Operator

To ensure you correct actual or potential non-compliance we may

- advise on corrective actions verbally or in writing
- require you to take specific actions in writing
- issue a notice
- require you to review your procedures or management system
- change some of the conditions of your permit
- decide to undertake a full review of your permit

Any breach of a permit condition is an offence and we may take legal action against you.

● We will normally provide advice and guidance to assist you to come back into compliance either after an offence is committed or where we consider that an offence is likely to be committed. This is without prejudice to any other enforcement response that we consider may be required.

● Enforcement action can include the issue of a formal caution, prosecution, the service of a notice and or suspension or revocation of the permit.

See our Enforcement and Civil Sanctions guidance for further information

This report does not relieve the site operator of the responsibility to

- ensure you comply with the conditions of the permit at all times and prevent pollution of the environment
- ensure you comply with other legislative provisions which may apply.

Non-compliance scores and categories

CCS category	Description	Score
C1	A non-compliance which could have a major environmental effect	60
C2	A non-compliance which could have a significant environmental effect	31
C3	A non-compliance which could have a minor environmental effect	4
C4	A non-compliance which has no potential environmental effect	0.1

Operational Risk Appraisal (Opra) - Compliance assessment findings may affect your Opra score and/or your charges. This score influences the resource we use to assess permit compliance.

Section 6 – General Information

Data protection notice

The information on this form will be processed by Natural Resources Wales (NRW) to fulfill its regulatory and monitoring functions and to maintain the relevant public register(s). NRW may also use and/or disclose it in connection with:

- offering/providing you with its literature/services relating to environmental matters
- consulting with the public, public bodies and other organisations (e.g. Health and Safety Executive, local authorities) on environmental issues
- carrying out statistical analysis, research and development on environmental issues
- providing public register information to enquirers
- investigating possible breaches of environmental law and taking any resulting action
- preventing breaches of environmental law
- assessing customer service satisfaction and improving its service
- Freedom of Information Act/Environmental Information Regulations request.

NRW may pass it on to its agents/representatives to do these things on its behalf. You should ensure that any persons named on this form are informed of the contents of this data protection notice.

Disclosure of information

NRW will provide a copy of this report to the public register(s). However, if you consider that any information contained in this report should not be released to the public register(s) on the grounds of commercial confidentiality, you must write to your local area office within twenty working days of receipt of this form indicating which information it concerns and why it should not be released, giving your reasons in full.

Customer charter

What can I do if I disagree with this compliance assessment report?

If you are unable to resolve the issue with your site officer, you should firstly discuss the matter with the officer's line managers. If you wish to raise your dispute further through our official **Complaints** and Commendations procedure, phone our general enquiry number **0300 065 3000** (Mon to Fri **08.00–18.00**) and ask for the **Customer Contact team** or send an email to enquiries@naturalresourceswales.gov.uk If you are still dissatisfied you can make a complaint to the Public Services Ombudsman for Wales. For advice on how to complain to the Ombudsman phone their helpline on **(0845) 601 0987**.

Meeting notes

Project:	Coed Darcy		
Subject:	Crymlyn Tip Permit Compliance and Surrender		
Date and time:	30 th January 2014, 10:30	Meeting no:	2
Meeting place:	Llan Coed House	Minutes by:	Richard Mitchener
Present:	Mike Poland Richard Mitchener Adam Putt Peter Stanley Kay Roberts Joanne Fitton Gareth Davies	Representing:	Atkins (Operator's consultant) Atkins Atkins CNC/NRW - stability CNC/NRW - hydrogeology CNC/NRW - hydrogeology CNC/NRW - Senior Environment Officer

ITEM	DESCRIPTION & ACTION	RESPONSIBLE
1	Introduction	
1.1	MP set out the complex regulatory background - Remedial Action Plan (RAP) works agreed between BP and EAW in c.2000. The measures within the plan were focused on maintenance and risk management of a mothballed site. - Outline planning consent was granted by Neath Port Talbot Borough Council (NPTBC) for the "urban village" development was granted in XXXX. This consent includes the tip area with the actual landfill to be open space and the lower areas to be part of the surface water management system for the site. - Conditions relating to contamination (the standard conditions) were include din the consent and are discharged on a plot by plot basis, supported by risk assessment as needed. - A Section 106 agreement was signed by BP and NPTBC which imposed, inter alia, particular criteria for the reuse of materials within the site. It is understood that the EAW was consulted on this document but under legal advice did not comment. The RAP required a number of actions in the tip area, including remediation of the lagoons and the installation/maintenance of a marine ply bund within Crymlyn Bog itself to collect any oil seeping from the site into the SAC. Capping of the tip was also included in the RAP. It is understood by Atkins that the use a permeable cap was agreed between URS (as BP's consultant) and the EAW. It was noted that CNC/NRW does not recall any such agreement.	For info

Next meeting:

Distribution:	Attendees plus Neil Williams (St Modwen) Lee Owen (Prosurv)
Date issued:	File ref:

NOTE TO RECIPIENTS:

These meeting notes record Atkins understanding of the meeting and intended actions arising therefrom. Your agreement that the notes form a true record of the discussion will be assumed unless adverse comments are received in writing within five days of receipt.

ITEM	DESCRIPTION & ACTION	RESPONSIBLE
1.2	MP set out the background to the tip. Ash bund constructed in the 1930s to contain oil losses as a result of bombing. At some later time wastes from the site were deposited behind this bund. RM stated that although licensed from 1977 under COPA it is likely that waste was deposited prior to this date. MP highlighted that the licensed area also included a series of lagoons which had, and continue to, form part of the wider site's drainage system. Historically these functioned as oil interceptors and contained a significant volume of oily sludge which was remediated – verification reports for these works have been submitted to the regulators and approved. . In addition, there was a drum store in the lower part of the tip. The drums buried in this area have been removed. A verification report has been submitted to the regulators and approved. MP noted that the tip has received a range of waste included asbestos, vanadium and oily sludges. MP noted that measures to extract oils from the tip were ongoing. approximately 800m³ was collected by Celtic with a further 200m³ collected by Hydrock so far. Works are ongoing.	For info
1.3	MP outlined St. Modwen's objectives: - Formally move tip into long term management - Agree and install cap - Agree aftercare and management plan - Be in compliance with permit requirements - Remove lagoon areas from Environmental Permitting - Sludges have been removed and water quality is much improved - Remove low lying peat lands from the permit.	For info
1.4	GS and PS noted that there was some confusion over what materials had been placed on the tip so far. MP and RM explained that the "Area 1" materials, which were soils and rock which had been remediated (mostly for asbestos), were moved to the tip in 2008 with the agreement of the EAW. These materials were used to improve the land from as a regulation layer rather than a cap.	For info
2	Groundwater	
2.1	GD highlighted the need for a single borehole plan for the area, clearly linking borehole ID numbers to both the data and the borehole logs. AP confirmed that a survey of the remaining boreholes had just been completed. A single plan will be prepared from this. RM confirmed that existing data would be correlated with this new plan in a quality assured way to provide the baseline for ongoing monitoring.	RM
2.2	RM noted that additional borehole logs would be provided. However, no all boreholes from which data has been collected over the years would have an extant log. GD recognised this and did not consider it a bar to progress	RM
2.3	KR noted that the data did not tell a very clear picture of the site condition and groundwater flow directions. There was a discrepancy between the understood site-wide groundwater flow regime and that reported in the ESID. RM proposed that further assessment should be undertaken and that the dataset should, if appropriate be split between leachate	RM

ITEM	DESCRIPTION & ACTION	RESPONSIBLE
	and groundwater in a more explicit way. KR also requested further consideration of seasonal variation. RM noted that there was more data that would enable this to be done.	
2.4	KR & JF noted that not all groundwater quality data was provided in the ESID report. RM acknowledged that all data should be included. RM noted that the data available at the time was old – more recent data would be included in the revised report. MP explained that in terms of receptor monitoring improvements were being implemented to allow access to the boreholes on the bog.	RM
2.5	JF requested that typical landfill contaminants ammonium and chloride be added to the suite. Vanadium should also be added as it is known that this metal had been deposited in the site.	AP
2.6	KR noted that the groundwater quality provided was now quite old and requested that this be updated. RM agreed that more up to date data would be included in the revised report.	RM/AP
2.7	KR requested that the ash bund and the plywood barrier be shown on a drawing in the ESID. RM agreed that this would be done	RM
2.8	JF noted that validation reports had been submitted (voluntarily) for the lagoons and these were generally acceptable. However, no information had been received regarding the soils in the lower area. MP accepted that a validation report would be needed to support surrender of these areas.	To note
2.9	Capping of the site. JF noted that as far as CNC/NRW was concerned there was no agreement that a permeable cap was suitable for the site. PS noted that a landfill directive compliant cap may be required. RM suggested that, given that the site does not have any form of leachate collection or any basal lining, and given that groundwater and leachate are highly likely to be in connection, a low permeability cap would not have any significant environmental benefit. It would either increase the time for the site to reach surrender (as a result of reduced infiltration through the waste) or increase the concentration of dissolved hydrocarbons in groundwater local to the site which could impact the SSSI. RM also noted that although measures were ongoing to remove free oil significant volumes are likely to remain in the pore space even after this work is complete. JF/KR noted that this argument would have to be set out formally in the revised documents. PS stated that is there were to be a movement away from the landfill directive requirements he would seek agreement from others in his team	RM
2.10	JF/KR asked for the ESID drawings to be updated to reflect the issues discussed in the meetings.	RM
2.11	PS requested further discussion on the acceptability criteria set out in the submissions. For some parameters these values were not	

ITEM	DESCRIPTION & ACTION	RESPONSIBLE
	considered conservative enough or consistent with those agreed under the Section 106. It was noted that the values for Hg and Pb may have been transposed in the table.	
3	Stability Risk Assessment	Click to enter text
3.1	PS noted that the samples of the treated sludge proposed for capping had been undertaken at the default strains which were likely to be higher than the strains that the soils would be subjected to when placed. PS required that this was discussed in the SRA	MC
3.2	PS noted that it was not clear how the materials tested (batch 1 and batch 2) related to proposed capping materials. MP explained that these were two batches of sludges that had been remediated through addition of wood chip and then bioremediation. There is enough of these materials to cap the site as proposed and therefore no import of materials was proposed. MP noted that some further testing (chemical and geotechnical) might be needed as the materials were used. It was agreed that the SRA would be updated to make it clearer what was proposed.	RM/MC
3.3	PS asked that the actual aim of the capping works should be clarified.	MC
3.4	PS requested that the history of the site and any agreements made is clarified. RM noted that this would be done in the ESID report.	RM
3.5	PS noted that he was concerned about the lack of surface water management with regards to erosion as well as pore water pressures. MP noted that the low areas of the tip will form the surface water management area for the whole of the southern catchment of Coed Darcy. It was agreed that this would be considered in the SRA more explicitly.	MC/RM
3.6	PS requested justification for not analysing the slopes using residual shear strength. While PS recognised that if the proposed materials were non-plastic this could be appropriate but discussion is needed.	MC
3.7	PS noted that the peat present beneath the waste had not been considered in the stability analysis. RM noted that as the peat was effectively horizontal and no basal containment was assumed in any assessment it wasn't important. PS requested that the peat was discussed within the text and either ruled out or assessed using appropriate values.	MC
3.8	PS also noted that the ash bund had not been assessed. If the SRA was to satisfy the improvement condition then this would need to be discussed/assessed as it contains the waste on this boundary.	MC
3.9	PS requested that all analysis included consideration of plant loadings where appropriate.	MC
3.10	PS requested that details of the volumes to be used, their source	MC

ITEM	DESCRIPTION & ACTION	RESPONSIBLE
	and validation testing to be undertaken be provided. In particular he requested clarification on the asbestos content that would be acceptable MP noted that it may be necessary to import topsoil but other materials would be won from within the Coed Darcy site.	
3.11	PS requested discussion of differential settlement, especially with regard to the potential for voids within the waste. If available, historical photographs would be very helpful.	MC/AP
3.12	PS expressed concern about planting trees on the site given the relatively thin cap proposed. RM undertook to review this with the ecologists	RM
3.13	It was agreed that the revised report would be submitted to satisfy the permit requirements for an SRA as well as supporting the CQA report.	MC
4	Surrender	
4.1	GD noted that he had spoken to Nadine Jones and Paul Williams in the permitting and installations team. He confirmed that RGN6 and EPR 5.02 were the appropriate guidance documents.	To note
4.2	It was noted that the Section 106 was not signed by the EAW. Therefore any application based on compliance with the Section 106 would need to justify these values. MP noted that Atkins had reviewed the numbers which in many cases were lower than Atkins' SSVs. Where Atkins' numbers were lower these have been used.	To note
4.3	The boundary will need to be clearly defined, and ideally marked on the ground.	AP
4.4	Records of waste deposits should be provided in the surrender application where applicable.	AP
4.5	Where remediation had been undertaken the reasons for this and the outcomes should be set out.	To note
4.6	The monitoring that is being undertaken (whether as part of the landfill management or the wider site) should be set out clearly.	To note
4.7	The long term use of the areas to be surrendered should be provided to give context.	To note
4.8	GD suggested a pre application meeting should be held before progressing the surrender application.	To note

Appendix B

Ground Gas Monitoring Coed Darcy

12 monitoring rounds were conducted from Oct 2010 to May2013.
The results have been screened against EA 140016 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15141606/LFTGN015.pdf) 1% threshold for methane and 1.5% threshold for carbon dioxide.

Key

Exceedance of 1% of CH₄

Exceedance of 1.5% of CO₂

Detectable H₂S or CO

Round	Date	Borehole ID	Flow Peak (l/h)	Flow Steady (l/h)	CH4 Peak %	CH4 Steady %	CH4 Steady > 1%	CO2 Peak %	CO2 Steady %	CO2 Steady > 1.5%	O2 Peak %	O2 Steady %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative pressure	Location
1	12/10/2010	CARW024		0		0.6	N		2	1		19.3	1	1		N	1017		In landfill
1	12/10/2010	CARW029b		0		0.2	N		0.5	N		20.9		N		N	1017		Non-landfill site 1
1	12/10/2010	MSMW033d		0		0.1	N		1.6	1		19.2		N		N	1017	-0.2	Non-landfill permit area
1	12/10/2010	MSMW033s		0.1		0	N		0	N		21.5		N		N	1017	-0.2	Non-landfill permit area
1	12/10/2010	MSMW034		0.2		0.1	N		0.1	N		20.9		N		N	1017	-0.2	Non-landfill permit area
1	12/10/2010	MSMW035d		0		0	N		0	N		21		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW035d2		0.1		0	N		0	N		21		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW035s		0.1		0	N		0	N		21.2		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW152d		0		0.1	N		0	N		21.5		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW156d		0		0.1	N		0	N		21.2		N		N	1017	-0.2	Non-landfill permit area
1	12/10/2010	MSMW228		0		0.1	N		0.7	N		20.1		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW235		1.5		15.9	1		11.5	1		0.6		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW236		0		2.4	1		0.2	N		20.8		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW238		0		0.7	N		2.9	1		16.2		N		N	1017	-0.2	In landfill
1	12/10/2010	MSMW239		0		0.1	N		0	N		21.5		N		N	1017	-0.2	Non-landfill permit area
2	25/10/2010	CARW024		-1.1		0.8	N		3.5	1		18.8	0	N		1	1025		In landfill
2	25/10/2010	CARW029b		-1.1		1.3	1		1.5	1		18.8	0	N		0	1025		Non-landfill site 1
2	25/10/2010	MSMW033d		-1		0	N		2	1		19.5	0	N		0	1025	0.6	Non-landfill permit area
2	25/10/2010	MSMW033s		-1		0	N		0.2	N		21.8	0	N		0	1025	0.6	Non-landfill permit area
2	25/10/2010	MSMW034		-1		0.1	N		0.9	N		20.2	0	N		0	1025	0.6	Non-landfill permit area
2	25/10/2010	MSMW035d		-1		0	N		1	N		21	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW035d2		-1		0	N		0.4	N		21.5	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW035s		-1		0	N		0.2	N		21.5	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW152d		-1		0.1	N		0.3	N		21.6	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW156d		-0.8		0.1	N		0.1	N		21.8	0	N		0	1025	0.6	Non-landfill permit area
2	25/10/2010	MSMW228		-1.1		0.1	N		9.1	1		5.6	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW235		-1.1		13	1		12.1	1		0.5	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW236		-1.1		44.6	1		4.4	1		10.2	0	N		1	1025	0.6	In landfill
2	25/10/2010	MSMW238		-0.8		5.2	1		10.3	1		4.2	0	N		0	1025	0.6	In landfill
2	25/10/2010	MSMW239		-1		0.3	N		3	1		18	0	N		0	1025	0.6	Non-landfill permit area
3	17/11/2010	CARW024		-0.4		0.1	N		6	1		17.6		N		N	995		In landfill
3	17/11/2010	MSMW033d		-0.3		0	N		1.9	1		19.2		N		N	995	0.51	Non-landfill permit area
3	17/11/2010	MSMW033s		-0.3		0	N		0.1	N		21.6		N		N	995	0.51	Non-landfill permit area
3	17/11/2010	MSMW034		-0.3		0	N		0.4	N		21.1		N		N	995	0.51	Non-landfill permit area
3	17/11/2010	MSMW035d		-0.3		0.1	N		1.2	N		20.9		N		N	995	0.51	In landfill
3	17/11/2010	MSMW035d2		-0.3		0	N		0.2	N		21.5		N		N	995	0.51	In landfill
3	17/11/2010	MSMW035s		-0.3		0	N		0.6	N		21.4		N		N	995	0.51	In landfill
3	17/11/2010	MSMW152d		-0.4		0	N		0.2	N		21.8		N		N	995	0.51	In landfill
3	17/11/2010	MSMW156d		-0.3		0.1	N		0.1	N		21.6		N		N	995	0.51	Non-landfill permit area
3	17/11/2010	MSMW235		1.6		16.4	1		8.8	1		1.2		N		N	995	0.51	In landfill
3	17/11/2010	MSMW236		1.2		0.1	N		0.2	N		21.2		N		N	995	0.51	In landfill
4	19/04/2011	CARW024		-1		0.1	N		0.6	N		19.6	0	N		1	1013		In landfill
5	28/11/2011	CARW015	0	0		40.5	1		4.2	1		1.1	0	N		0	1015	NR	Non-landfill site 1
5	28/11/2011	CARW024	0	0		0	N		0.3	N		21.2	0	N		0	1015	NR	In landfill
5	28/11/2011	CARW025	9	1.5		90.6	1		1.2	N		0.3	7	1		0	1015	NR	Non-landfill site 1
5	28/11/2011	CARW029b	4.4	0.2		0.8	N		2.3	1		19.7	0	N		0	1015	NR	Non-landfill site 1
5	28/11/2011	GA7s	6	0		0	N		0.9	N		20.7	0	N		0	1015	NR	Non-landfill permit area
5	28/11/2011	MSMW154d	2.7	0		0.4	N		0.3	N		20.4	0	N		2	1016	NR	Offsite (south)

Round	Date	Borehole ID	Flow Peak (l/h)	Flow Steady (l/h)	CH4 Peak %	CH4 Steady %	CH4 Steady > 1%	CO2 Peak %	CO2 Steady %	CO2 Steady > 1.5%	O2 Peak %	O2 Steady %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative pressure	Location
5	28/11/2011	MSMW154s	-0.2	0		1.3	1		13.9	1		1	0	N	0	N	1016	NR	Offsite (south)
5	28/11/2011	MSMW155d	1.4	0		0	N		0.4	N		20.7	0	N	0	N	1015	NR	Non-landfill permit area
5	28/11/2011	MSMW155s	0.2	0		0	N		0.1	N		21.3	0	N	0	N	1015	NR	Non-landfill permit area
5	28/11/2011	MSMW156d	0	0		0	N		3.1	1		20.2	0	N	0	N	1015	NR	Non-landfill permit area
5	28/11/2011	MSMW156s1	-2.2	0		0.4	N		6	1		7.1	0	N	0	N	1015	NR	Non-landfill permit area
5	28/11/2011	MSMW156s2	0	0		5.8	1		6.6	1		20.6	0	N	0	N	1015	NR	Non-landfill permit area
6	06/12/2011	CARW015	0	0		14.2	1		2.9	1		0.6	0	N	0	N	1007	-0.16	Non-landfill site 1
6	06/12/2011	CARW024	0	0		0	N		0.7	N		21.1	0	N	0	N	1007	-0.27	In landfill
6	06/12/2011	CARW025		Tap open		73.8	1		0.6	N		5.8	2	1	0	N	1007	-0.16	Non-landfill site 1
6	06/12/2011	CARW029b	0	0		0	N		0.6	N		21.5	0	N	0	N	1007	3.71	Non-landfill site 1
6	06/12/2011	GA7s	0	0		0	N		1.3	N		20.8	0	N	0	N	1007	0.08	Non-landfill permit area
6	06/12/2011	MSMW154d	0	0		8.2	1		2.7	1		17	0	N	2	1	1007	-0.04	Offsite (south)
6	06/12/2011	MSMW154s	0.7	0		19.9	1		13.1	1		0.9	0	N	0	N	1007	-0.04	Offsite (south)
6	06/12/2011	MSMW155d	0.5	0		0.3	N		1.8	1		19.2	0	N	0	N	1007	-0.04	Non-landfill permit area
6	06/12/2011	MSMW155s	5.5	0		0.9	N		0.5	N		19.8	0	N	0	N	1007	-0.04	Non-landfill permit area
6	06/12/2011	MSMW156d	0	0		0	N		0.3	N		21.7	0	N	0	N	1007	-0.37	Non-landfill permit area
6	06/12/2011	MSMW156s1	0	0		3.5	1		4.2	1		16.1	0	N	0	N	1007	-0.37	Non-landfill permit area
6	06/12/2011	MSMW156s2	0.3	0		34.2	1		4.2	1		11.5	7	1	0	N	1007	-0.37	Non-landfill permit area
7	15/12/2011	CARW024	0	0		0	N		0.4	N		21.4	0	N	0	N	1000	1.56	In landfill
7	15/12/2011	CARW025	16.8	2.2		99.9	1		0.6	N		0.6	0	N	0	N	1000	-0.46	Non-landfill site 1
7	15/12/2011	CARW029b	0.2	0		0.6	N		2.1	1		19.7	0	N	0	N	1000	1.56	Non-landfill site 1
7	15/12/2011	GA7s	0	0		0	N		3	1		20.1	0	N	0	N	1000	2.6	Non-landfill permit area
7	15/12/2011	MSMW154d	-2.4	0		4.8	1		1.8	1		18.3	0	N	0	N	1000	-0.51	Offsite (south)
7	15/12/2011	MSMW154s	-4.4	0		15.5	1		11.2	1		3.5	0	N	0	N	1000	-0.51	Offsite (south)
7	15/12/2011	MSMW155d	-0.1	0		0.2	N		1.3	N		20.5	0	N	0	N	1000	-0.45	Non-landfill permit area
7	15/12/2011	MSMW155s	6.2	0		3.6	1		1.1	N		18	0	N	0	N	1000	-0.45	Non-landfill permit area
7	15/12/2011	MSMW156d	0	0	0.1	0	N		0.3	N		21.6	0	N	0	N	1000	-0.45	Non-landfill permit area
7	15/12/2011	MSMW156s1	-0.8	0	6	5.7	1	3	2.7	1		19.1	0	N	0	N	1000	-0.45	Non-landfill permit area
7	15/12/2011	MSMW156s2	-1.4	0	42.8	0.8	N	4.4	0.1	N	9.9	21.5	2	1	3	1	1000	-0.45	Non-landfill permit area
8	03/01/2012	CARW015	-2.3	0		0.4	N		2.7	1		1.8		N		N		1.64	Non-landfill site 1
8	03/01/2012	CARW024	0	0		0	N		0.1	N		21.4	0	N	0	N	1006	-82.2	In landfill
8	03/01/2012	CARW025	22.3	1.6		90.8	1		0.4	N		3.1	8	1	0	N	1006	-0.46	Non-landfill site 1
8	03/01/2012	CARW029b	0	0		0.1	N		0.2	N		21.3	0	N	0	N	1006	0	Non-landfill site 1
8	03/01/2012	GA7s	-7.5	0		0.1	N		4.3	1		18.9	0	N	0	N	1006	-0.17	Non-landfill permit area
8	03/01/2012	MSMW154d	7.9	1.3		3.3	1		1.3	N		18.8	0	N	9	1	1006	-0.14	Offsite (south)
8	03/01/2012	MSMW154s	6.2	1.2		13.1	1		11.8	1		0.7	0	N	0	N	1006	-0.14	Offsite (south)
8	03/01/2012	MSMW155d	-0.4	0		0.1	N		1.5	1		18.9	0	N	0	N	1006	-0.17	Non-landfill permit area
8	03/01/2012	MSMW155s	3.9	0.1		2.9	1		1.5	1		16.4	0	N	0	N	1006	-0.17	Non-landfill permit area
8	03/01/2012	MSMW156d	0	0		0	N		0.1	N		21.5	0	N	0	N	1006	-82.2	Non-landfill permit area
8	03/01/2012	MSMW156s1	0	0		2.9	1		2.7	1		18.8	0	N	0	N	1006	-82.2	Non-landfill permit area
8	03/01/2012	MSMW156s2	0	0		34.1	1		4.3	1		10.3	0	N	6	1	1006	-14.39	Non-landfill permit area
9	12/02/2013	CARW024	0	0	0.1	0.1	N		0.1	N		20.9	0	N	0	N		0.38	In landfill
9	12/02/2013	CARW025	0	0	0.2	0.2	N		0.1	N		20.9	0	N	0	N	1021	0.63194444	Non-landfill site 1
9	12/02/2013	CARW029b	0	0	0.1	0.1	N		0.2	N		20.8	0	N	0	N	1021	1.01	Non-landfill site 1
9	12/02/2013	GA7s	0.2	0.1	7	4.5	1	0	2.4	1	0	8.1	0	N	0	N	1021	0.68	Non-landfill permit area
9	12/02/2013	MSMW154d	0	0	50.3	49.6	1	0	5.7	1	0	6.8	0	N	0	N	1021	0.4	Offsite (south)
9	12/02/2013	MSMW154s	0.1	0.1		83.7	1		7.8	1		0.9	0	N	0	N	1021	0.4	Offsite (south)
9	12/02/2013	MSMW155d	0.1	0.1	0.3	0.1	N	0	0.3	N	0	20.3	0	N	0	N	1021	0.4	Non-landfill permit area
9	12/02/2013	MSMW155s	0	0	0.2	0.2	N	0	0.1	N	0	20.7	0	N	0	N	1021	0.4	Non-landfill permit area
9	12/02/2013	MSMW156d	0	0	0.6	0.6	N		2.8	1		19.5	0	N	0	N	1021	-1.9	Non-landfill permit area
9	12/02/2013	MSMW156s1	0	0	3.6	3.6	1		2.4	1		18.4	0	N	0	N	1021	-1.9	Non-landfill permit area
9	12/02/2013	MSMW156s2	0.1	0.1	1	0.9	N		0.2	N		20.4	0	N	0	N	1021	-1.9	Non-landfill permit area
10	09/04/2013	CARW002	0.4	0	0.1	0	N		0.4	N		21.6	0	N	0	N	1002	0	Offsite (east)
10	09/04/2013	CARW005	2.1	0.2	0	0	N		0	N		21.7	0	N	0	N	1002	0	Offsite (east)
10	09/04/2013	CARW007	0	0	0	0	N		0.6	N		21	0	N	0	N	1002	0	Non-landfill permit area
10	09/04/2013	CARW024	0	0	0	0	N		0	N		21.5	0	N	1	1	1003	0	In landfill
10	09/04/2013	CARW025	5.1	3.8	94.6	31.6	1		0.1	N		19.6	0	N	0	N	1003	0	Non-landfill site 1
10	09/04/2013	CARW029b	0.1	0	0	0	N		0.3	N		21.3	0	N	0	N	1003	0	Non-landfill site 1
10	09/04/2013	CBH02	-0.1	-0.1	0	0	N		0	N		21.6	0	N	0	N	1003	-0.02	In landfill
10	09/04/2013	CBH04	0.1	0.1	0.3	0.3	N		0	N		21.4	0	N	0	N	1003	-0.02	In landfill

Round	Date	Borehole ID	Flow Peak (l/h)	Flow Steady (l/h)	CH4 Peak %	CH4 Steady %	CH4 Steady > 1%	CO2 Peak %	CO2 Steady %	CO2 Steady > 1.5%	O2 Peak %	O2 Steady %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative pressure	Location
10	09/04/2013	CBH20	0.2	2	34.9	34.7	1		8.6	1		1.5	0	N	0	N	1003	0.05	Offsite (east)
10	09/04/2013	CBH31	0.5	0.4	44.7	44.7	1		4.6	1		2.1	11	1	2	1	1003	0.05	In landfill
10	09/04/2013	CBH33	-0.1	-0.1	2.8	2.8	1		7.7	1		3.7	0	N	1	1	1004	0.05	In landfill
10	09/04/2013	CBH36	0.1	0.1	3.2	3.2	1		9.7	1		3.9	0	N	1	1	1003	0.07	In landfill
10	09/04/2013	CBH37	0.1	0	0.8	0.8	N		5.7	1		10.3	0	N	1	1	1003	0.07	In landfill
10	09/04/2013	CBH41	0	0	12.7	11.6	1		2.5	1		15.7	0	N	0	N	1003	0.06	In landfill
10	09/04/2013	CBH42	-0.1	0	18	18	1		1.7	1		15.5	0	N	1	1	1001	-0.05	In landfill
10	09/04/2013	CBH48	-0.1	0.1	8.8	8.7	1		7.6	1		2.1	0	N	1	1	1003	0.05	In landfill
10	09/04/2013	CBH58	0	0	0.5	0.5	N		2.7	1		16.3	0	N	1	1	1004	0.05	In landfill
10	09/04/2013	CBH63	-0.1	-0.1	0	0	N		11.1	1		4.7	0	N	1	1	1003	0.08	In landfill
10	09/04/2013	GA7s	0	0	0.1	0.1	N		0.1	N		21.4	0	N	0	N	1003	-0.02	Non-landfill permit area
10	09/04/2013	MSMW027s	-0.1	-0.1	0	0.1	N		0	N		21.7	0	N	0	N	1002	-0.02	Non-landfill permit area
10	09/04/2013	MSMW034d2	0	0	0	0	N		0.1	N		21.4	0	N	0	N	1002	0	Non-landfill permit area
10	09/04/2013	MSMW035d	0	0	0	0	N		0.1	N		21.4	0	N	1	1	1002	0	In landfill
10	09/04/2013	MSMW035d2	0	0	0	0	N		0.1	N		21.4	0	N	0	N	1002	0	In landfill
10	09/04/2013	MSMW035s	0	0	0	0	N		0.3	N		21.6	0	N	0	N	1002	0	In landfill
10	09/04/2013	MSMW155d	0	0	0	0	N		0.2	N		21.6	0	N	0	N	1003	-0.02	Non-landfill permit area
10	09/04/2013	MSMW155s	0	0	1.6	0.9	N		0.1	N		21.5	0	N	0	N	1003	-0.02	Non-landfill permit area
10	09/04/2013	MSMW156d	0	0	0	0	N		0	N		21.7	0	N	1	1	1003	0.01	Non-landfill permit area
10	09/04/2013	MSMW156s1	0.8	0.2	0.8	0.5	N		0.3	N		20.9	0	N	0	N	1003	0.01	Non-landfill permit area
10	09/04/2013	MSMW156s2	0	0	0.8	0.2	N		0	N		21.6	0	N	0	N	1003	0.01	Non-landfill permit area
10	09/04/2013	MSMW235	0.2	0.2	20.8	20.8	1		9.7	1		0.7	5	1	2	1	1001	0.05	In landfill
10	09/04/2013	MSMW236	0	0	11.5	11.5	1		1.1	N		18.7	0	N	1	1	1001	0.05	In landfill
10	09/04/2013	MSMW238	0	0	39.4	39	1		5.2	1		11.6	0	N	0	N	1001	0.05	In landfill
11	24/04/2013	CARW002	0	0	0.1	0.1	N		2.4	1		20.6	0	N	0	N	1026	0.11	Offsite (east)
11	24/04/2013	CARW005	0	0	0	0	N		0.1	N		21.3	0	N	0	N	1027	0.09	Offsite (east)
11	24/04/2013	CARW007	-0.1	-0.1	0	0	N		0.7	N		20.6	0	N	0	N	1027	0.09	Non-landfill permit area
11	24/04/2013	CARW024	0	0	0	0	N		0.4	N		20.9	0	N	0	N	1026	0.13	In landfill
11	24/04/2013	CARW025	9.5	4.3	84.1	17.4	1		0.4	N		17.1	0	N	0	N	1026	0.12	Non-landfill site 1
11	24/04/2013	CARW029b	0	0	0.1	0	N		0.1	N		0.1	0	N	0	N	1026	0.12	Non-landfill site 1
11	24/04/2013	CBH02	0	0	0	0	N		0.1	N		21.2	0	N	0	N	1026	0.11	In landfill
11	24/04/2013	CBH04	0	0	0.4	0.4	N		0.2	N		21	0	N	0	N	1026	0.11	In landfill
11	24/04/2013	CBH20	0.2	0.2	35	34.9	1		9.1	1		0.5	2	1	10	1	1025	0.13	Offsite (east)
11	24/04/2013	CBH31	0	0	33.2	33.2	1		5.6	1		4.7	211	1	3	1	1025	0.11	In landfill
11	24/04/2013	CBH33	0	0	0	0	N		0	N		21.5	0	N	0	N	1025	0.14	In landfill
11	24/04/2013	CBH36	0	0	0	0	N		0	N		21.4	0	N	0	N	1025	0.14	In landfill
11	24/04/2013	CBH37	0	0	0.2	0.2	N		0.6	N		19.5	0	N	0	N	1025	0.14	In landfill
11	24/04/2013	CBH41	16	15.9	64.1	63.9	1		3	1		0.7	2	1	0	N	1025	0.1	In landfill
11	24/04/2013	CBH42	0	0	53.2	53.2	1		5.3	1		0.6	0	N	8	1	1025	0.14	In landfill
11	24/04/2013	CBH48	0.1	0.1	2.5	2.5	1		4.3	1		11.9	0	N	0	N	1025	0.09	In landfill
11	24/04/2013	CBH58	0	0	0.2	0	N		0.2	N		21.1	0	N	0	N	1025	0.11	In landfill
11	24/04/2013	CBH63	-0.2	-0.2	0	0	N		2.9	1		17.5	0	N	0	N	1025	0.1	In landfill
11	24/04/2013	GA7s	0	0	0	0	N		0.3	N		21.4	0	N	0	N	1027	0.2	Non-landfill permit area
11	24/04/2013	MSMW027s	0	0	0	0	N		0	N		21.4	0	N	0	N	1027	0.1	Non-landfill permit area
11	24/04/2013	MSMW034d2	0	0	0	0	N		0.2	N		21.1	0	N	0	N	1026	0.11	Non-landfill permit area
11	24/04/2013	MSMW035d	-0.1	-0.1	0	0	N		0.3	N		21.4	0	N	0	N	1027	0.07	In landfill
11	24/04/2013	MSMW035d2	0	0	0	0	N		0.1	N		21.4	0	N	0	N	1027	0.07	In landfill
11	24/04/2013	MSMW035s	-4.5	-4.5	0	0	N		2.2	1		19	0	N	0	N	1027	0.07	In landfill
11	24/04/2013	MSMW154d	-4.7	-4.7	0.2	0.2	N		0.3	N		20.7	0	N	0	N	1027	0.07	Offsite (south)
11	24/04/2013	MSMW154s	0	0	3.3	1.3	1		2.7	1		16.9	0	N	0	N	1027	0.07	Offsite (south)
11	24/04/2013	MSMW155d	0	0	0	0	N		0.4	N		21.3	0	N	0	N	1027	0.09	Non-landfill permit area
11	24/04/2013	MSMW155s	-3.8	-3.8	0.1	0.1	N		0	N		20.9	0	N	0	N	1027	0.09	Non-landfill permit area
11	24/04/2013	MSMW156d	0	0	0	0	N		0.1	N		21.4	0	N	0	N	1026	0.13	Non-landfill permit area
11	24/04/2013	MSMW156s1	0.1	0.1	0.1	0.1	N		0.5	N		21	0	N	0	N	1026	0.13	Non-landfill permit area
11	24/04/2013	MSMW156s2	0.2	0.1	0	0	N		0	N		21.4	0	N	0	N	1026	0.13	Non-landfill permit area
11	24/04/2013	MSMW235	0	0	20.4	20.4	1		9.5	1		0.3	0	N	2	1	1025	0.11	In landfill
11	24/04/2013	MSMW236	0	0	16.1	16.1	1		7.9	1		11	0	N	0	N	1025	0.11	In landfill
11	24/04/2013	MSMW238	0	0	34.8	34.8	1		5.8	1		11.8	0	N	0	N	1025	0.11	In landfill
12	08/05/2013	CARW002	-0.2	-0.2	0.6	0.6	N		7.2	1		16.9	0	N	4	1	1004	0.07	Offsite (east)
12	08/05/2013	CARW005	0.4	0.4	0.2	0.2	N		0.8	N		19.7	0	N	0	N	1004	0.07	Offsite (east)

Round	Date	Borehole ID	Flow Peak (l/h)	Flow Steady (l/h)	CH4 Peak %	CH4 Steady %	CH4 Steady > 1%	CO2 Peak %	CO2 Steady %	CO2 Steady > 1.5%	O2 Peak %	O2 Steady %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative pressure	Location
12	08/05/2013	CARW007	0	0	0.1	0.1	N		0.5	N		20.9	0	N	0	N	1004	0.07	Non-landfill permit area
12	08/05/2013	CARW024	0	0	0.1	0.1	N		0	N		21.3	0	N	0	N	1004	-0.05	In landfill
12	08/05/2013	CARW025	0	0	31.5	20.5	1		14.5	1		14	0	N	0	N	1004	-0.07	Non-landfill site 1
12	08/05/2013	CARW029b	0	0	2	1.8	1		0.05	N		20.5	0	N	0	N	1005	-0.06	Non-landfill site 1
12	08/05/2013	CBH02	0	0	0.2	0.2	N		0.8	N		19.6	0	N	0	N	1004	0.04	In landfill
12	08/05/2013	CBH04	0	0	0.6	0.6	N		0.1	N		21	0	N	0	N	1004	0.04	In landfill
12	08/05/2013	CBH20	0.2	0.2	39.1	39.1	1		9.4	1		0.7	16	1	2	1	1003	0.18	Offsite (east)
12	08/05/2013	CBH31	0	0	45.8	45.8	1		4.2	1		0.1	368	1	3	1	1003	0.18	In landfill
12	08/05/2013	CBH33	0	0	0.4	0.3	N		0	N		21.5	0	N	0	N	1003	0.14	In landfill
12	08/05/2013	CBH36	0	0	0.1	0.1	N		0	N		21.5	0	N	0	N	1003	0.06	In landfill
12	08/05/2013	CBH37	0.1	0.1	0.1	0.1	N		0	N		21.5	0	N	0	N	1003	0.14	In landfill
12	08/05/2013	CBH41	0.2	0.2	46.8	46.8	1		2.6	1		0.9	0	N	0	N	1003	0.14	In landfill
12	08/05/2013	CBH42	0	0	84.8	84.4	1		2.2	1		0.9	0	N	0	N	1004	0.07	In landfill
12	08/05/2013	CBH48	0	0	11.7	11.7	1		8.7	1		0.4	0	N	2	1	1003	0.18	In landfill
12	08/05/2013	CBH58	0	0	0.1	0.1	N		0	N		21.4	2	1	0	N	1003	0.14	In landfill
12	08/05/2013	CBH63	0	0	0.1	0.1	N		1.9	1		19.2	0	N	0	N	1003	0.06	In landfill
12	08/05/2013	GA7s	0	0	0.1	0.2	N		0.7	N		20.3	0	N	0	N	1004	-0.05	Non-landfill permit area
12	08/05/2013	MSMW027s	0	0	0.1	0.1	N		2.8	1		17.7	0	N	0	N	1004	-0.07	Non-landfill permit area
12	08/05/2013	MSMW034d2	0.2	0.2	0.1	0.1	N		0.6	N		20.3	0	N	0	N	1004	0.07	Non-landfill permit area
12	08/05/2013	MSMW035d	0.2	0.2	0.1	0.1	N		0.8	N		20.5	0	N	0	N	1004	0.06	In landfill
12	08/05/2013	MSMW035d2	0.2	0.2	0.1	0.1	N		0.3	N		21.4	0	N	0	N	1004	0.06	In landfill
12	08/05/2013	MSMW035s	0	0	0.1	0.1	N		1.7	1		19.6	0	N	0	N	1004	0.06	In landfill
12	08/05/2013	MSMW154d	0.1	0.1	0.2	0.2	N		0.3	N		20.8	0	N	1	1	1004	-0.05	Offsite (south)
12	08/05/2013	MSMW154s	0.1	0.1	18.6	18.6	1		12.8	1		0.8	0	N	1	1	1004	-0.05	Offsite (south)
12	08/05/2013	MSMW155d	0.1	0.1	0.1	0.1	N		0.1	N		21.5	0	N	0	N	1004	-0.07	Non-landfill permit area
12	08/05/2013	MSMW155s	-2	-2	0.1	0.1	N		1.2	N		17.8	0	N	0	N	1004	-0.07	Non-landfill permit area
12	08/05/2013	MSMW156d	0	0	0.1	0.1	N		0	N		21.4	0	N	0	N	1004	-0.05	Non-landfill permit area
12	08/05/2013	MSMW156s1	0.1	0.1	0.1	0.1	N		0.1	N		21.3	0	N	0	N	1004	-0.05	Non-landfill permit area
12	08/05/2013	MSMW156s2	0.1	0.1	17.4	17.4	1		1.2	N		16.8	0	N	4	1	1004	-0.05	Non-landfill permit area
12	08/05/2013	MSMW235	-0.2	-0.2	23	22.9	1		9.4	1		0.8	0	N	2	1	1004	0.04	In landfill
12	08/05/2013	MSMW236	0	0	22.3	22.2	1		7.4	1		4.4	1	1	1	1	1004	0	In landfill
12	08/05/2013	MSMW238	0.1	0.1	34.9	34.9	1		7	1		6.1	0	N	1	1	1004	0	In landfill

Appendix C

Ground Gas Monitoring Coed Darcy

5 monitoring rounds were conducted from Oct 2013 to May 2014.

The results have been screened against EA 140016 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15141606/LFTGN015.pdf) 1% threshold for methane and 1.5% threshold for carbon dioxide.

The data has been provided by Atkins site team situated on Coed Darcy site.

Key

Exceedance of 1% of CH₄

Exceedance of 1.5% of CO₂

Detectable H₂S or CO

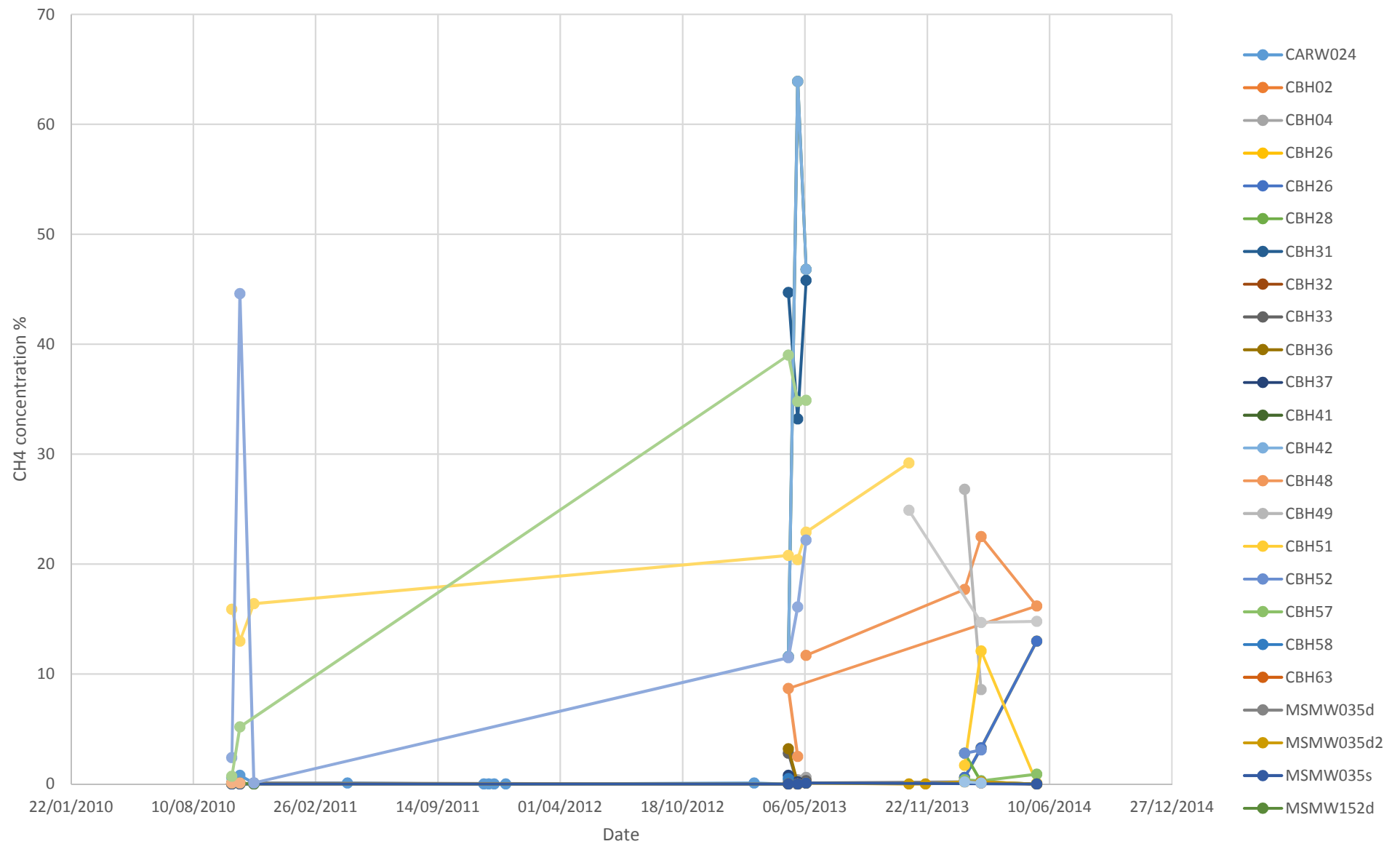
Round	Date	Borehole ID	Flow l/hr	CH4 Peak %	CH4 Steady %	CH4 Steady >1%	CO2 Peak %	CO2 Steady %	CO2 Steady >1%	O2 Steady %	O2 Min %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative Pressure	Location
13	23/10/2013	CARW029b	8.7	0.1	0.1	N	2.7	2.0	1	18.9	18.8	0.0	N	0.0	N	993	1.4	Non-landfill site 1
13	23/10/2013	GA7s	1.1	0.3	0.2	N	13.1	12.3	1	3.0	1.5	0.0	N	1.0	1	990	20.4	Non-landfill permit area
13	23/10/2013	MSMW027s	0.1	0.0	0.0	N	7.0	7.0	1	11.4	11.4	0.0	N	0.0	N	991	-0.4	Non-landfill permit area
13	23/10/2013	MSMW035d2	3.7	0.1	0.0	N	2.0	1.4	1	19.9	19.5	0.0	N	0.0	N	1003	0.2	In landfill
13	23/10/2013	MSMW154s		3.6	3.3	1	10.2	8.3	1	7.2	7.2	0.0	N	2.0	1	990	9.1	Offsite (south)
13	23/10/2013	MSMW155d	3.2	0.0	0.0	N	1.3	1.3	1	19.8	19.8	0.0	N	0.0	N	993	16.7	Non-landfill permit area
13	23/10/2013	MSMW155s	7.3	2.6	2.5	1	0.7	0.7	N	19.8	19.7	0.0	N	0.0	N	993	-0.4	Non-landfill permit area
13	23/10/2013	MSMW156d	0.1	0.1	0.0	N	0.2	0.1	N	21.0	19.8	0.0	N	1.0	1	998	-0.6	Non-landfill permit area
13	23/10/2013	MSMW156s1	4.9	76.6	64.8	1	13.8	11.2	1	3.8	2.1	9.0	1	0.0	N	999	0.7	Non-landfill permit area
13	23/10/2013	MSMW156s2	5.9	29.9	25.8	1	8.7	8.0	1	7.0	6.9	0.0	N	0.0	N	999	-1.6	Non-landfill permit area
13	23/10/2013	MSMW231	0.1	25.3	24.9	1	6.8	6.7	1	1.9	1.8	0.0	N	1.0	1	1012	-0.7	In landfill
13	23/10/2013	MSMW235	0.0	29.2	29.2	1	10.0	10.0	1	0.1	0.1	0.0	N	3.0	1	994	1.4	In landfill
14	19/11/2013	CARW007	-1.7	0.2	0.1	N	1.7	1.0	1	20.6	20.0	0.0	N	0.0	N	1016	-0.6	Non-landfill permit area
14	19/11/2013	CARW008	-2.4	1.2	0.3	N	4.4	0.9	N	20.3	15.7	0.0	N	4.0	1	1016	-0.6	Non-landfill permit area
14	19/11/2013	CARW009	-2.5	0.1	0.1	N	0.5	0.5	N	20.9	20.9	0.0	N	2.0	1	1016	-0.6	Non-landfill permit area
14	19/11/2013	CARW025	-0.5	80.5	14.2	1	1.1	0.2	N	18.3	7.7	0.0	N	1.0	1	1015	0.7	Non-landfill site 1
14	19/11/2013	CARW029b	1.8	0.2	0.1	N	4.0	4.0	1	8.2	8.2	0.0	N	0.0	N	1015	0.0	Non-landfill site 1
14	19/11/2013	CARW033	-1.4	0.1	0.0	N	1.7	0.4	N	21.4	21.0	0.0	N	6.0	1	1015	-0.6	Non-landfill permit area
14	19/11/2013	CARW034	-1.2	0.5	0.4	N	0.2	0.1	N	21.3	21.2	0.0	N	0.0	N	1015	-0.2	Non-landfill permit area
14	19/11/2013	GA7s	-4.3	0.1	0.1	N	6.6	6.6	1	11.6	11.6	0.0	N	0.0	N	1015	-1.5	Non-landfill permit area
14	19/11/2013	MSMW027s	0.0	0.1	0.0	N	5.2	5.2	1	15.4	14.3	0.0	N	0.0	N	1015	-0.5	Non-landfill permit area
14	19/11/2013	MSMW029s	0.0	0.2	0.2	N	1.5	1.4	1	19.0	19.0	0.0	N	5.0	1	1015	-0.6	Non-landfill permit area
14	19/11/2013	MSMW035d2	0.0	0.0	0.0	N	4.7	4.7	1	17.6	16.6	0.0	N	1.0	1	1016	-0.7	In landfill
14	19/11/2013	MSMW154d	-8.0	2.3	2.3	1	4.4	4.4	1	13.6	13.6	0.0	N	4.0	1	1015	-7.9	Offsite (south)
14	19/11/2013	MSMW154s	-4.0	33.2	33.2	1	11.3	11.3	1	4.0	4.0	0.0	N	3.0	1	1015	-0.9	Offsite (south)
14	19/11/2013	MSMW155d	-0.4	0.1	0.0	N	1.8	0.1	N	21.5	18.8	0.0	N	0.0	N	1015	-0.4	Non-landfill permit area
14	19/11/2013	MSMW155s	-1.7	0.5	0.4	N	1.6	1.6	1	16.4	16.5	0.0	N	0.0	N	1015	-1.7	Non-landfill permit area
14	19/11/2013	MSMW156d	-1.0	0.1	0.0	N	0.3	0.2	N	21.4	19.3	0.0	N	0.0	N	1015	-0.6	Non-landfill permit area
14	19/11/2013	MSMW156s1	-1.2	67.1	67.1	1	6.8	6.1	1	3.6	3.5	1.0	1	6.0	1	1015	-0.5	Non-landfill permit area
14	19/11/2013	MSMW156s2	1.0	13.1	12.8	1	5.4	5.1	1	10.9	10.5	0.0	N	0.0	N	1015	0.1	Non-landfill permit area
15	22/01/2014	CARW007	0.0	0.6	0.6	N	3.1	3.1	1	17.4	17.3	0.0	N	0.0	N	1005	1.7	Non-landfill permit area
15	22/01/2014	CARW008	0.0	2.5	2.5	1	2.4	2.4	1	13.2	13.2	0.0	N	9.0	1	1005	-0.3	Non-landfill permit area
15	21/01/2014	CARW009	0.2	0.6	0.6	N	0.8	0.8	N	20.0	20.0	0.0	N	8.0	1	1001		Non-landfill permit area
15	21/01/2014	CARW033	0.0	0.2	0.2	N	0.5	0.1	N	21.2	21.1	0.0	N	6.0	1	1001	-0.7	Non-landfill permit area
15	21/01/2014	CARW034	-0.8	7.4	1.5	1	1.3	3.0	1	20.6	19.0	0.0	N	3.0	1	1002	-0.8	Non-landfill permit area
15	22/01/2014	CBH20	-0.6	60.0		N			N			60.0	1		N			Offsite (east)
15	22/01/2014	CBH26	-1.1	0.6	0.6	N	0.8	0.7	N	19.5	19.1	0.0	N	4.0	1	1005	-0.4	In landfill
15	22/01/2014	CBH28	-1.6	2.8	2.8	1	10.6	10.6	1	1.0	1.0	0.0	N	0.0	N	1005	-0.1	In landfill
15	22/01/2014	CBH32	-1.6	0.4	0.3	N	2.6	2.1	1	16.2	14.6	0.0	N	0.0	N	1006	-0.5	In landfill
15	22/01/2014	CBH48	-0.7	18.3	17.7	1	4.3	4.2	1	11.5	11.2	0.0	N	0.0	N	1005	-0.1	In landfill
15	22/01/2014	CBH49	0.0	26.8	26.8	1	0.8	0.8	N	18.3	18.3	0.0	N	0.0	N	1005	-0.3	In landfill
15	22/01/2014	CBH51	-1.4	1.7	1.7	1	2.6	2.6	1	16.3	16.3	0.0	N	5.0	1	1005	-0.4	In landfill

Round	Date	Borehole ID	Flow l/hr	CH4 Peak %	CH4 Steady %	CH4 Steady >1%	CO2 Peak %	CO2 Steady %	CO2 Steady >1%	O2 Steady %	O2 Min %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative Pressure	Location
15	22/01/2014	CBH52	-0.9	2.8	2.8	1	1.6	1.6	1	18.1	17.5	0.0	N	0.0	N	1005	-0.3	In landfill
15	22/01/2014	CBH57	-0.3	0.4	0.4	N	0.7	0.7	N	0.8	0.8	0.0	N	1.0	1	1005	-0.8	In landfill
15	21/01/2014	GA7s	-5.7	0.2	0.2	N	4.2	4.3	1	11.4	11.4	0.0	N	0.0	N	1004	-0.5	Non-landfill permit area
15	21/01/2014	MSMW027s	0.1	0.2	0.2	N	5.1	5.1	1	14.4	14.4	0.0	N	0.0	N	1004	-0.5	Non-landfill permit area
15	21/01/2014	MSMW029s	0.0	0.2	0.2	N	1.5	1.3	1	19.6	19.4	0.0	N	3.0	1	1003	-0.7	Non-landfill permit area
15	22/01/2014	MSMW035d1		0.2	0.2	N	0.3	0.3	N	21.1	20.1	0.0	N	0.0	N	1005	0.1	In landfill
15	22/01/2014	MSMW035d2	0.1	0.2	0.2	N	0.9	0.9	N	13.9	13.9	0.0	N	0.0	N	1005	0.1	In landfill
15	21/01/2014	MSMW154d	7.7	16.8	16.7	1	5.1	5.1	1	11.9	10.4	0.0	N	1.0	1	1005	10.4	Offsite (south)
15	21/01/2014	MSMW154s	13.0	67.0	67.0	1	9.8	9.8	1	0.1	0.1	1.0	1	0.0	N	1005	-0.6	Offsite (south)
15	21/01/2014	MSMW155d	-0.2	0.3	0.2	N	2.4	2.4	1	16.0	16.6	0.0	N	0.0	N	1005		Non-landfill permit area
15	21/01/2014	MSMW155s	3.8	13.5	13.4	1	2.3	2.3	1	4.7	4.7	0.0	N	0.0	N	1005	4.1	Non-landfill permit area
15	22/01/2014	MSMW226	-1.6	0.3	0.2	N	0.8	0.8	N	20.0	19.0	0.0	N	1.0	1	1006	-0.4	In landfill
16	18/02/2014	CARW007	-1.0	0.2	0.2	N	0.3	0.2	N	20.2	18.6	0.0	N	1.0	1	994	-0.5	Non-landfill permit area
16	18/02/2014	CARW008	0.0	2.0	1.7	1	2.5	2.0	1	14.4	13.4	0.0	N	6.0	1	994	-0.4	Non-landfill permit area
16	18/02/2014	CARW009	-1.8	0.5	0.5	N	0.6	0.6	N	19.6	19.6	0.0	N	8.0	1	994	-1.2	Non-landfill permit area
16	18/02/2014	CARW025	-0.6	62.4	18.8	1	0.8	0.3	N	16.9	8.7	0.0	N	7.0	1	997	-0.7	Non-landfill site 1
16	18/02/2014	CARW029b	1.1	0.1	0.1	N	3.1	3.1	1	6.7	6.7	0.0	N	0.0	N	997	-0.7	Non-landfill site 1
16	18/02/2014	CARW033	0.0	0.2	0.2	N	0.1	0.0	N	20.8	20.7	0.0	N	4.0	1	994	-0.7	Non-landfill permit area
16	18/02/2014	CARW034	-0.5	15.9	1.8	1	2.2	0.3	N	20.2	16.3	0.0	N	6.0	1	994	-0.6	Non-landfill permit area
16	18/02/2014	CBH20	-0.2	71.8	71.8	1	5.0	5.0	1	0.1	0.1	82.0	1	0.0	N	997	-0.7	Offsite (east)
16	18/02/2014	CBH26		3.3	3.3	1	9.7	9.7	1	0.6	0.6	0.0	N	0.0	N	1000	-0.8	In landfill
16	18/02/2014	CBH28	-0.9	0.2	0.2	N	2.8	2.8	1	16.4	16.4	0.0	N	0.0	N	994		In landfill
16	18/02/2014	CBH32	-1.0	0.1	0.1	N	2.1	1.8	1	18.0	18.4	0.0	N	0.0	N	994	-0.2	In landfill
16	18/02/2014	CBH48	-0.8	23.0	22.5	1	5.3	5.1	1	10.8	8.6	0.0	N	0.0	N	1000	-0.6	In landfill
16	18/02/2014	CBH49	-0.5	8.6	8.6	1	0.5	0.5	N	19.1	17.4	0.0	N	0.0	N	1000	-0.1	In landfill
16	18/02/2014	CBH51	0.0	12.1	12.1	1	10.0	10.0	1	2.0	2.0	0.0	N	1.0	1	1000	-0.8	In landfill
16	18/02/2014	CBH52	-0.5	3.4	3.1	1	0.8	0.8	N	19.4	19.3	0.0	N	0.0	N	1000	-0.5	In landfill
16	18/02/2014	CBH57	-0.3	0.3	0.3	N	1.7	1.7	1	13.2	13.2	0.0	N	0.0	N	994	-1.1	In landfill
16	18/02/2014	GA7s	9.2	0.1	0.1	N	2.7	2.7	1	15.5	15.5	0.0	N	0.0	N	997	-0.7	Non-landfill permit area
16	18/02/2014	MSMW027s	0.0	0.2	0.2	N	5.2	5.2	1	13.7	13.7	0.0	N	0.0	N	997	-0.8	Non-landfill permit area
16	18/02/2014	MSMW029s	0.0	0.1	0.1	N	1.0	0.8	N	19.8	19.4	0.0	N	4.0	1	994	-0.7	Non-landfill permit area
16	18/02/2014	MSMW035d1	-6.4	0.2	0.2	N	2.1	1.8	1	18.6	18.2	0.0	N	0.0	N	994	-0.8	In landfill
16	18/02/2014	MSMW035d2	0.4	0.2	0.2	N	0.7	0.7	N	16.3	16.3	0.0	N	0.0	N	994	0.3	In landfill
16	18/02/2014	MSMW154d	0.0	2.2	2.2	1	2.6	2.6	1	18.6	18.6	0.0	N	2.0	1	1007	-0.8	Offsite (south)
16	18/02/2014	MSMW154s	4.0	21.4	21.4	1	11.1	11.1	1	0.7	0.7	0.0	N	0.0	N	1007	-1.0	Offsite (south)
16	18/02/2014	MSMW155d	0.0	0.1	0.1	N	1.3	0.8	N	20.4	20.3	0.0	N	0.0	N	1010	-0.9	Non-landfill permit area
16	18/02/2014	MSMW155s	0.0	1.3	1.3	1	0.9	0.8	N	18.9	18.9	0.0	N	0.0	N	1007		Non-landfill permit area
16	18/02/2014	MSMW156d	-1.7	0.1	0.1	N	0.1	0.1	N	20.9	20.9	0.0	N	0.0	N	1002	-0.9	Non-landfill permit area
16	18/02/2014	MSMW156s1	-0.1	62.8	62.8	1	2.4	2.3	1	4.3	4.3	3.0	1	6.0	1	1002	-0.6	Non-landfill permit area
16	18/02/2014	MSMW156s2	-3.2	24.3	24.3	1	4.2	4.2	1	0.9	0.9	0.0	N	0.0	N	1002	-0.9	Non-landfill permit area
16	18/02/2014	MSMW226	-0.4	0.1	0.1	N	0.2	0.2	N	20.1	19.5	0.0	N	1.0	1	994	-0.7	In landfill
16	18/02/2014	MSMW231	0.0	14.7	14.7	1	4.2	4.2	1	14.3	14.3	0.0	N	3.0	1	1000		In landfill
16	18/02/2014	RFSW018	-4.1	3.9	3.9	1	2.7	2.7	1	0.5	0.5	0.0	N	0.0	N	997	-0.7	Offsite (east)
17	20/05/2014	CARW007	0.0	0.0	0.0	N	1.1	0.4	N	21.0	21.0	1.0	1	0.0	N	1005	-0.3	Non-landfill permit area
17	20/05/2014	CARW008	-0.1	0.1	0.1	N	1.5	1.5	1	19.0	19.0	2.0	1	2.0	1	1005	-0.1	Non-landfill permit area
17	20/05/2014	CARW009	0.0	0.7	0.7	N	0.8	0.8	N	19.7	19.7	2.0	1	11.0	1	1005	-0.1	Non-landfill permit area
17	20/05/2014	CARW025	0.0	0.9	0.9	N	0.7	0.1	N	21.4	21.4	0.0	N	0.0	N	1006	-0.4	Non-landfill site 1
17	20/05/2014	CARW029b	3.4	38.3	38.3	1	3.4	3.4	1	0.2	0.2	0.0	N	0.0	N	1006	-0.4	Non-landfill site 1
17	20/05/2014	CARW033	0.0	0.0	0.0	N	0.1	0.1	N	21.5	21.5	1.0	1	5.0	1	1005	-0.5	Non-landfill permit area
17	20/05/2014	CARW034	0.0	0.5	0.5	N	2.1	2.1	1	19.3	19.3	0.0	N	0.0	N	1005	-0.2	Non-landfill permit area
17	20/05/2014	CBH20	-0.1	56.6	56.6	1	11.0	11.0	1	0.2	0.2	29.0	1	0.0	N	1005	-0.4	Offsite (east)
17	20/05/2014	CBH26	0.2	13.0	13.0	1	10.6	10.6	1	0.3	0.3	0.0	N	0.0	N	1006	-0.4	In landfill
17	20/05/2014	CBH28	0.0	3.0	0.0	N	3.0	0.1	N	21.1	21.1	0.0	N	0.0	N	1005	-0.3	In landfill
17	20/05/2014	CBH32	-0.2	0.6	0.0	N	0.3	0.1	N	21.1	21.1	0.0	N	0.0	N	1005	-0.3	In landfill
17	20/05/2014	CBH48	-0.2	16.3	16.2	1	7.7	7.6	1	5.3	5.3	0.0	N	0.0	N	1003	-0.6	In landfill
17	20/05/2014	CBH51	-0.1	0.1	0.1	N	0.1	0.1	N	21.1	21.1	0.0	N	0.0	N	1006	-0.6	In landfill

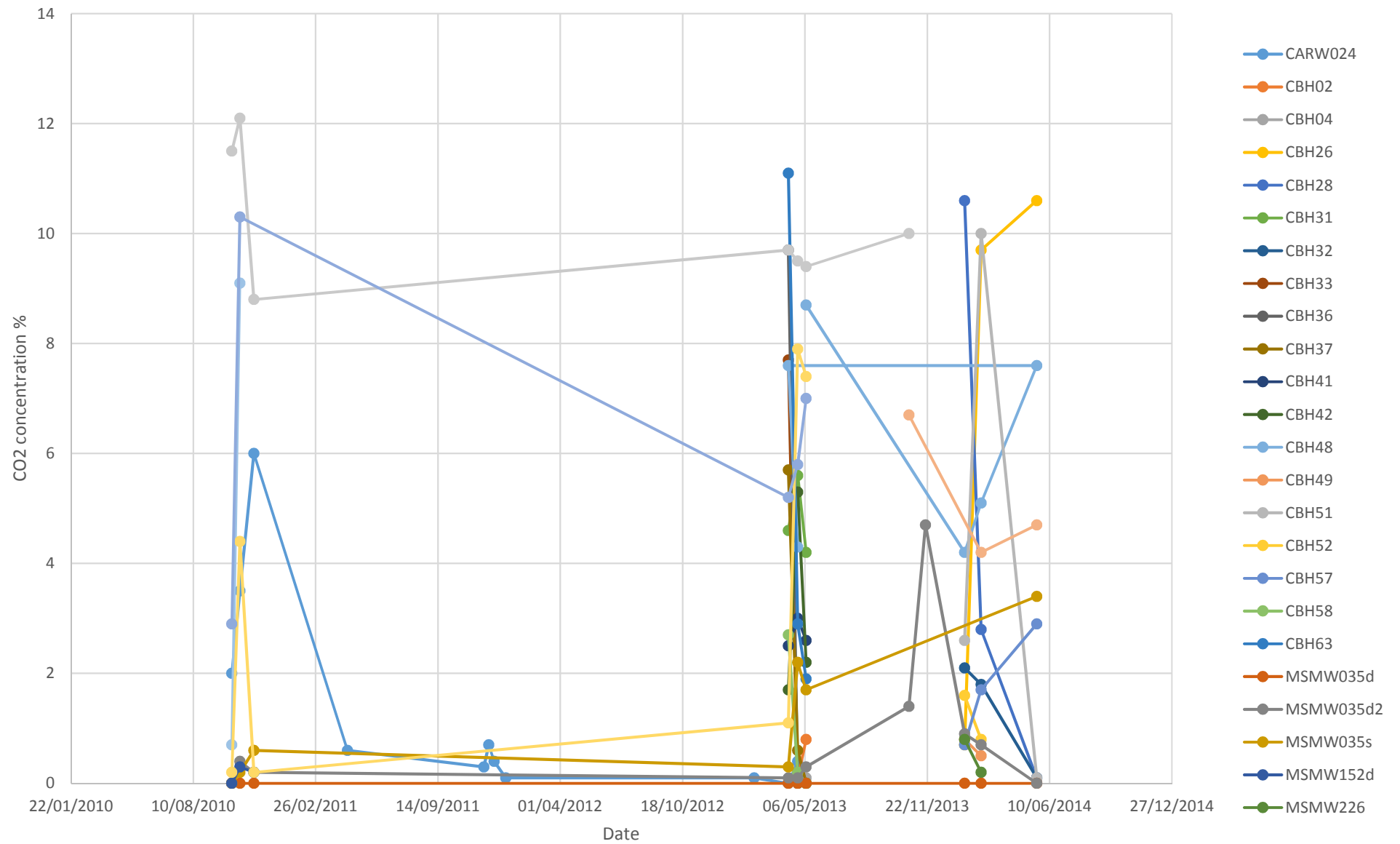
Round	Date	Borehole ID	Flow l/hr	CH4 Peak %	CH4 Steady %	CH4 Steady >1%	CO2 Peak %	CO2 Steady %	CO2 Steady >1%	O2 Steady %	O2 Min %	H2S (ppm)	H2S Detectable	CO (ppm)	CO Detectable	Atm Pressure	Relative Pressure	Location
17	20/05/2014	CBH57	0.0	1.0	0.9	N	2.9	2.9	1	14.7	14.7	1.0	1	0.0	N	1005	-0.3	In landfill
17	20/05/2014	GA7s	-0.1	0.0	0.0	N	3.3	3.3	1	9.9	9.9	0.0	N	0.0	N	1005	-0.4	Non-landfill permit area
17	20/05/2014	MSMW029s	0.1	0.0	0.0	N	1.5	1.5	1	19.5	19.5	1.0	1	0.0	N	1005	-0.3	Non-landfill permit area
17	20/05/2014	MSMW034d2	0.0	0.0	0.0	N	1.2	1.2	1	21.2	21.2	1.0	1	1.0	1	1005	-0.2	Non-landfill permit area
17	20/05/2014	MSMW035d1	0.0	0.0	0.0	N	0.4	0.4	N	20.6	20.6	1.0	1	0.0	N	1004	-0.2	In landfill
17	20/05/2014	MSMW035d2	0.0	0.0	0.0	N	0.0	0.0	N	21.4	21.4	1.0	1	0.0	N	1005	-0.2	In landfill
17	20/05/2014	MSMW035s	-0.1	0.0	0.0	N	3.4	3.4	1	15.8	15.8	1.0	1	0.0	N	1005	-0.2	In landfill
17	20/05/2014	MSMW154d	6.7	12.1	12.1	1	6.5	6.5	1	9.8	9.8	0.0	N	4.0	1	1006	-0.5	Offsite (south)
17	20/05/2014	MSMW154s	5.7	60.5	60.5	1	9.8	9.8	1	0.3	0.3	1.0	1	0.0	N	1006	-0.4	Offsite (south)
17	20/05/2014	MSMW155d	0.2	0.0	0.0	N	1.2	1.2	1	20.7	20.8	1.0	1	0.0	N	1006	-0.4	Non-landfill permit area
17	20/05/2014	MSMW155s	0.0	0.1	0.1	N	1.0	1.0	1	12.9	12.9	0.0	N	0.0	N	1006	-0.3	Non-landfill permit area
17	20/05/2014	MSMW156d	0.1	0.0	0.0	N	1.3	0.1	N	21.8	21.8	1.0	1	0.0	N	1006	-0.3	Non-landfill permit area
17	20/05/2014	MSMW156s1	-8.1	56.9	46.2	1	4.7	4.1	1	8.5	8.5	1.0	1	0.0	N	1006	-0.3	Non-landfill permit area
17	20/05/2014	MSMW156s2	0.1	13.2	12.9	1	3.0	3.0	1	11.8	11.8	0.0	N	1.0	1	1006	-0.3	Non-landfill permit area
17	20/05/2014	MSMW231	0.0	15.1	14.8	1	4.9	4.7	1	12.2	12.2	0.0	N	1.0	1	1005	-0.6	In landfill

Appendix D

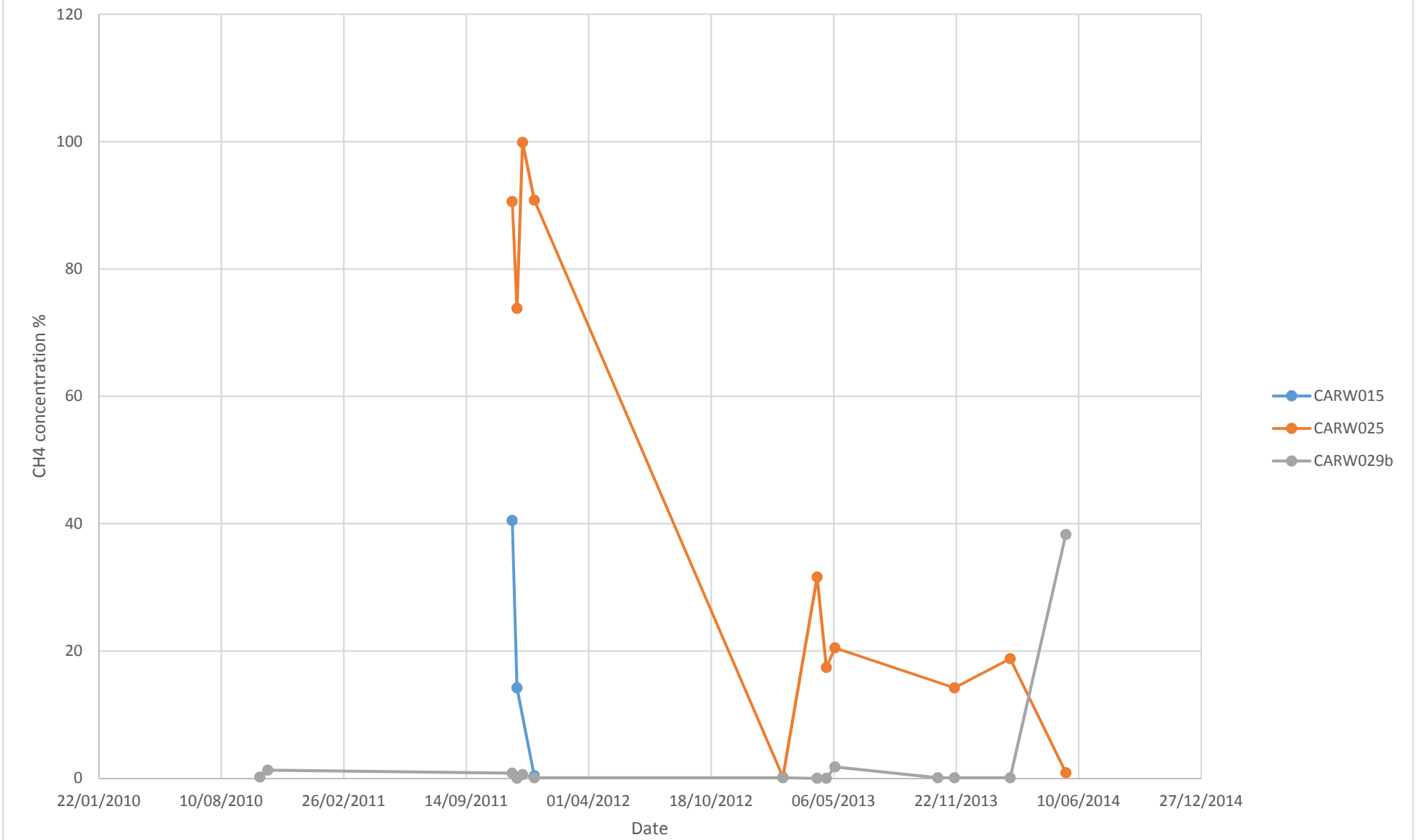
CH₄ concentrations from boreholes located in the landfilled area



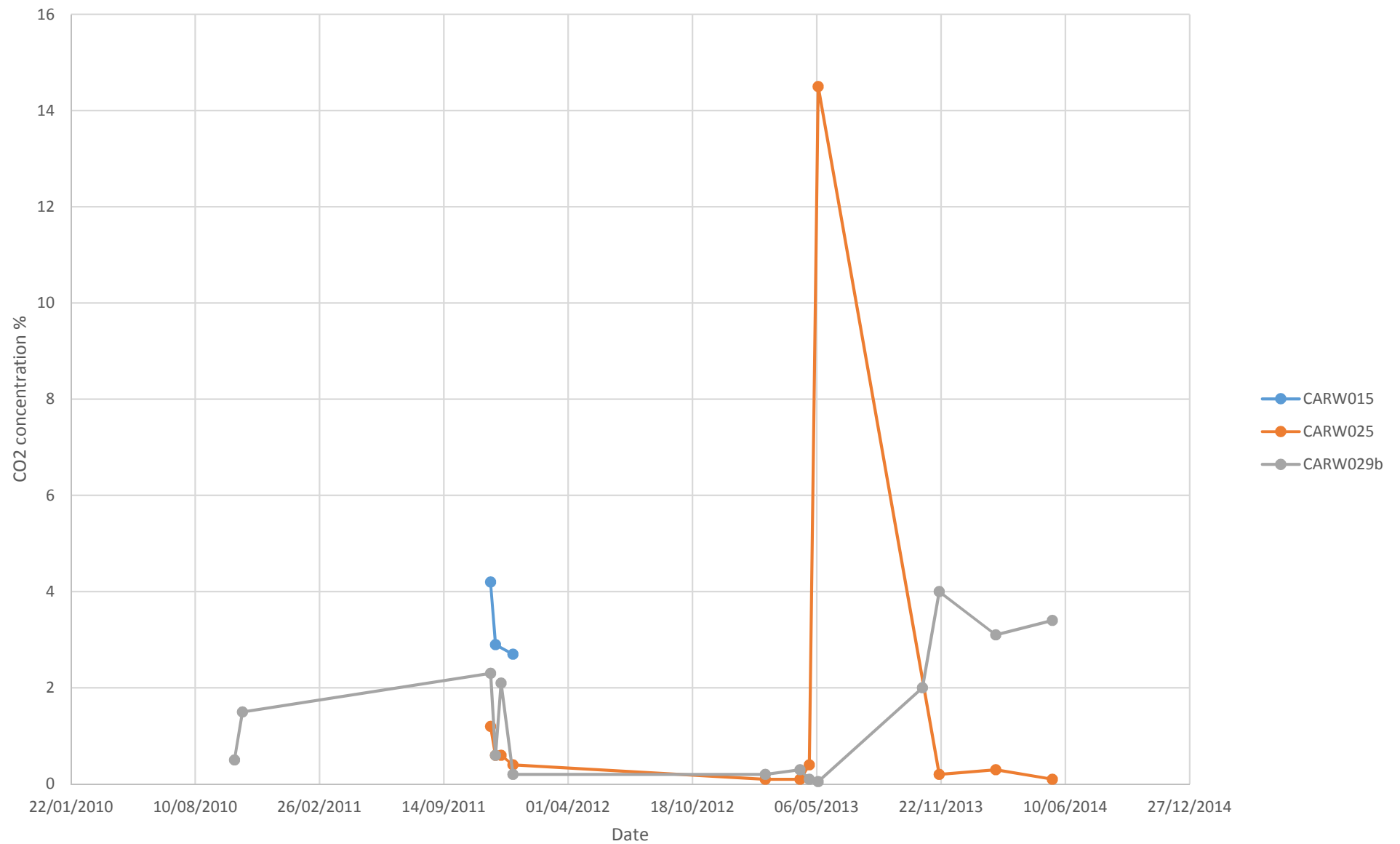
CO2 concentrations from boreholes located within the landfilled area



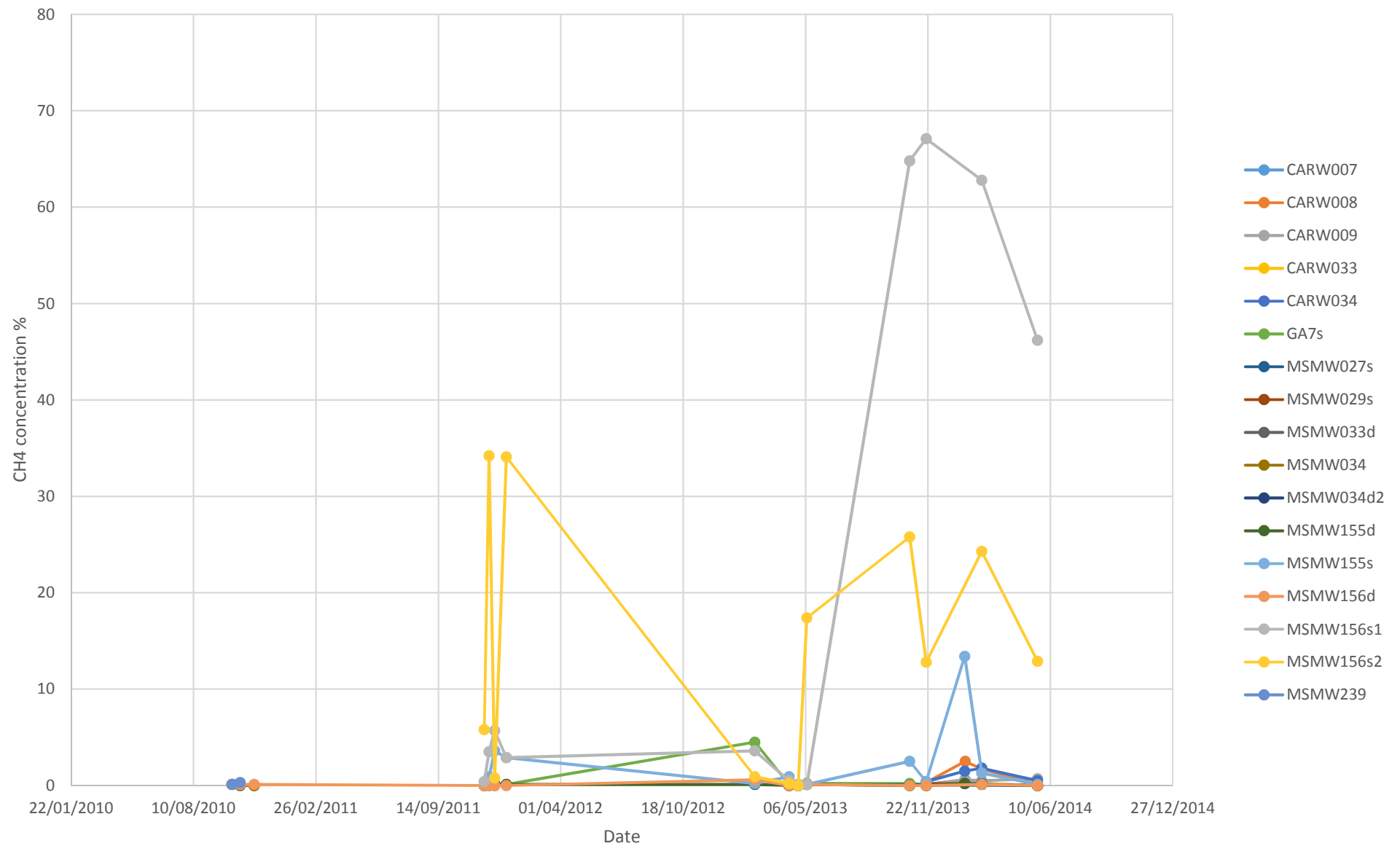
CH4 concentrations from boreholes located in the non-landfill site 1 area



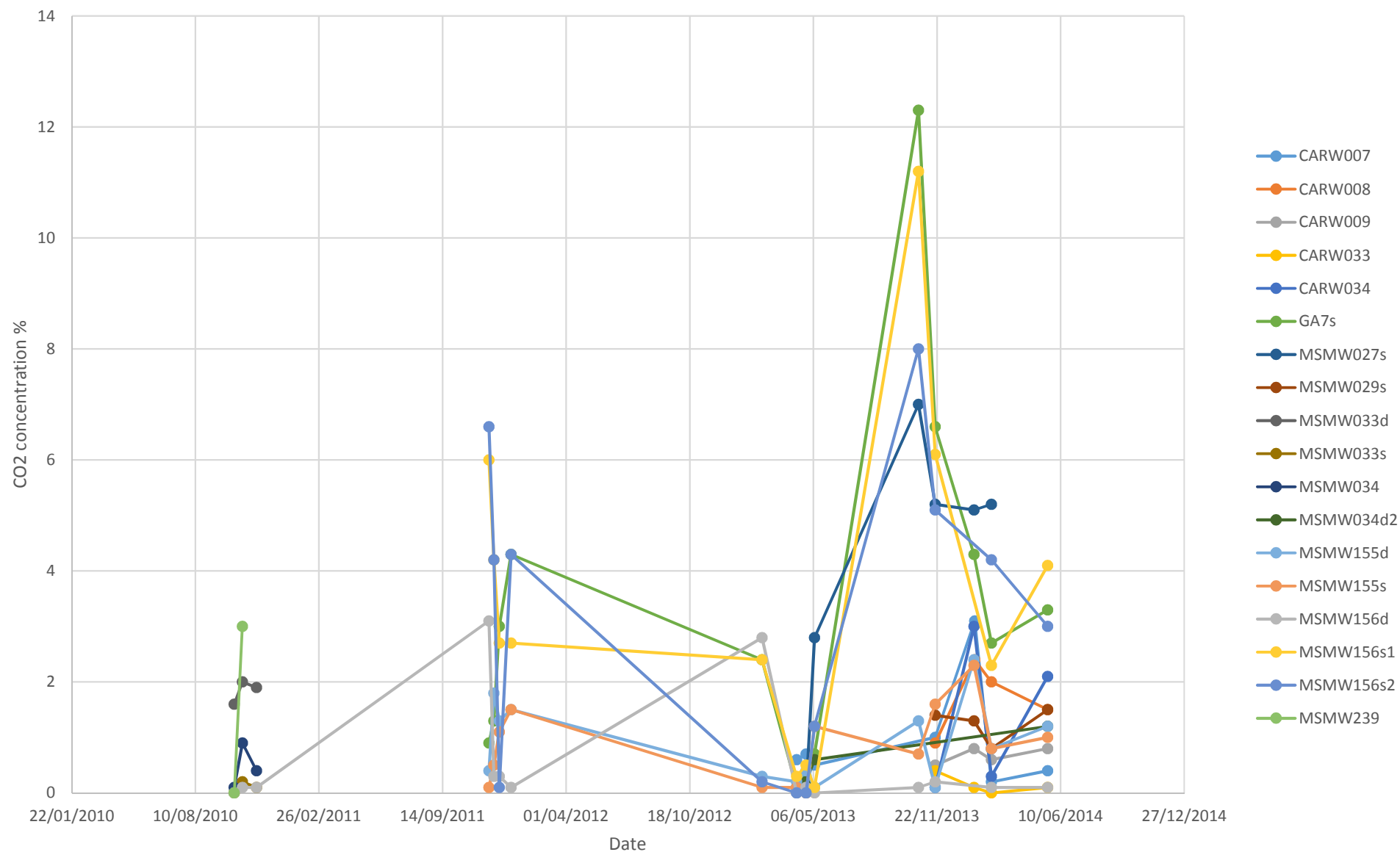
CO2 concentration from boreholes located within the non-landfill site 1 area



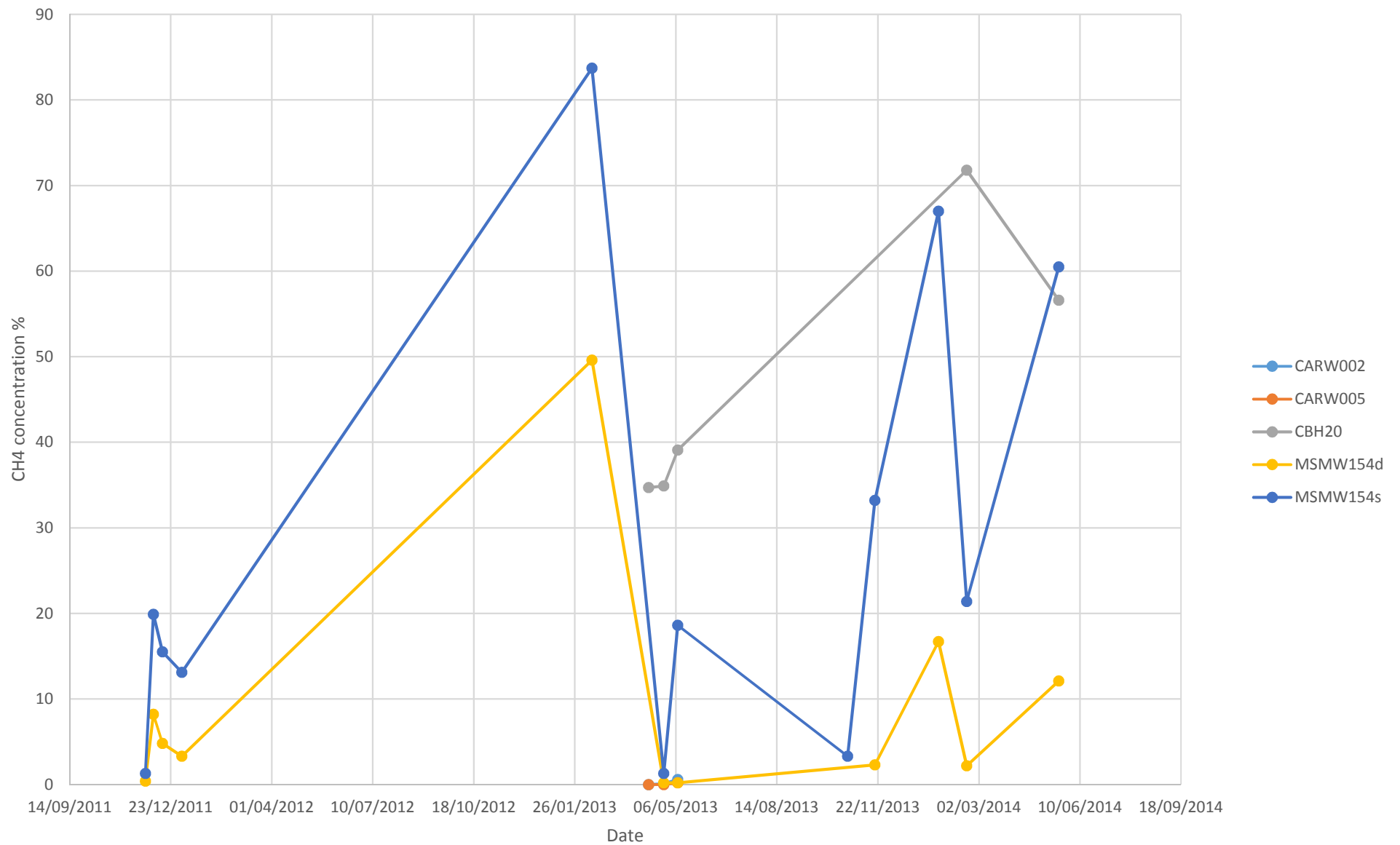
CH₄ concentrations from boreholes in non-landfill area outside Site 1 but within the permit boundary



CO2 concentrations from boreholes in non-landfill area outside Site 1 but within the permit boundary



CH4 concentrations from boreholes located outside of the permit boundary



CO2 concentrations from boreholes located outside of the permit boundary

