

Report No: AM5554/1/1
Date: March 2007

CLOSURE PLAN
for
NANT-Y-GWYDDON LANDFILL SITE,
GELLI, MID-GLAMORGAN, WALES

Prepared for
AMGEN RHONDDA LIMITED

Encia Consulting Ltd
Bryn Pica
Llywdcoed
Aberdare
Mid Glamorgan
CF 44 0BX

Tel: 01685 870770
Fax: 01685 874684

**Project Quality Assurance
Information Sheet**

Closure Plan for the Nant-y-Gwyddon Landfill Site, Gelli, Mid Glamorgan.

AMGEN RHONNDA LIMITED

Report Number : AM5554/1/1 ***Report Status*** : FINAL

Report Date : March 2007

Prepared for : Amgen Rhondda Limited

Prepared by : Encia Consulting Limited
Bryn Pica
Llwydcoed
Aberdare
CF44 0BX

***Reviewed
by:***

**Katie Edwards – BSc (Hons) MSc FGS
Senior Environmental Scientist**

***Approved
by:***

**Lee Foulkes – BSc (Hons) MSc
Environmental Manager**

Executive Summary

The Nant-y-Gwyddon Landfill Site, Gelli, Rhondda, ceased accepting any waste for landfill disposal on the 12th March 2002, following a decision of the licence holder Amgen Rhondda Ltd. and its shareholders.

Site remediation has now been completed with the construction of a fully engineered landfill cap over the completed phase 1 area and the removal of landfill infrastructure in the un-tipped phase 2 area.

The licence holder now wishes to re-apply for the status of 'definitive closure' in accordance with the procedures outlined in the Landfill Directive Regulatory Guidance Note 7 (RGN 7). Encia Consulting Ltd. has produced this Closure Plan with reference to RGN 7 and as such it forms the licence holder's application for the status of 'definitive closure'.

TABLE OF CONTENTS

1.	INTRODUCTION.....	1
1.1	Terms of Reference.....	1
1.2	Background.....	1
1.3	Site Setting and General Description.....	1
2.	INFORMATION REQUIRED FOR DEFINITIVE CLOSURE.....	2
2.1	Relevant Area.....	2
2.2	Waste Mass Stability.....	2
2.3	Site Infrastructure.....	3
3.	ENVIRONMENTAL MONITORING.....	4
3.1	Leachate Monitoring.....	5
3.2	Groundwater Monitoring.....	6
3.3	Surface Water Monitoring.....	7
4.	LANDFILL GAS INFRASTRUCTURE.....	8
4.1	Landfill Gas Monitoring.....	8
5.	REPORTING SIGNIFICANT ENVIRONMENTAL EFFECTS.....	9
6.	COMPLIANCE WITH THE EUROPEAN HABITATS DIRECTIVE.....	9

Appendix A – Drawings.

Drawing No.	Description:
AM5554/1/001	Location Plan
AM5554/1/002	General Layout
AM5554/1/003	Leachate Management and Monitoring
AM5554/1/004	Landfill Gas Management and Monitoring
AM5554/1/005	Surface Water Monitoring

Appendix B – Closure Plan Template.

Appendix C – Table 1a, 1b and 1c (Leachate, Groundwater and Surface Water Monitoring Analysis Suites and Action Thresholds).

Appendix D – Amgen Policy Rules and Procedures (PRP No. 510) Environmental Monitoring Procedures and Maintenance of Equipment.

Appendix E – Amgen Policy Rules and Procedures (PRP No. 503) Environmental Emergency Action Plan.

Appendix F – Nant-y-Gwyddon Landfill Inert Bund, Stability Assessment – 2006 Update Report, Arup October 2006.

1.0 INTRODUCTION

1.1 Terms of Reference

Amgen Rhondda Ltd. (ARL) has commissioned Encia Consulting Ltd. (Encia) to prepare an application for the formal closure of the Nant-y-Gwyddon Landfill Site, in accordance with the procedures outlined in Landfill Directive Regulatory Guidance Note 7 (RGN7).

With clarifications [inserted here in square brackets], paragraph 1.4 of RGN 7 reads as follows:

“For existing sites that closed between 16 July 2001 and July 2002, but which did not provide a Conditioning Plan, the relevant requirements of Regulation 15 [of the Landfill (England and Wales) Regulations 2002] apply (see section 5.2 – 5.9). We [the Environment Agency] do not need to issue a closure notice to start the closure process in these circumstances, but operators should be encouraged to provide the relevant information so that they can enter the aftercare phase sooner rather than later (see Section 9).”

This Closure Report forms part of ARL's application for the Site to enter into the post closure / aftercare phase and should be read in conjunction with the following documents:

- Completed Closure Report Template.
- Nant-y-Gwyddon Landfill Site Working Plan.

1.2 Background

The Nant-y-Gwyddon Landfill Site ceased accepting waste in March 2002, following a decision of the operator and its shareholder, Rhondda Cynon Taff County Borough Council (RCTCBC). ARL informed the Environment Agency of this change of status in a letter dated 12 March 2002.

The licence holder's previous application for the status of 'definitive closure' was not granted by the Environment Agency at the time, due to the lack of a clear remediation strategy for the site.

Since that time ARL has completed extensive remediation works at the site, under the direction of the Nant-y-Gwyddon Landfill Site Remediation Sub Group Committee. This group formed by RCTCBC, included representatives from various stakeholders including representatives of the Agency and members of the local community group Rhondda Against Nant-y-Gwyddon Tip (RANT). The details of the remediation works that have now been completed at the site are described further in Section 2.3.

1.3 Site Setting and General Description.

As shown on Drawing AM5554/1/001, the Site is situated on the west side of the Rhondda Fawr Valley, at OS National Grid Reference SS 980 940, and lies some 200m above the valley floor. It is serviced by a purpose built road located on the Northern slope of Mynydd-y-Gelli, accessed via the B4223 (Gelli).

The landfill site boundary comprises an area of approximately 24 ha and consists of 3 main areas:

- **Phase 1 Landfill** – Containing approximately 1.25 million m³ of waste in an area of approximately 9 ha. This area has now been fully remediated with the construction of an engineered geocomposite capping layer and drainage measures.
- **Phase 2** – The 3.5 ha area historically referred to as Phase 2, previously consisted of an engineered barrier system (liner) and leachate storage facility. These have now been removed and the restored area now consists of gently sloping grassland and a small surface water lagoon and associated drainage.
- **Site Offices, Weighbridge, Car Park and Landfill Gas Compound** – These are located adjacent to the site entrance. Further information related to the landfill gas compound is provided in Section 4.0.

2.0 INFORMATION REQUIRED FOR DEFINITIVE CLOSURE

2.1 Relevant Area

Drawing AM5554/1/002 outlines the location and extent of landfill in the phase 1 area. Due to the early closure of the site in March 2002, no waste was deposited within the phase 2 area and all landfill engineering previously in-place has now been removed and the area restored.

No waste has been deposited within the remainder of the land under the control of the waste management licence holder (ARL).

2.2 Waste Mass Stability

The stability of Landfill Waste at the Nant-y-Gwyddon Landfill Site has been the subject of several investigative reports. Most notably is the report by Earth Science Partnership (ESP), Nant-y-Gwyddon Landfill Site - Study of Slope Stability, January 2004 as commissioned by the Welsh Assembly Government (WAG).

Whilst the resulting document did not present clearly a series of conclusion or recommendation, it did make the following comments:

“The latest stability analysis indicates factors of safety in excess of 1.5 for larger slides on the liner. Such a value would normally be considered acceptable for the temporary condition.”

“In our view, Amgen Rhondda and their consultants, Arup, are well qualified to produce and implement an appropriate design to ensure the ongoing stability of the landfill and to undertake the necessary ongoing monitoring and review exercises.”

As per Section 2.1.3 of the site licence and the corresponding statement in the working plan, ARL has commissioned annual surveys of site stability with particular reference to the Inert Retaining Bund on the eastern slope of the landfill. A copy of the previous report detailing the result of the annual site inspection undertaken by Arup is provided in Appendix F. The content of this report has previously been accepted by the Environment Agency.

2.3 Site Infrastructure

The Nant-y-Gwyddon Landfill Site was designed and operated as a containment Landfill and consists of a management infrastructure for the control and disposal of contaminated water (leachate) and landfill gas.

Waste disposal operations at Nant-y-Gwyddon were split into Phase 1, now containing approximately 1.25 million tonnes of landfill waste and Phase 2. Despite the construction of an engineered barrier system (basal liner) over the 3 hectare area of Phase 2, no waste has been deposited within this phase, due to the early closure of the site in March 2002.

Void space calculation based on waste input rates at the time of closure suggest that the site had approximately 9 years of landfilling left. Therefore the early closure of the site in March 2002 resulted in an un-consented landform. This was resolved by the granting of a new planning consent for the site in April 2005 allowing the completion of remediation work (landfill capping) in September 2005.

Leachate Management Infrastructure

Landfill waste deposited in the Phase 1 area is contained by the presence of a basal engineered barrier (basal liner) and leachate drainage system.

As detailed in the Site's Working Plan Document this consists of the following:

- 300 mm graded colliery spoil, with leachate collector drains (in no fines granular surrounds and geotextile wrap), placed on
- 2.5 mm HDPE Geomembrane, placed on
- 300 mm graded colliery spoil with sub liner drainage (as above), placed on
- Compacted colliery spoil sub-grade, placed on
- Excavated and re-compacted ground.

The completed phase 1 area is now fully capped with an engineered (permanent) landfill cap. Since its completion in September 2005 this has been shown to be successful in acting as a barrier to infiltration and thus significantly reducing the volume of leachate produced at the site.

The permanent cap covers the entire area of the landfill and is tied into the basal liner at the margins of the landfill, thus completing containment engineering. The cap consists of the following elements as reference in the approved validation report for the works:

- 750 mm restoration soils, placed upon
- 300 mm colliery spoil protection layer (nominal particle size 20 mm), placed upon
- 6 mm non-woven Geosynthetic drainage layer and subsurface collector drains, placed upon
- 1 mm LLDPE Geomembrane fully welded and tested, placed upon
- 6 mm non-woven Geosynthetic drainage layer and subsurface collector drains, placed upon
- 200 mm cap foundation layer (nominal particle size 20 mm), placed on
- graded / regularised landfill surface.

In addition to the above the following active leachate extraction measures have now been installed at the site:

- 7 no. pneumatic pumps (AP3 type) situated within landfill gas extraction wells situated in the landfill area.
- A fixed pumping station, situated at the base of the landfill western flank (an area previously referred to as Jones's Bund).

Leachate collected from the site's basal drainage and active pumping systems are pipe to a large concrete holding tank located in the eastern area of the site. From this location leachate is discharged untreated to the foul sewer network via a dedicated 1.5 km underground pipeline.

This discharge is done in accordance with a Consent to Discharge (No. AN00117), as provided and regulated by the water authority (Dwr Cymru / Welsh Water).

Leachate Management / Maintenance

The operator carries out annual CCTV inspection and jetting of the leachate pipeline present at the site. Daily visual inspection of the leachate pipeline is carried out by the site supervisor (i.e. checking for any obvious signs of potential blockages).

The fixed leachate pumping installation within the Jones's Bund area is covered by a service maintenance agreement with TT Pumps Ltd. Service visits are carried out every 6 months. The control system is equipped with telemetry, programmed to send a message to a specific person if leachate within the installation reaches a level of 900 mm. A flashing beckon on the control station is also activated if these conditions persist.

3.0 ENVIRONMENTAL MONITORING

The site's current working plan document outlines the manner in which leachate, groundwater and surface water sampled are obtained at the site along with a specific suite of chemical analysis for each.

Laboratory analysis of a range of water chemistry determinands are required on a monthly, quarterly and annual frequency, depending on: their association with leachate contamination, association with wastes types deposited at the site, relative cost of analysis and the logistics involved in accurately quantifying their presence.

Tables 1a, 1b and 1c (Appendix C) reproduced from the working plan, detail the analysis required for leachate, groundwater and surface water monitoring (respectively).

The following sections provide an update summary of the leachate, groundwater and surface water monitoring infrastructure currently operated at the site.

3.1 Leachate Monitoring

ARL carries out monitoring of leachate levels and contamination concentrations on a monthly basis. Two sampling locations are provided for leachate samples to be collected directly from the landfill waste and a third, external to the waste for the monitoring of leachate quality prior to disposal.

Leachate Level Monitoring

Leachate level monitoring is carried out monthly through dip measurement by a suitably qualified landfill technician. The location of the 6 monitoring points currently used are illustrated in Drawing No. AM5554/1/003 and a description provided below:

- **L5a (leachate inspection manhole L5a)** – L5a is a leachate inspection chamber located within the landfill immediately adjacent to the Inert Bund retaining the eastern margin of the waste. This chamber is linked directly to the basal drainage system, at a location considered to be the lowest point in the landfill. Leachate collected by the basal drainage system flows to this point under the influence of gravity - prior to exiting the landfill via an underground pipeline.

A consistent flow of leachate can be observed at this location, although the flow rates have reduced noticeably since the completion of permanent capping in Summer 2005.

- **Leachate Monitoring Piezometers (LMP 1a, 1b, 6, 7 and 8)** – These were installed in 2003 and 2004 following a requirement for improved information on general leachate level within the waste.

Leachate Quality Monitoring

Leachate monitoring and sampling (for third party analysis) is undertaken at 3 locations at the site. The location of these monitoring points is illustrated in Drawing No. AM5554/1/003 and a description provided below:

- **L5a (leachate inspection manhole L5a)** – Leachate sampled at this location is sourced directly from the waste. It is thought to be the most representative monitoring location for leachate generated directly within the waste mass.
- **LPS 1 (Jones Bund Pumping Station)** – As part of the remediation works a leachate extraction sump has been constructed in the area previously referred to as Jones Bund. Leachate sampled at this location is sourced directly from the waste. Previously leachate samples were taken from the leachate attenuation lagoons (LL01) however this has ceased due to the removal of this infrastructure during the summer 2006 restoration works.
- **L5 (leachate holding tank)** – Prior to disposal (to foul sewer), leachate from the waste mass and attenuation lagoon is stored within the leachate holding tank. This regulates the discharge of leachate (trade effluent) to the foul sewer at a rate of 6 l/s.

Samples of leachate obtained from the above locations are tested on-site for a range of basic parameters (i.e. in-situ testing of pH, Temperature and Electrical Conductivity) and samples submitted for third party laboratory analysis as per the suites of analysis provided in Table 1a (Appendix C).

3.2 Groundwater Monitoring

The Nant-y-Gwyddon site is equipped with a total of 22 groundwater monitoring boreholes, 10 of which are down-gradient of the landfill, 9 up-gradient and 3 of which are considered to be perpendicular to groundwater flow. Monitoring is carried out on a monthly frequency for both level and water quality. Third party analysis is carried out in accordance with those schedules listed in Table 1b (Appendix C).

The location of each of these groundwater monitoring points is illustrated in Drawing No. AM5554/1/003 and an overview of their specification provided in Table 2 below.

Table 2: General specification of 22 groundwater monitoring boreholes situated at the Nant-y-Gwyddon Landfill Site.

Aquifer	BH ID	Location	Co-Ordinates			Depth mbgl	Ave Water mAOD
			East	North	mAOD		
Upper Aquifer	NG 105	Upgradient	297719	193376	346.8	15.0	335.08
	NG 106		297659	193831	349.0	14.4	338.11
	NG 107		297660	193896	341.6	8.4	336.59
	NG 108		297683	193958	337.0	36.0	Dry
	BH1		297743	193905	336.7	21.0	Dry
	BH3		297866	193794	346.8	9.5	Dry
	BH4	Adjacent	297800	194132	336.1	8.8	326.58
	BH9		298045	193802	343.8	21.2	322.92
	BH10		297931	193765	350.7	43.0	312.37
	NG 104	Downgradient	298146	193946	331.2	15.0	320.02
Main Aquifer	GW 94	Upgradient	297674	194008	337.0	29.1	329.97
	NG 109		297681	193951	336.7	79.6	Dry
	BH2		297779	193877	337.5	45.0	299.86
	NG 101	Downgradient	298030	194230	315.2	34.5	290.08
	BH5		297944	194157	323.9	34.8	295.48
	GW 96		298507	193729	319.7	68.2	267.74
	GW 97		298785	193978	321.1	53.8	275.32
	NG 110		298383	194156	278.0	17.9	266.08
	BH6		298146	194107	304.6	28.2	283.04
	BH7		298142	194027	318.4	40.0	279.35
	BH8		298170	193889	337.5	61.8	275.89
Lower Aquifer	NG 111	Downgradient	298375	194156	278.6	51.2	233.69

Groundwater Infrastructure Procedures and Maintenance

The methods used for the collection and analysis of groundwater samples are provided in ARL Policy Rules and Procedures (PRP) Document No. 501. A copy of this document is provided in Appendix D.

3.3 Surface Water Monitoring

ARL currently monitor the quality of surface water at seven locations on and around the Nant-y-Gwyddon Landfill Site. The location of these points is illustrated in Drawing No. AM5554/1/005 (Appendix A) and a description provided below:

The surface water monitoring points **SW1**, **SW5**, **SW6**, and **SW8** are within the immediate vicinity of the landfill site and located along the Nant-y-Gwyddon stream:

- **SW5** (settlement lagoon in phase 2 area) – Previously the monitoring location SW 5 referred to the water sampled from the sites fire lagoon. The fire lagoon was removed during the 2005 / 2006 remediation work and the monitoring point has now been relocated to the settlement lagoon situated in the restored phase 2 area.
- **SW6** (upper Nant-y-Gwyddon stream) - The majority of the surface water collected from the area surrounding the landfill is discharged into the stream here. Site drainage discharge at this location is covered by a Consent to Discharge Surface Water (EA Ref: AN0308201) as regulated by the Environment Agency.
- **SW8** (middle Nant-y-Gwyddon) – This monitoring point is located half way down the Nant-y-Gwyddon watercourse. It is aimed at identifying any potential impact from groundwater issues evident upstream of this location.
- **SW1** (lower Nant-y-Gwyddon) - Flow rates are increased due to groundwater input from streams at, or above, this point.

In addition, there are three more distant surface water monitoring points (**SW2**, **SW3**, and **SW4**), which are located as follows:

- **SW4** (Glyncornel Nature Reserve Lake) – Located just upstream of the lake in a small spring. Tracer tests have shown that 80% of the groundwater passing below the landfill emerges on the lower slopes of the Rhondda Fawr Valley, some of which feed into this lake.
- **SW2** (Nant-y-Clydach Fach) – This stream flows in a south-easterly direction through the Clydach Vale Country Park and is also fed by groundwater thought to originate beneath the site.
- **SW3** (Cwm Cae Dafydd Tributary) – This tributary originates on the south-western margin of the licensed Site, flows south through the village of Cwm Clydach, and into the Nant Clydach (a major tributary of the Rhondda Avon Fawr).

Surface Water Infrastructure Procedures and Maintenance

The methods used for the collection and analysis of surface water samples, is provided in ARL Policy Rules and Procedures (PRP) Document No. 510. A copy of this document is provided in Appendix D.

4.0 LANDFILL GAS INFRASTRUCTURE

Drawing No AM5554/1/004 show the general layout of the landfill gas extraction system at the Nant-y-Gwyddon Landfill Site. It consists of the following elements:

- Geo-synthetic gas drainage layer and pipe-work (underneath the plastic cap).
- 40 no. vertical landfill gas extraction wells
- Collection pipe-work connected to 4 no. control manifolds and dewatering knockout pots.
- Gas extraction plant and high temperature enclosed landfill gas flare (400 m³/hr capacity)
- Jenbacher 316GS Landfill Gas Power Generation Set (rated 652 kW/hr).

Monitoring and Maintenance of Landfill Gas Infrastructure

Section 2.5.1.3 of the site's Working Plan details the measures employed for the operation, maintenance and review of the landfill gas management system. This has been reproduced here and been updated where appropriate.

Daily Visual Inspection – The landfill gas infrastructure: vertical gas extraction wells, extraction pipe-work, gas extraction plant and high temperature flare and landfill gas engine, are inspected for any visible signs of defect. This is carried out by the site supervisor on a daily basis and any defect logged and reported to the site manager for immediate repairs to be arranged.

Daily Monitoring – Operational parameters of the gas extraction plant, high temperature flare and engine are checked twice daily and logged. This enables any potential problems with the landfill gas extraction system to be identified at the earliest opportunity. For example; increased concentrations of oxygen could be an indication of a defect in the gas extraction pipe-work – Such an event would be reported to the site manager and result in an immediate inspection of the gas extraction system.

Landfill Gas Balancing – In order to maintain gas quality / concentrations an exercise of landfill gas balancing is carried out fortnightly. This is carried out by a suitably trained landfill gas technician in accordance with table 6 (Section 5) of the site's Working Plan Document.

3.4 Landfill Gas Monitoring

The site licence holder (ARL) carries out a series of monitoring activities to ensure the safe control and disposal of landfill gas at the Nant-y-Gwyddon Landfill Site. These are described in detail in Section 5 of the working plan document for the site and consist of the following:

- Raw (in-waste) Landfill Gas Monitoring
- Sub-Surface (external to waste) Landfill Gas Monitoring
- Site Boundary Hydrogen Sulphide Air Quality Monitoring
- Annual Flare / Landfill Gas Engine Emissions Monitoring

5.0 REPORTING SIGNIFICANT ENVIRONMENTAL EFFECTS

The site licence holder maintains a set of Policy, Rules and Procedures (PRP's) covering various aspects of operational management. PRP No. 503 outlines procedures to be followed in the case of an environmental emergency. A copy of this document is provided in Appendix E.

An environmental emergency is considered to be the identification of one or more of the following conditions on site:

- Malfunction, breakdown or failure of equipment or techniques, accident or fugitive emissions, which has caused, is causing or may cause significant pollution.
- Breach of a limit specified in the Site Licence / Working Plan.
- Any other significant adverse environmental effect.

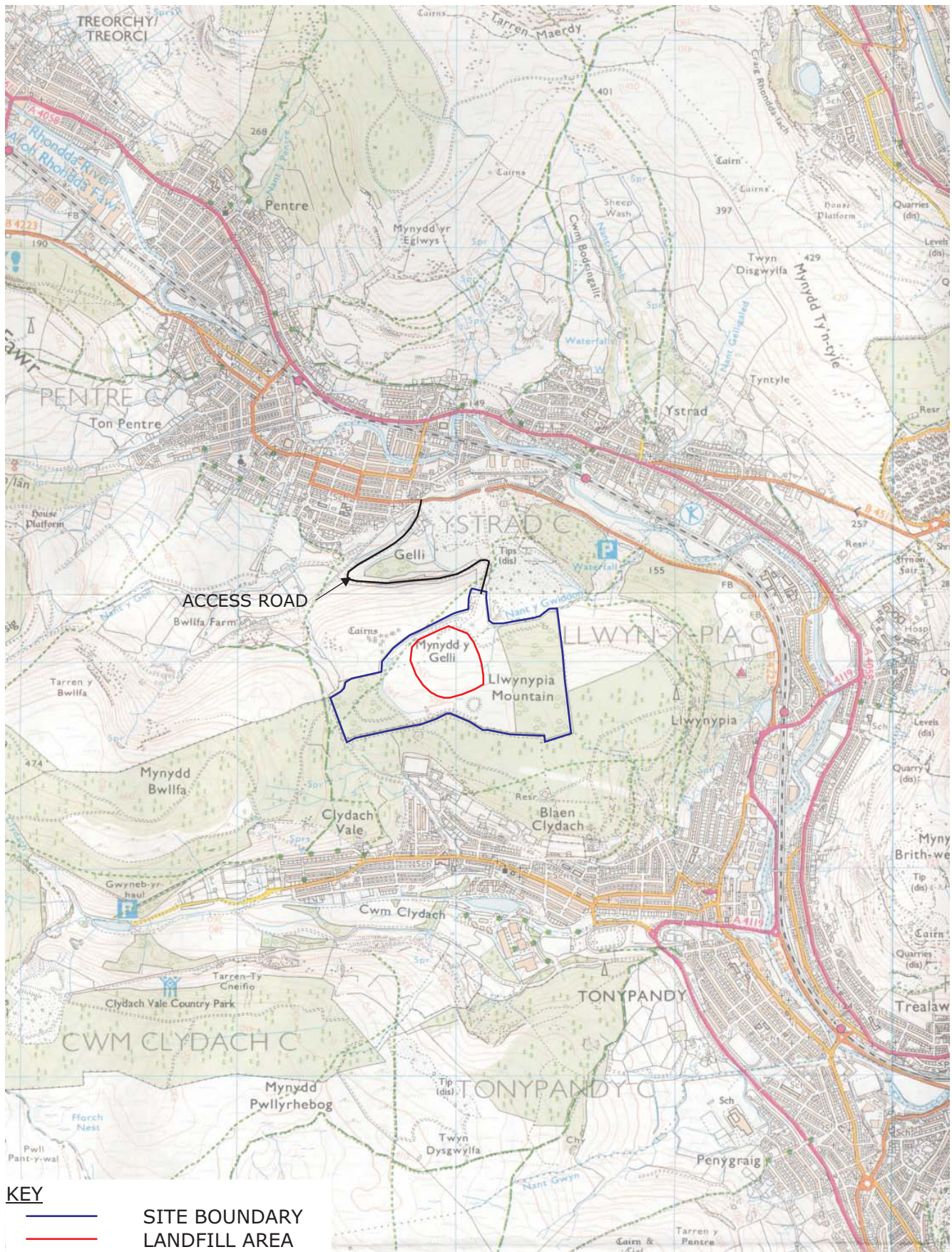
The Environment Agency will be formally notified within 24 hours of the identification of any of the above conditions on site. Measures to remediate any potential impact will be agreed with the Environment Agency and a follow-up report completed.

6.0 COMPLIANCE WITH THE EUROPEAN HABITATS DIRECTIVE

The European Habitats Directive has been implemented in England and Wales, through the Conservation (Natural Habitats etc) Regulations 1994, which requires risk assessments to be undertaken for sites that might attract gulls (such as landfills) if they exist within 5 km of a European site.

However, although there is a SSSI within 1 km of the Nant-y-Gwyddon Landfill Site, there are no European sites within 5 km. Therefore, it is considered that there is no requirement to carryout any further risk assessments in order to comply with the Habitats Directive.

APPENDIX A – Drawings



CLIENT
AMGEN RHONDDA
NANT-Y-GWYDDON
LANDFILL SITE
NANT-Y-GWYDDON ROAD
GELLI
MID-GLAMORGAN
CF41 7TL



JOB TITLE

CLOSURE PLAN FOR NANT-Y-
GWYDDON LANDFILL SITE

DRAWING TITLE

LOCATION PLAN
(DRG NO. AM5491/1/001)

SCALE

1:25,000

DATE

09/03/2007

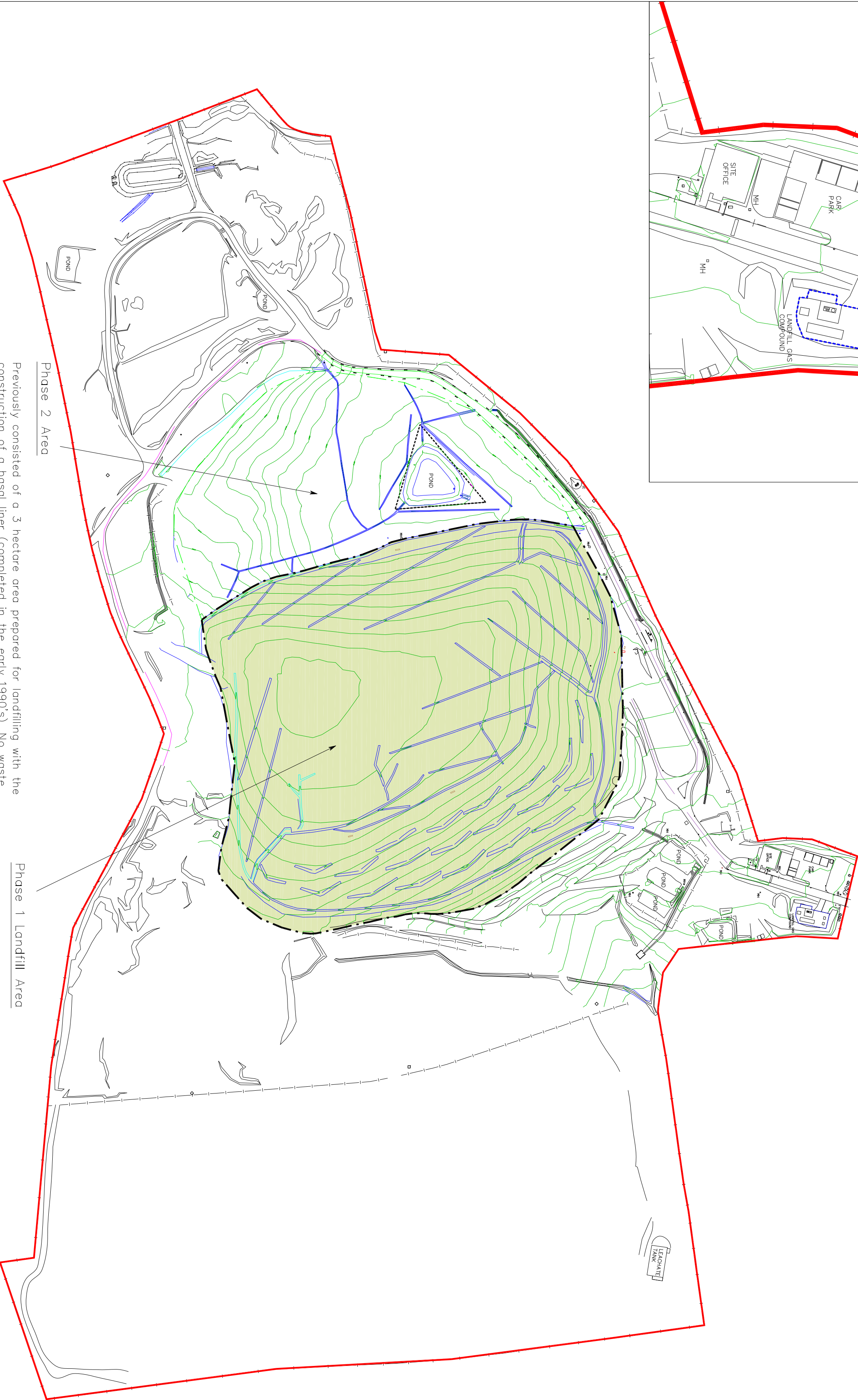
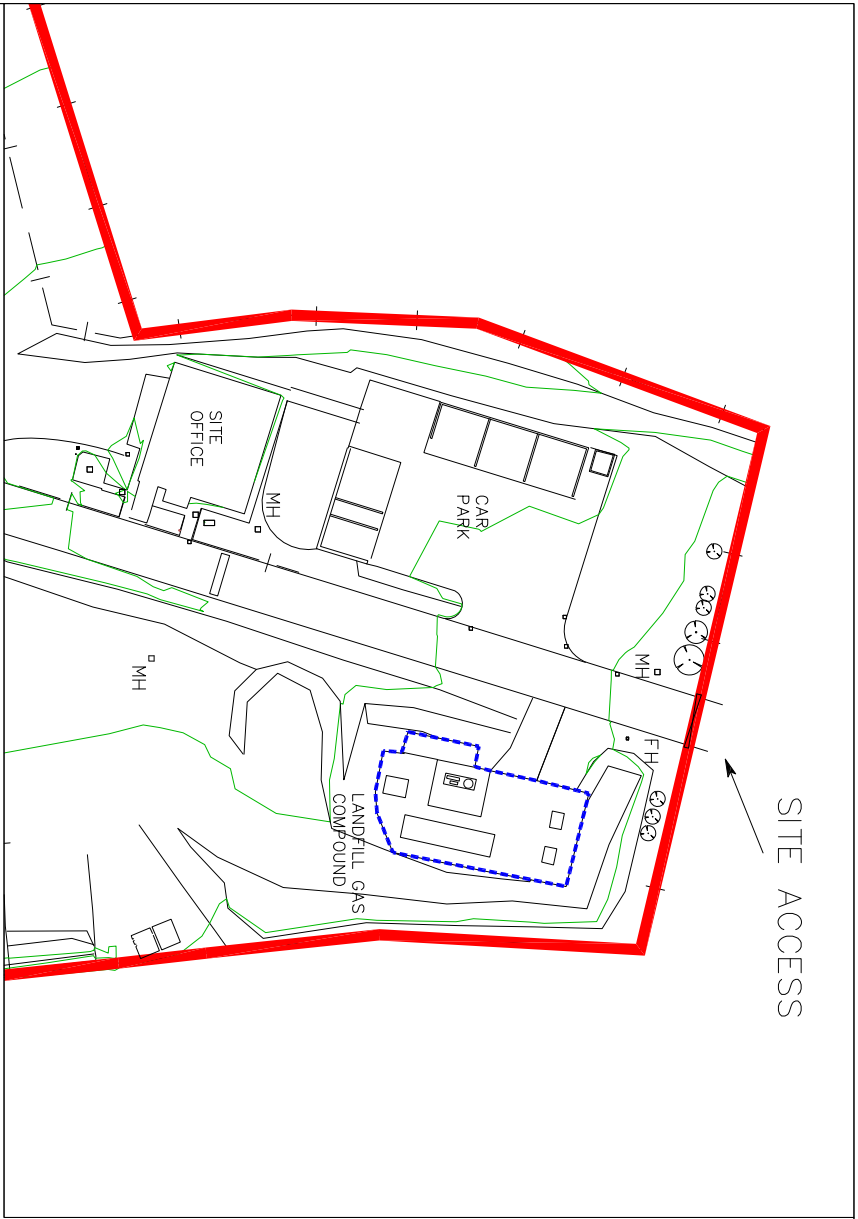
DRAWN

L.F

APPROVED

N.D

REPRODUCED FROM ORDNANCE SURVEY 1:50,000 MAP OF 1991 WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE, CROWN COPYRIGHT, LICENCE NUMBER AL50604A.



Previously consisted of a 3 hectare area prepared for landfilling with the construction of a basal liner (completed in the early 1990's). No waste was ever deposited within this area.

Subsequently, the current site operator (Amgen) constructed 3 (14,000 m3 capacity) leachate holding lagoons (completed in Dec 2001) for the control of leachate.

Both the basal liner and leachate lagoons have now been removed and the area restored with a shallow surface water lagoon.

Phase 1 Landfill Area

The Phase 1 landfill covers an area of approximately 9.5 hectares and was operated during the period November 1987 – March 2002. It contains approximately 1.25 million tonnes of Household, Commercial and Non-Hazardous Industrial Waste.

Now fully remediated and restored with the construction of an engineered landfill cap and surface water drainage infrastructure (completed September 2005).

NOTES:

KEY:

- WML BOUNDARY
- AREA OF LANDFILL WASTE

REV	DESCRIPTION	DATE

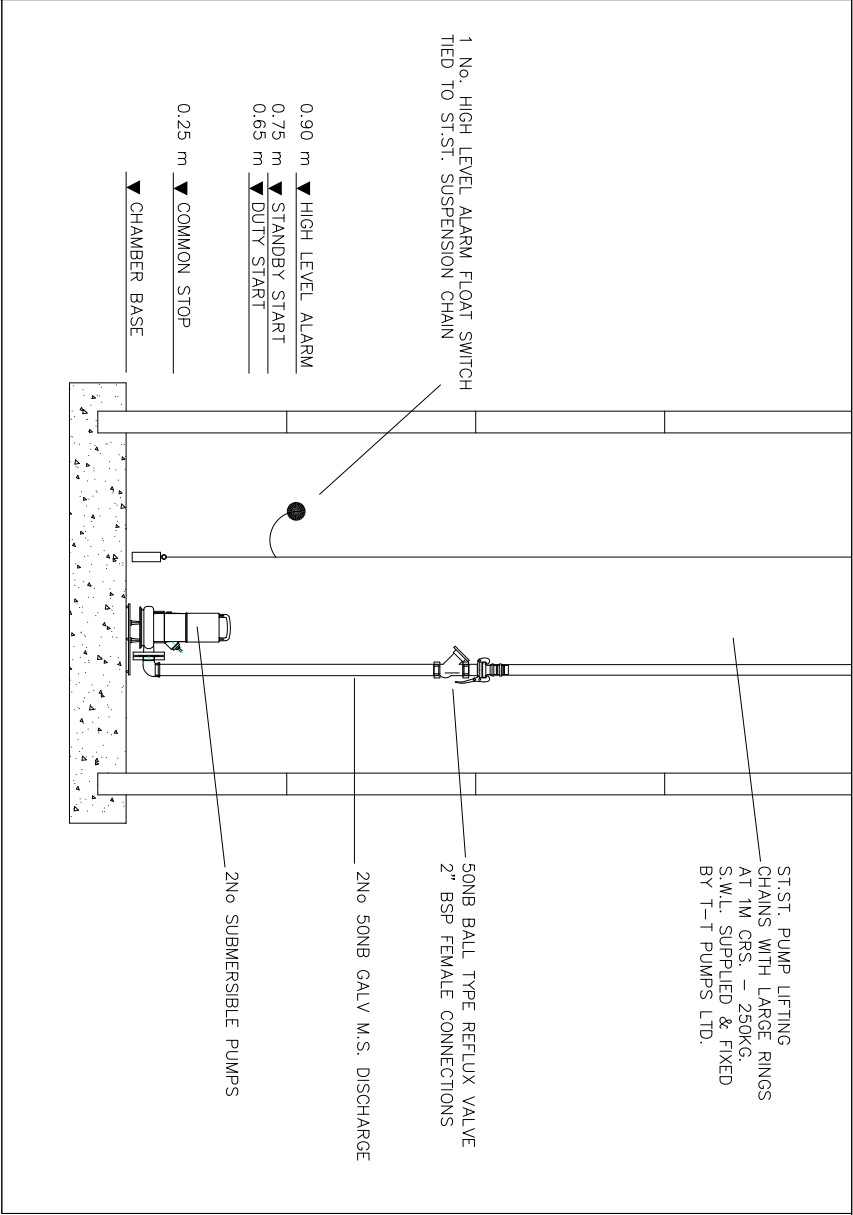
ENCIA CONSULTING LIMITED
BRYN PICCA, LLWYDGOED
ABERDARE, SOUTH WALES
TEL: – 01685 870770 FAX: – 01685 874684

AMGEN RHONDDA LTD.
BRYN PICCA
LLWYDGOED
ABERDARE
CF74 0BX
TEL: 01685 870770
FAX: 01685 874684

CLOSURE PLAN
NANT-Y-GWYDDON
LANDFILL

GENERAL LAYOUT

DRAWN	SIGNATURE	DATE	STATUS
JTJ		05/03/07	FOR COMMENT
LF		05/34/07	FOR APPROVAL
			DRAFT
			FINAL
SCALE	1 : 2500	SHEET	A2
		DRAWING NO.	AM5554/1/002
		REVISION	–



SCALE 1 : 250
PUMPING STATION DETAIL (JONES BUND)



LEACHATE CONTAMINATION MONITORING POINTS:

- LPs1 (LEACHATE PUMPING STATION JONES BUND)
- L5a (INSPECTION MANHOLE)
- L5 (LEACHATE HOLDING TANK)

TO FOUL SEWER CONNECTION

NOTES:

KEY:

- WML BOUNDARY
- AREA OF LANDFILL WASTE
- LEACHATE DISCHARGE PIPEWORK (SURFACE)
- LEACHATE DISCHARGE PIPELINE (UNDERGROUND)
- LEACHATE INSPECTION CHAMBER /SUMP
- LEACHATE EXTRACTION POINT
- LEACHATE MONITORING PIEZOMETER
- GROUNDWATER MONITORING POINT

REV	DESCRIPTION	DATE

ENCIA

ENCIA CONSULTING LIMITED
BRYN PICCA, LLWYDGOED
ABERDARE, SOUTH WALES
TEL: - 01685 870770 FAX: - 01685 874684

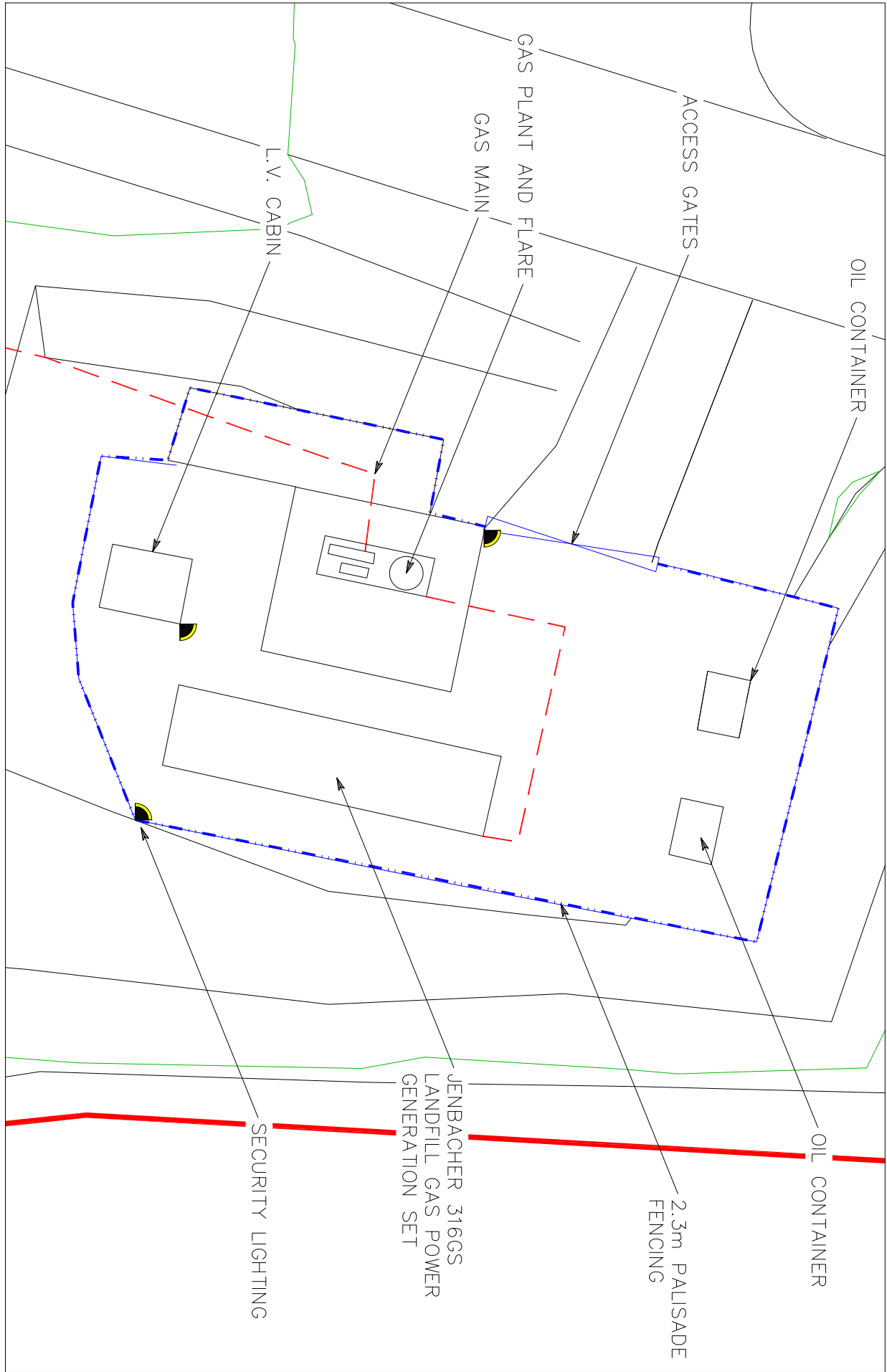
AMGEN
Rhonda Ltd
WASTE MANAGEMENT

AMGEN RHONDDA LTD.
BRYN PICCA
LLWYDGOED
ABERDARE
CF44 0BX
TEL: 01685 870770
FAX: 01685 874684

DRAWING TITLE
CLOSURE PLAN
NANT-Y-GWYDDON
LANDFILL

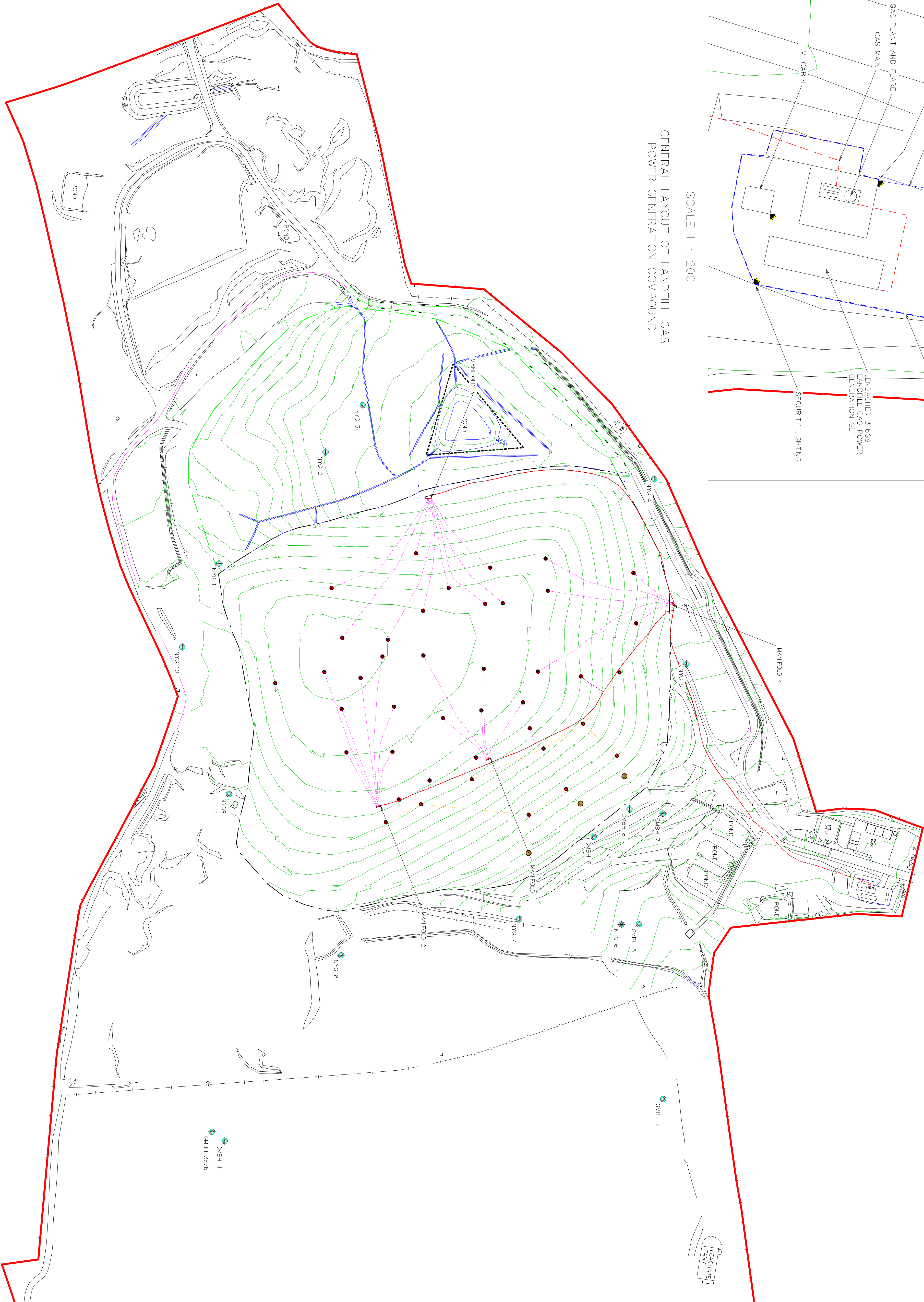
DRAWING TITLE
LEACHATE MANAGEMENT
AND MONITORING

DRAWN	SIGNATURE	DATE	STATUS
JTU		05/03/07	FOR COMMENT
APPROVED	SIGNATURE	DATE	FOR APPROVAL
LF		05/03/07	DRAFT
			FINAL
SCALE	SHEET	DRAWING NO.	REVISION
1 : 2500	A2	AM5554/1/003	-



SCALE 1 : 200

GENERAL LAYOUT OF LANDFILL GAS POWER GENERATION COMPOUND



KEY:

- WML BOUNDARY
- PHASE 1 LANDFILL AREA
- GAS MAIN
- GAS LINE (UNDERGROUND)
- GAS LINE (SURFACE)
- GAS EXTRACTION WELL WITH MONITORING POINT
- SUBSURFACE LANDFILL GAS MONITORING BOREHOLE
- LEACHATE INSPECTION CHAMBER
- LANDFILL GAS CONTROL MANIFOLD AND DEMATERING KNOCKOUT POT

NOTES

REV.	DESCRIPTION	DATE

ENCIA
ENCIA CONSULTING LTD.
BRYN PICCA, LLWYDGOED
ABERDARE, CF44 0BX
TEL: - 01685 870770 FAX: - 01685 874684

AMGEN
AMGEN RHONDDA LTD
BRYN PICCA
LLWYDGOED
ABERDARE
CF44 0BX

CLOSURE PLAN
NANT-Y-GWYDDON
LANDFILL SITE

LANDFILL GAS MANAGEMENT
AND MONITORING

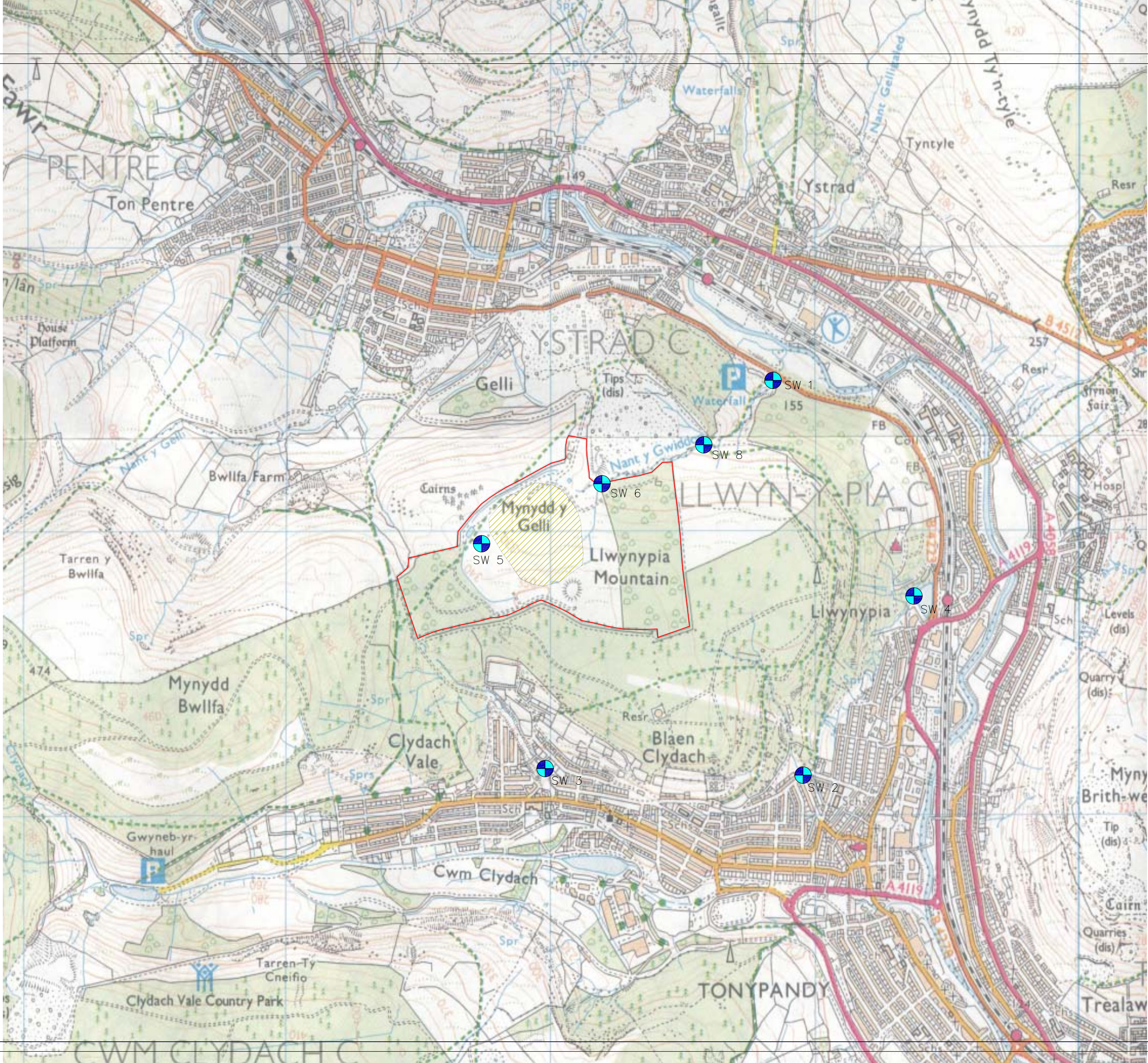
DATE	SIGNATURE	STATUS
08/03/07	JTU	FOR COMMENT
08/03/07	LF	FOR APPROVAL
		DRAFT
		FINAL

SCALE 1 : 2000

SHEET A1

DRAWING NO. AM5554/1/004

REVISION



NOTES:

KEY:

WML BOUNDARY

AREA OF LANDFILL WASTE

SURFACE WATER MONITORING POINT

REV.	DESCRIPTION	DATE

ENCIA

ENCIA CONSULTING LIMITED
BRYN PICA, LLWYDCOED
ABERDARE, SOUTH WALES
TEL: - 01685 870770 FAX: - 01685 874684

CLIENT

AMGEN RHONDDA LTD
BRYN PICA
LLWYDCOED
ABERDARE
CF44 0BX

TEL: 01685 870770
FAX: 01685 874684

JOB TITLE

CLOSURE PLAN
NANT-Y-GWYDDON
LANDFILL

DRAWING TITLE

SURFACE WATER
MONITORING POINTS

DRAWN JTJ	SIGNATURE	DATE 05/03/07	STATUS FOR COMMENT ☐
APPROVED LF	SIGNATURE	DATE 05/03/07	FOR APPROVAL ☐
			DRAFT ☐
			FINAL ☒

SCALE 1 : 10,000	SHEET A2	DRAWING NO. AM5554/1/005	REVISION -
---------------------	-------------	-----------------------------	---------------

380mm

APPENDIX B – Closure Plan Template

Closure Report – Template

Section A - Where your site is progressing to Definitive Closure

You need to complete this section where your site is complete and/ or you do not propose to accept any more waste at the site.

A1.0 Area of the site progressing to definitive closure

Please provide a drawing (minimum scale 1:2500), indicating the area of the site you propose to definitively close.

Drawing Reference: [AM5554/1/002](#)

A1.1 Waste mass stability

Please provide evidence that the capped and restored landfill will remain stable in the long term, or provide a justification as to why such evidence is unnecessary?

Report Reference: [Closure Report Encia Report No. AM5554, Stability Assessment – 2006 Update Report. Arup October 2006.](#)

A1.2 Site Infrastructure

A1.2.1 Leachate Infrastructure

Please provide details of the infrastructure that is in place to manage leachate during the after care period, or provide a justification as to why such details are unnecessary?

Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.

Leachate Infrastructure: [Closure Report Encia Report No. AM5554, Drawing AM5554/1/003 and Nant-y-Gwyddon Landfill Site Working Plan Document.](#)

A1.2.2 Leachate infrastructure maintenance

Please provide details, or reference to a document, which describes your procedures for maintaining the leachate management infrastructure during the aftercare period.

Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.

Leachate Infrastructure management: [Closure Report Encia Report No. AM5554, Nant-y-Gwyddon Landfill Site Working Plan Document and Amgen PRP No 510.](#)

A1.2.3 Leachate monitoring

Please provide details, or reference to a document, which describes your procedures for monitoring leachate head and quality during the aftercare period. This should include details of contingency arrangements should assessment or compliance levels be exceeded. See RGN 7, V2, Section 5.5.1. *Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Leachate Monitoring: [Closure Report Encia Report No. AM5554, Drawing AM5554/1/003, Nant-y-Gwyddon Landfill Site Working Plan Document and Amgen PRP No 510.](#)

A1.2.4 Groundwater Infrastructure

Please provide details of the infrastructure that is in place to monitor groundwater during the after care period, or provide a justification as to why such details are unnecessary?

Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.

Groundwater Infrastructure: [Closure Report](#), [Encia Report No. AM5554](#), [Drawing AM5554/1/003](#), [Nant-y-Gwyddon Landfill Site Working Plan Document](#) and [Amgen PRP No. 510](#).

A1.2.5 Groundwater infrastructure maintenance

Please provide details, or reference to a document, which describes your procedures for maintaining the groundwater monitoring infrastructure (including extraction where applicable) during the aftercare period. *Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Groundwater Infrastructure maintenance: [Closure Report](#), [Encia Report No. AM5554](#) and [Amgen PRP No. 510](#).

A1.2.6 Groundwater monitoring

Please provide details, or reference to a document, which describes your procedures for monitoring groundwater quality during the aftercare period. This should include details of contingency arrangements should control (assessment) or trigger (compliance) levels be exceeded. *See RGN 7, V2, Section 5.5.1. Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Groundwater Monitoring: [Closure Report](#), [Encia Report No. AM5554](#), [Nant-y-Gwyddon Landfill Site Working Plan Document](#) and [Amgen PRP No. 510](#).

A1.2.7 Landfill Gas Infrastructure

Please provide details of the infrastructure that is in place to manage landfill gas during the aftercare period, or provide a justification as to why such details are unnecessary?

Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.

Landfill gas Infrastructure: [Closure Report](#), [Encia Report No. AM5554](#), [Drawing AM5554/1/004](#) and [Nant-y-Gwyddon Landfill Site Working Plan Document](#).

A1.2.8 Landfill gas Infrastructure maintenance

Please provide details, or reference to a document, which describes your procedures for maintaining the landfill gas management infrastructure during the aftercare period. *Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Landfill gas infrastructure management: [Closure Report](#), [Encia Report No. AM5554](#) and [Nant-y-Gwyddon Landfill Site Working Plan Document](#).

A1.2.9 Landfill gas monitoring

Please provide details, or reference to a document, which describes your procedures for monitoring landfill gas during the aftercare period. This should include details of contingency arrangements should assessment or compliance levels be exceeded.

See RGN 7, V2, Section 5.5.1. Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.

Landfill gas monitoring: [Closure Report](#), Encia Report No. AM5554, Drawing AM5554/1/004, Nant-y-Gwyddon Landfill Site Working Plan Document and Amgen PRP No. 510.

A1.2.10 Slope stability/ settlement

Please provide details, or reference to a document, which describes your procedures for maintaining the restored surface of the landfill and any slopes and the stability of any other structures not included above during the aftercare period. *Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Restored surface infrastructure management: [Closure Report](#) Encia Report No. AM5554, [Stability Assessment – 2006 Update Report](#), Arup October 2006 and NYG Landfill Site Working Plan.

A1.2.11 Restored surface monitoring

Please provide details, or reference to a document, which describes your procedures for monitoring the restored surface of the landfill and any slopes and the stability of any other structures not included above during the aftercare period. *Please provide copies, or where they are already existing references to all relevant drawings, plans and documents.*

Restored surface monitoring: [Closure Report](#) Encia Report No. AM5554, [Stability Assessment – 2006 Update Report](#), Arup October 2006 and NYG Landfill Site Working Plan.

A1.3 Reporting

A1.3.1 Significant Environmental Effects

Please provide details, or reference to a document, which describes your procedures for reporting significant environmental effects to us (See RGN 7 V2, section 5.6).

Significant environmental effects: [Closure Report](#) Encia Report No. AM5554, [Nant-y-Gwyddon Landfill Site Working Plan Document](#) and Amgen PRP 503.

A1.4 Habitats

A1.4.1 Habitats sites

If your site is within a specified distance of a European site for nature conservation, or other designated site please provide details, or reference to a document, which describes how you will ensure that there is no impact from your landfill on that site during the aftercare phase. This may be achieved through completion of a nuisance and health risk assessment and the implementation of any mitigation measures identified.

**APPENDIX C –
Table 1a, 1b and 1c (Leachate, Groundwater and Surface Water
Monitoring Analysis Suites and Action Thresholds.**

Table 1a: Suites of Chemical Analysis for Leachate Monitoring at the Nant-y-Gwyddon Landfill Site as agreed in the site's Working Plan Document.

Parameter	Monthly Suite	Quarterly Suite	Annual Suite	Lower Detection Limit mg/l	Action Threshold
1,2-Dichloroethane		X	X	0.0002 mg/l	n/a
Acetone			X	0.1 mg/l	n/a
Acrylonitrile			X	0.1 mg/l	n/a
Alkalinity	X	X	X	3 mg/l	n/a
Ammoniacal Nitrogen	X	X	X	0.3 mg/l	n/a
Arsenic			X	0.001 mg/l	n/a
Benzene		X	X	0.0003 mg/l	n/a
BOD	X	X	X	1 mg/l	n/a
Cadmium		X	X	0.0005 mg/l	n/a
Calcium		X	X	0.1 mg/l	n/a
Chloride	X	X	X	2 mg/l	n/a
Chromium		X	X	0.005 mg/l	n/a
COD	X	X	X	20 mg/l	n/a
Conductivity	X	X	X	10 mg/l	n/a
Copper		X	X	0.005 mg/l	n/a
Anionic Detergents and Surfactants			X	0.3 mg/l	n/a
Dimethoxymethane			X	0.1 mg/l	n/a
Dimethylethanolamine			X	0.1 mg/l	n/a
Dissolved Oxygen				0.5 mg/l	n/a
Formaldehyde			X	0.02 mg/l	n/a
Iron		X	X	0.05 mg/l	n/a
Lead		X	X	0.005 mg/l	n/a
Magnesium		X	X	0.1 mg/l	n/a
Manganese			X	0.005 mg/l	n/a
Mercury			X	0.0001 mg/l	n/a
Methanol			X	5 mg/l	n/a
Nickel		X	X	0.005 mg/l	n/a
Nitrate		X	X	0.3 mg/l	n/a
Nitrite		X	X	0.1 mg/l	n/a
pH	X	X	X	0.1 pH Units	n/a
Phenol		X	X	0.1 mg/l	n/a
Phosphate		X	X	0.1 mg/l	n/a
Potassium		X	X	0.1 mg/l	n/a
Propan-1-ol			X	0.1 mg/l	n/a
Propan-2-ol			X	0.1 mg/l	n/a
Propylamine			X	0.01 mg/l	n/a
Sodium		X	X	0.2 mg/l	n/a
Sulphate		X	X	5 mg/l	n/a
Sulphide		X	X	0.01 mg/l	n/a
Suspended Solids	X	X	X	2 mg/l	n/a
Styrene		X	X	0.0004 mg/l	n/a
Temperature	X	X	X	0.1 °C	n/a
TOC	X	X	X	0.3 mg/l	n/a
Toluene			X	0.0003 mg/l	n/a
Total Oxidised Nitrogen		X	X	0.3 mg/l	n/a
Trichloroethane		X	X	0.0001 mg/l	n/a
Trichloroethylene		X	X	0.0001 mg/l	n/a
Trimethylamine			X	0.0001 mg/l	n/a
Water/leachate level / piezometric head	X	X	X	0.1 m	n/a
Xylene		X	X	0.0008 mg/l	n/a
Zinc		X	X	0.005 mg/l	n/a

Table 1b: Suites of Chemical Analysis for Groundwater Monitoring at the Nant-y-Gwyddon Landfill Site as agreed in the site's Working Plan Document.

Parameter	MONTHLY Suite	Quarterly Suite	Annual Suite	Lower Detection Limit mg/l	Action Threshold (mg/l)
1,2-Dichloroethane		X	X	0.0002 mg/l	0.001
Acetone			X	0.1 mg/l	
Acrylonitrile			X	0.1 mg/l	
Alkalinity	X	X	X	3 mg/l	
Ammoniacal Nitrogen	X	X	X	0.3 mg/l	
Arsenic			X	0.001 mg/l	0.01
Benzene		X	X	0.0003 mg/l	0.001
BOD	X	X	X	1 mg/l	0.03
Cadmium		X	X	0.0005 mg/l	0.0001
Calcium		X	X	0.1 mg/l	250
Chloride	X	X	X	2 mg/l	250
Chromium		X	X	0.005 mg/l	0.05
COD	X	X	X	20 mg/l	
Conductivity	X	X	X	10 mg/l	
Copper		X	X	0.005 mg/l	0.001
Anionic Detergents and Surfactants			X	0.3 mg/l	
Dimethoxymethane			X	0.1 mg/l	
Dimethylethanolamine			X	0.1 mg/l	
Dissolved Oxygen				0.5 mg/l	
Formaldehyde			X	0.02 mg/l	0.1
Iron		X	X	0.05 mg/l	0.2
Lead		X	X	0.005 mg/l	0.01
Magnesium		X	X	0.1 mg/l	50
Manganese			X	0.005 mg/l	0.05
Mercury			X	0.0001 mg/l	0.00001
Methanol			X	5 mg/l	
Nickel		X	X	0.005 mg/l	0.05
Nitrate	X	X	X	0.3 mg/l	50
Nitrite	X	X	X	0.1 mg/l	0.1
pH	X	X	X	0.1 pH Units	
Phenol		X	X	0.1 mg/l	0.03
Phosphate		X	X	0.1 mg/l	2.2
Potassium		X	X	0.1 mg/l	12
Propan-1-ol			X	0.1 mg/l	
Propan-2-ol			X	0.1 mg/l	
Propylamine			X	0.01 mg/l	
Sodium		X	X	0.2 mg/l	170
Sulphate		X	X	5 mg/l	400
Sulphide		X	X	0.01 mg/l	0.00025
Suspended Solids	X	X	X	2 mg/l	
Styrene		X	X	0.0004 mg/l	0.05
Temperature	X	X	X	0.1 °C	
TOC	X	X	X	0.3 mg/l	
Toluene		X	X	0.0003 mg/l	0.004
Total Oxidised Nitrogen		X	X	0.3 mg/l	
Trichloroethane		X	X	0.0001 mg/l	0.0001
Trichloroethylene		X	X	0.0001 mg/l	0.0001
Trimethylamine			X	0.0001 mg/l	
Water/leachate level / piezometric head	X	X	X	0.1 m	
Xylene		X	X	0.0008 mg/l	0.003
Zinc		X	X	0.005 mg/l	0.008

Table 1c: Suites of Chemical Analysis for Surface Water Monitoring at the Nant-y-Gwyddon Landfill Site as agreed in the site's Working Plan Document.

Parameter	Monthly Suite	Quarterly Suite	Annual Suite	Lower Detection Limit mg/l	Action Threshold (mg/l)
1,2-Dichloroethane		X	X	0.0002 mg/l	0.001
Acetone			X	0.1 mg/l	
Acrylonitrile			X	0.1 mg/l	
Alkalinity	X	X	X	3 mg/l	
Ammoniacal Nitrogen	X	X	X	0.3 mg/l	
Arsenic			X	0.001 mg/l	0.01
Benzene			X	0.0003 mg/l	0.001
BOD	X	X	X	1 mg/l	0.03
Cadmium		X	X	0.0005 mg/l	0.0001
Calcium		X	X	0.1 mg/l	250
Chloride	X	X	X	2 mg/l	250
Chromium		X	X	0.005 mg/l	0.05
COD	X	X	X	20 mg/l	
Conductivity	X	X	X	10 mg/l	
Copper		X	X	0.005 mg/l	0.001
Anionic Detergents and Surfactants			X	0.3 mg/l	
Dimethoxymethane			X	0.1 mg/l	
Dimethylethanolamine			X	0.1 mg/l	
Dissolved Oxygen	X	X	X	0.5 mg/l	
Formaldehyde			X	0.02 mg/l	0.1
Iron		X	X	0.05 mg/l	0.2
Lead		X	X	0.005 mg/l	0.01
Magnesium		X	X	0.1 mg/l	50
Manganese			X	0.005 mg/l	0.05
Mercury			X	0.0001 mg/l	0.00001
Methanol			X	5 mg/l	
Nickel		X	X	0.005 mg/l	0.05
Nitrate		X	X	0.3 mg/l	50
Nitrite		X	X	0.1 mg/l	0.1
pH	X	X	X	0.1 pH Units	
Phenol			X	0.1 mg/l	0.03
Phosphate		X	X	0.1 mg/l	2.2
Potassium		X	X	0.1 mg/l	12
Propan-1-ol			X	0.1 mg/l	
Propan-2-ol			X	0.1 mg/l	
Propylamine			X	0.01 mg/l	
Sodium		X	X	0.2 mg/l	170
Sulphate		X	X	5 mg/l	400
Sulphide		X	X	0.01 mg/l	0.00025
Suspended Solids	X	X	X	2 mg/l	
Styrene			X	0.0004 mg/l	0.05
Temperature	X	X	X	0.1 °C	
TOC	X	X	X	0.3 mg/l	
Toluene			X	0.0003 mg/l	0.004
Total Oxidised Nitrogen			X	0.3 mg/l	
Trichloroethane			X	0.0001 mg/l	0.0001
Trichloroethylene			X	0.0001 mg/l	0.0001
Trimethylamine			X	0.0001 mg/l	
Water/leachate level / piezometric head				0.1 m	
Xylene			X	0.0008 mg/l	0.003
Zinc		X	X	0.005 mg/l	0.008

**APPENDIX D –
Amgen Policy Rules and Procedures (PRP No. 510) Environmental
Monitoring Procedures and Maintenance of Equipment.**

Environmental Monitoring Procedures and Maintenance of Equipment

1.0 Introduction

- 1.1 Amgen Cymru is committed to environmental monitoring on all sites under the care of the Company. In addition to the actual monitoring procedures and recording of information, Amgen Cymru implements training of employees in the correct use and maintenance of monitoring equipment and requirements for calibration.
- 1.2 Environmental monitoring is performed on sites that comprise active and/or closed landfills and civic amenity sites. Monitoring is undertaken according to the specified schedules and requirements as agreed with the Environment Agency.
- 1.3 Environmental monitoring is performed within confined spaces (including groundwater wells, leachate chambers and wells, gas wells) and at the ground surface (including surface water ponds, leachate lagoons, discharge points, channels).
- 1.4 A variety of portable equipment is used for on-site environmental monitoring. All types of equipment will benefit from optimal performance if correctly used, maintained and calibrated. Equipment also includes the in-situ boreholes constructed for sampling groundwater, leachate and gas, and these must be maintained to enable effective monitoring.
- 1.5 Safety issues must be considered when performing monitoring as sample collection is often undertaken at hazardous locations and the risk of exposure to contaminated water and landfill gas should be kept to a minimum.
- 1.6 Records of all environmental monitoring data are maintained and kept up to date for inspection.

2.0 Safety

- 2.1 Amgen Cymru personnel who undertake environmental monitoring are required to access potentially hazardous areas on site, such as surface water and leachate lagoons, leachate chambers, channels, outfalls and landfill gas boreholes.
 - 2.2 Exposure to leachate, landfill gas, uncapped wastes and contaminated water can occur. Therefore, the Company will provide personnel with the appropriate Personal Protective Equipment (PPE).
 - 2.3 Defective or damaged PPE must be reported and replaced. Any changes, damage or alterations that have occurred to sampling locations preventing or restricting access to those locations will be reported to the site manager for rectification.
-

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

- 2.4 Personnel will receive training in the safe procedures for environmental monitoring and use of PPE.

3.0 Training in Environmental Monitoring and Use of Equipment

- 3.1 Employees of the Company who routinely or occasionally undertake environmental monitoring will receive appropriate training in the procedures involved and for the operation, storage, maintenance and calibration of equipment.
- 3.2 In accordance with the Company's policies, training will be delivered through in-house coaching and induction courses in addition to external courses.
- 3.3 Evaluation of training will be undertaken by the company to identify the training and development needs of personnel involved in environmental monitoring.

4.0 Procedures for Groundwater, Surface Water and Leachate Monitoring

4.1 Containers and Field Equipment Preparation

- 4.1.1 In addition to performing in-situ tests with portable equipment it is routinely necessary to collect liquid samples for detailed laboratory analysis.
- 4.1.2 As directed by the testing service laboratory, a minimum size of sample will be collected for various tests and usually this is 1 litre of liquid from each sampling location.
- 4.1.3 Sterilised plastic bottles with sealable lids will be used for all water and leachate samples. A set of adhesive labels and a pen are necessary to record sample collection details and the tests required on each container.
- 4.1.4 When collecting liquids a dedicated bailer will be used for each sample. If a Waterra pumping system is used, this will be fitted at each monitoring point and will not be moved to another location.
- 4.1.5 Groundwater monitoring boreholes will be purged prior to sample collection. Amgen Cymru personnel will be trained in the correct procedure for borehole purging.
- 4.1.6 If samples can not be delivered to the laboratory on the day of collection they must be stored in a refrigerator in the interim period. The testing laboratory will be provided with analysis request forms detailing which determinants are to be tested for.

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

4.2 Sampling Procedure for the Monitoring of Groundwater Boreholes

- 4.2.1 Prior to sampling at a monitoring point, the borehole location will be checked with reference to the site borehole layout plan. A note will be made of the condition of the monitoring point.
- 4.2.2 Using a dip meter, the level of water in the borehole will be measured; following this the well will be purged as instructed during training.
- 4.2.3 A sample bottle will be rinsed twice with water from the purging operation, although this is not undertaken if the bottle contains a fixative. The sample container will be completely filled so that there is no air space at the top and sealed making it airtight. It will be necessary to note the sample colour, odour and any suspended particles.
- 4.2.4 Each sample bottle will be labelled, to include: date, time, site, borehole location and sampling point number. When sampling is complete, it is necessary to record the date of the sampling operation and the date of delivery to the laboratory.

4.3 Sampling Procedure for the Monitoring of Surface Water

- 4.3.1 Surface water can be sampled if direct access to the body of water is possible. Alternatively, sampling should be performed from a safe location where a bailer can be lowered into the water.
- 4.3.2 A sample bottle will be rinsed twice, filled and sealed ensuring an airtight fit. The bottle will not be rinsed if it is supplied with a fixative.
- 4.3.3 Correct and accurate labelling of the sample bottle will be ensured, including the following information: date, time, site name, sampling location and sampling point number.

4.4 Sampling Procedure for the Monitoring of Landfill Leachate

- 4.4.1 Each sample container will be labelled, to include: date, time, site, borehole or chamber location, and sampling point number. A note must be made of the date of sampling operations and the date of delivery to the testing laboratory.

4.5 Procedure for Measuring Groundwater and Leachate Levels

- 4.5.1 Groundwater and leachate levels will be measured in boreholes using a portable dip meter.

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

- 4.5.2 If several monitoring points are measured with a single dip meter, cross-contamination will be prevented by cleaning the dipper probe and any tape contaminated with leachate. Separate dip meters should be used for measuring leachate and groundwater levels.

5.0 Procedures for Landfill Gas Monitoring

5.1 Pre-Sampling Procedures

- 5.1.1 Prior to sampling, the gas analysing instrument will be checked to ensure it is within the calibration date. Calibration will be checked with a can of calibration gas and if the results are outside the recommended limits the equipment must be returned to the manufacturer or authorised service agency.
- 5.1.2 The instrument's battery life will be checked before the start of a monitoring round to ensure there is sufficient power for the sampling operations. If the instrument contains a filter this must be checked to make sure it is clean prior to sampling.
- 5.1.3 A dip meter reading will be taken to measure the depth of liquid in gas monitoring boreholes.

5.2 Gas Monitoring Procedure at Boreholes

- 5.2.1 Samples taken from a gas monitoring borehole must be representative of the gases in the ground. Gases present in the borehole may not be representative of the ground atmosphere on the day of sampling since they may have become stratified, or 'stagnant'. It is therefore important that sufficient time is allowed on sampling each borehole to enable fresh gases to be drawn into the well. The duration of pumping will vary between different boreholes depending on their size and depth.
- 5.2.2 All gas monitoring boreholes will be fitted with a removable airtight gas tap bung, which is necessary to avoid air being drawn into the well casing during sampling.

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

5.3 *Gas Sampling Procedure*

- 5.3.1 At the start of the sampling operations the monitoring technician will note weather conditions and atmospheric pressure. Borehole covers and headworks will be inspected for damage, which will be reported to the site manager for repair.
- 5.3.2 Prior to sampling, the gas meter will be switched on and a sample of air pumped through ensuring that the reading is zero for methane and carbon dioxide and is approximately 21% for oxygen. Gas pressure within the borehole will be measured by connecting a pressure meter to the gas tap with a section of rubber tubing.
- 5.3.3 A sample will be tested by connecting the gas analyser to the gas tap fitted to the borehole. While gas is being drawn through the instrument the level indicator will be observed continuously for changes over a period of 2 minutes or longer until a stable reading is obtained.
- 5.3.4 The following peak readings will be measured: flammable gas (highest reading), carbon dioxide (highest reading) and oxygen (lowest reading). It is important to note if the readings stabilise after the peak reading has been obtained or if they fluctuate and decrease.
- 5.3.5 After a sample has been analysed the instrument will be disconnected from the gas tap and air will be pumped through to reset it to zero.
- 5.3.6 The gas monitoring borehole will be dipped to determine liquid level after sampling and the gas tap bung will be replaced ensuring a tight fit. Atmospheric pressure will be measured again, at the end of the monitoring round.

5.4 *Gas Sampling in Buildings, Voids and Service Ducts*

- 5.4.1 Monitoring procedures are essentially the same as for borehole sampling, but care must be exercised because of the confined nature of the sampling area.
 - 5.4.2 A Permit to Work system is operated by the Company for entry into confined spaces. Entry to such areas will only be permitted for trained personnel once a permit has been issued.
 - 5.4.3 An intrinsically safe gas analyser will be used prior to sampling, to establish that there are no flammable gas concentrations above the L.E.L.
 - 5.4.4 The gas monitoring procedure will be started at the door or opening of the building or void, working inwards.
-

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

- 5.4.5 Within larger spaces, the gas analyser will be used at different heights due to possible stratification of methane and carbon dioxide in landfill gas.

6.0 Maintenance and Calibration of Equipment

6.1 General Care and Maintenance of Monitoring Equipment

- 6.1.1 Amgen Cymru is committed to providing its staff with safe, suitable equipment that has been well maintained and is in working order.
- 6.1.2 Prior to use, portable equipment will be visually inspected for damage and any faults will be reported so that arrangements can be made for repair or replacement. Battery life will be tested before commencing on a monitoring round and if filters are incorporated these will be checked to make sure they are clean.
- 6.1.3 During the monitoring round, personnel will endeavour to keep portable equipment clean and free from dust, liquids and grease, except for those components which require direct contact with groundwater, leachate and landfill gas.
- 6.1.4 Monitoring equipment will not be left outside at site, unless the instrument is housed within a weatherproof box and is intended to be left on-site during a period of data logging.
- 6.1.5 After use, portable equipment will be cleaned and any dirty filters replaced. Instruments will be stored in the appropriate carrying cases.
- 6.1.6 Different types of equipment will require specific maintenance; therefore the manufacturer's instructions and guidance should be consulted.

6.2 Maintenance of Boreholes used for Logging

- 6.2.1 Groundwater, leachate and landfill gas observation wells are fitted with lockable steel covers. The condition of steel covers and borehole head works will be inspected on each monitoring round and any damage or faults reported to the site manager.
- 6.2.2 Gas monitoring boreholes are fitted with a gas tap bung enabling sampling to be performed without air entering the well casing. The condition of gas tap bungs will be inspected and any faults of damage reported so that a replacement can be fitted.
- 6.2.3 Borehole cover padlocks will be lubricated periodically to avoid deterioration.

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

6.3 *Equipment Calibration and Records*

- 6.3.1 Calibration of portable monitoring instrumentation will be performed either in-house by Amgen Cymru personnel, or through the equipment manufacturers or an authorised service agency.
- 6.3.2 A calibration record sheet will be kept and maintained listing all portable equipment used. This will include the following information:
- instrument makes and models,
 - faults or repairs required,
 - calibration schedule,
 - date of previous calibration.
- 6.3.3 Calibration requirements will differ between instruments; therefore the manufacturer's guidelines for calibration will be consulted.

7.0 Environmental Monitoring Records

- 7.1 All records of monitoring rounds performed and the analytical results obtained will be stored at the Amgen Cymru head office. A copy of monitoring records will be forwarded to the Environment Agency in accordance with site requirements.
- 7.2 Proformas for environmental monitoring data will be kept at the Amgen Cymru head office and completed during a monitoring round. As a basic requirement these will include the sample point location reference, determinant measured and any special requirements for laboratory analysis.
- 7.3 An environmental monitoring summary sheet for each site will be kept at the head office. These will document the intervals for sampling, the sample points to be used and the determinants to be monitored.

8.0 Availability and Amendments

- 8.1 The date that this policy is effective from is shown at the bottom of the document, and will also be shown in the file holding all of the current Policies, Rules and Procedures.
- 8.2 The Directors reserve the right to withdraw or amend this document without notice, but will consult with the staff on changes that affect your fundamental rights or duties.

POLICIES, RULES & PROCEDURES

Environmental Monitoring Procedures and Maintenance of Equipment

- 8.3 Aspects of this document may also affect, or be affected by, other Policies, Rules and Procedures and you should therefore make sure that you are familiar with all current versions.
- 8.4 A full set of current Policies, Rules and Procedures is held by the Administration Department. You are entitled to see the complete set at any time the Administration Department is open, and you are entitled to a copy if you do not have one. You can also discuss them with any of the Managers at a time that is convenient for the both of you.

POLICIES, RULES & PROCEDURES

**APPENDIX E –
Amgen Policy Rules and Procedures (PRP No. 503) Environmental
Emergency Action Plan.**

Environmental Emergency Action Plan

1.0 Introduction

- 1.1 This PRP document outlines procedures to be adopted in the event of an environmental emergency at any of Amgen Cymru / Rhondda waste management facilities.
- 1.2 An environmental emergency is defined as occurring when monitoring systems indicate samples or readings that are in breach of specified limits or are causing adverse environmental effects, or if the escape of fugitive emissions has occurred whether by malfunction or accident.
- 1.3 In the event of an environmental emergency, the Environment Agency will be notified by an authorised representative of the Site Operator who will complete and submit a Schedule 6 Notification Form (for PPC sites) within the time intervals and including the details as specified in this action plan.

2.0 Environmental Emergencies

- 2.1 Environmental emergencies requiring response, as specified by the PPC Permit, include the following:
 - (a) Malfunction, breakdown or failure of equipment or techniques, accident, or fugitive emission which has caused, is causing or may cause significant pollution.
 - (b) Breach of limits for gas, surface water, groundwater, and leachate as detected by the site monitoring apparatus implemented.
 - (c) Significant adverse environmental effects.
- 2.2 Measures for the prevention of pollution caused by fugitive emissions will be implemented by the Site Operator and are specific to the various operations performed by the Company. In the event of the escape of fugitive emissions which cause or may cause pollution, the Site Operator will implement the relevant measures put in place to rectify or reduce the situation and these measures are specific to the various operations undertaken by the Company.

3.0 On Site Actions in the Event of an Environmental Emergency

- 3.1 Upon discovering a potentially polluting break out or emission members of staff are advised to evacuate the area for reason of health and safety and contact a senior member of staff immediately (Site Manager, Environmental Manager, Operations Manager).
- 3.2 Staff must then await further instructions from senior management, whilst ensuring that the area remains confined and undisturbed.

4.0 Notification

Environmental Emergency Action Plan

- 4.1 In the event of an environmental emergency, the Site Operator will provide relevant details by completing a Notification Form as outlined in Schedule 6 of the PPC Permit. Copies of the Notification Form will be held at the Amgen Cymru head office.
- 4.2 Notification of any malfunction, breakdown or failure of equipment or techniques, accident, or fugitive emission which has caused, is causing or may cause significant pollution will be forwarded by the Site Operator to the Environment Agency within 24 hours of detection. Details required are as follows:
- (a) Date and time of the event
 - (b) Reference or description of the location of the event
 - (c) Description of where any release into the environment took place
 - (d) Substance(s) potentially released
 - (e) Best estimate of the quantity or rate of release of substances
 - (f) Measures taken, or intended to be taken, to stop any emission
- 4.3 Notification of any breach of a specified limit for landfill gas, groundwater, surface water or leachate will be forwarded by the Site Operator to the Environment Agency within 24 hours of detection. Details required are as follows:
- (a) Emission point reference / source
 - (b) Parameter(s)
 - (c) Limit
 - (d) Measured value and uncertainty
 - (e) Date and time of monitoring
 - (f) Measures taken, or intended to be taken, to stop the emission
- 4.4 Notification of the detection of any significant adverse environmental effects will be forwarded by the Site Operator to the Environment Agency within 24 hours of detection. Details required include the following:
- (a) Description of where the effect on the environment was detected
 - (b) Substance(s) detected
 - (c) Concentrations of substance(s) detected

Environmental Emergency Action Plan

(d) Date and time of monitoring / sampling

4.5 The Site Operator is required to submit to the Environment Agency any additional information about environmental emergency incidents as soon as is practicable. This information will be entered on the Schedule 6 Notification Form. The requirements for further information include the following:

(a) Any more accurate information on the matters notified

(b) Measures taken, or intended to be taken, to prevent a recurrence of the incident

(c) Measures taken, or intended to be taken, to rectify, limit or prevent any pollution of the environment which has been caused or may be caused by the emission

(d) The dates of any unauthorised emissions from the installation in the preceding 24 months

5.0 **Contacts**

5.1 Notification of environmental emergency incidents will be made to:

Environment Agency Wales
Rivers House
St Mellons Business Park
St Mellons
Cardiff, CF3 0EY

Tel. 02920 770088
Fax 02920 362487

6.0 **Availability and Amendments**

6.1 The date that this policy is effective from is shown at the bottom of the document and will also be shown in the file holding all of the current Policies, Rules and Procedures.

6.2 The Directors reserve the right to withdraw or amend this document without notice, but will consult with the staff on changes that affect your fundamental rights and duties.

6.3 Aspects of this document may also affect, or be affected by, other Policies, Rules and Procedures and you should therefore make sure that you are familiar with all current versions.

Environmental Emergency Action Plan

- 6.4 A full set of current Policies, Rules and Procedures is held by the Administration Department. You are entitled to see the complete set at any time the Administration Department is open, and you are entitled to a copy if you do not have one. You can also discuss them with any of the Managers at a time that is convenient for the both of you.

**APPENDIX F –
Nant-y-Gwyddon Landfill Inert Bund, Stability Assessment – 2006 Update
Report, Arup October 2006.**

Amgen Rhondda Limited

**Nant y Gwyddon
Landfill Inert Bund**

Stability Assessment -
2006 Update Report

Amgen Rhondda Limited

**Nant y Gwyddon
Landfill Inert Bund**

**Stability Assessment -
2006 Update Report**

October 2006

Ove Arup & Partners Ltd
4 Pierhead Street, Capital Waterside, Cardiff CF10 4QP
Tel +44 (0)29 2047 3727 Fax +44 (0)29 2047 2277
www.arup.com

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job number 119304

Job title	Nant y Gwyddon Landfill Inert Bund	Job number
		119304

Document title	Stability Assessment - 2006 Update Report	File reference
----------------	---	----------------

Document ref

Revision	Date	Filename	0001Annual Review Report 2006, TG.doc		
Draft 1	19/04/06	Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Terry Gordon	Terry Gordon	Terry Gordon
		Signature			
Issue	23/10/06	Filename	0001Annual Review Report 2006, TG.doc		
		Description	Final document		
			Prepared by	Checked by	Approved by
		Name	Terry Gordon	Terry Gordon	Terry Gordon
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document



Contents

	Page
1 INTRODUCTION	1
2 THE SITE	2
3 MONITORING	3
3.1 Leachate Levels/Pressures	3
3.2 Movement Monitoring	4
4 CONCLUSIONS AND RECOMMENDATIONS	7
4.1 Conclusions	7
4.2 Recommendations	7

References

Appendices

Appendix A

Piezometer Readings - Inert Bund

Appendix B

Piezometer Readings - Landfill

Appendix C

Monitoring of Movement Markers

1 INTRODUCTION

Amgen Rhondda Limited (ARL) has commissioned Arup to produce an independent investigation and assessment of the overall safety characteristics of the inert bund at Nant-y-Gwyddon Landfill Site. Annual assessments are required under Section 2.12 of the Site Working Plan (as updated in February 2002).

The following assessment reports were produced previously by Arup :-

- o Report Serial No. 01/5098 dated March 2001 (Reference 1);
- o Letter Report dated 18 October 2002 (Reference 2);
- o Report Serial No. 04/6329 dated July 2004 (Reference 3).

Several earlier reports were produced by others (Ref. Report 01/5098 for details).

At the time of the last assessment (July 2004 Report), deposition of household waste had ceased (in March 2002) and some 38% of the landfill had a designed, engineered cap (barrier system). During 2005, the engineered cap was extended to cover the remainder of the Phase 1 landfill site. Details of the works undertaken in 2005 are contained in 'Method Statement and Quality Plan, Phase 1 Capping and Restoration Works' (Reference 4).

This 2006 Stability Update Report assesses the results of routine monitoring and reviews the stability of the inert bund following the implementation of the additional capping and restoration works.

2 THE SITE

The location, topography, geology, hydrogeology and history of the site are described in Report Serial No: 01/5098, (Reference 1). Details of the construction of the inert bund and of the under-drainage and leachate drainage systems installed at the site are also described.

No reports of dangerous occurrences involving the inert bund have been made since the 2003/2004 assessment.

An inspection of the inert bund was made by Arup on 18th November 2005 during dry weather. No significant changes were apparent in the condition of the inert bund compared with the previous inspection by Arup on 30th July 2003. No evidence of instability was seen, nor any signs of erosion or ponding. Grass cover was well established on the bund and on the 1 on 3 face of the capped landfill uphill of the inert bund. Areas of the landfill capped during 2005 were sparsely grassed.

In addition to the inert bund and its vicinity, the landfill mound was inspected, including the capping works installed during 2005. The CQA Method Statement and Quality Plan, inclusive of design drawings, was made available for the purposes of this stability assessment (Reference 4). A brief description of the capping works is given below, based on interpretation of this document.

The cap includes a geotextile-protected, continuous (welded), double-textured, 1mm LLDPE geo-membrane. This is covered by a 1m thick layer of processed colliery spoil, including a 300mm surface layer, suitably enhanced for growing. There are surface water collection systems and sub-cap collection systems for landfill gas and perched leachate, as described below.

A geotextile-protected, cusped membrane beneath the LLDPE geo-membrane, in combination with leachate collection pipework, is designed to collect and convey leachate seepage and discharge it to leachate sumps. The same cusped membrane, in combination with landfill gas collection pipework, is designed to collect and convey landfill gas and discharge it to gas well heads.

A further geotextile-protected, cusped membrane, installed above the LLDPE geo-membrane, in combination with surface water collection pipework, is designed to collect and discharge surface water seepage to surface ditches. The surface of the capping layer is graded to suitable falls and provided with a system of surface water ditches and channels. During the inspection on 18th November 2005, erosion problems were evident at some drainage channels and it was understood that remedial works were being planned.

On the western side of the mound, controlled filling over the landfill cap was undertaken to achieve a suitable finished profile over and east of the former Jones' Bund.

An adjacent, low-lying area within the Phase 2 site was infilled during the 2005 capping works, following removal of the geo-membrane liner which had been in place for several years in anticipation of the Phase 2 landfilling. During the inspection on 18 November 2005, Arup was advised that the fill used for the infilling was coarse colliery spoil material (with much gravel and cobbles). Surface run-off from the surrounding Phase 2 area infiltrates this deposit and it was observed via manholes that the resulting ground water ponds to an elevation near to the ground surface.

3 MONITORING

3.1 Leachate Levels/Pressures

3.1.1 Standpipe Piezometers in the Inert Bund

The following installations remain serviceable and are monitored by ARL on a monthly frequency: -

GMBH5 (previously NYG3B)

GMBH6 (previously NYG1B)

GMBH7 (previously OA1)

GMBH8 (previously OA2)

The 2003/2004 Update Report (Reference 3) reviewed the results for April 2002 to March 2004 and compared them with previous readings. The readings taken during the remainder of 2004 and during 2005 are contained in Appendix A.

Table 1 summarises the readings for 2004/2005 and compares them with previous readings. It shows that the responses of these piezometers have remained unchanged from previous monitoring periods, with consistent annual maxima and minima over a period of some 5 years.

3.1.2 Standpipe Piezometers in the Landfill

To provide information on leachate pressures within the landfill, ten piezometers were installed in February/March 2003. They were installed in six boreholes, sunk at positions uphill of the capped 1 on 3 slope, and designated LMP 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a and 5b.

Only two of these piezometers (ie LMP1a, 1b) remain serviceable. The others became progressively distorted during 2003 as a result of on-going settlement of the refuse, eventually sufficient to prevent the dip metre probe from reaching the leachate.

Replacement piezometers LMP 6, 7 and 8 were installed in May 2004 using a specification designed to accommodate the effects of landfill settlement without impairing the function of the installations. Details of these piezometers are contained in Report Serial No. 04/6329 (Reference 3).

Readings taken between April 2003 and March 2004 were reviewed in Report Serial No. 04/6329. Readings taken since March 2004 are contained in Appendix B. In Table 2, they are summarised and compared with previous readings. The table shows that the pattern of leachate levels in piezometers LMP1a and 1b during 2005 was similar to that recorded previously, with generally subdued response to rainfall. In both piezometers, the range of fluctuations in the period since March 2004 was about 1m compared with about 0.5m in the period previously reviewed.

Similar subdued responses were measured in piezometers LMP 6, 7 and 8, but with slightly greater ranges of fluctuation of 0.6m, 2.3m and 2.5m respectively. The maximum leachate levels recorded in these piezometers (337.2mOD to 344.6mOD) are some 2m to 3m lower than those recorded in the previous piezometers (eg 347.7mOD in LMP 3b and 346.8mOD in LMP 4b), ie lower than the maximum levels used in the stability analyses undertaken for the 2003/2004 Update Report (Reference 3). However, they show the leachate to be distributed in a pattern similar to that found previously, with the upper 20m of the landfill containing a range of leachate heads (up to about 12m measured, compared with up to about 9m measured previously) and with significant vertical and lateral variation. In this

upper part of the landfill mound, there appears to be a series of disparate leachate bodies, with poor vertical and lateral connectivity, rather than a single, hydrostatic leachate body.

3.2 Movement Monitoring

To check for indications of possible ground movement, twelve movement markers were installed and their positions determined by precision survey in March 2003. Their positions are routinely re-checked, on 11 occasions by September 2005. Readings up to December 2003 were reviewed in Report Serial No. 04/6329.

The monitoring results since March 2003 are contained in Appendix C. Total movements recorded between March 2003 and November 2005 are summarised below:-

Marker	Overall Movement (mm)			Marker	Overall Movement (mm)		
	Easting	Northing	Level		Easting	Northing	Level
SM1	-6	-6	-15	SM7	+12	+2*	-103
SM2	-3*	-11	-2*	SM8	+13	-5*	-115
SM3	-7*	-16	-16	SM9	-12	-16	-191
SM4	-8*	-9	-21	SM10	-38	-25	-135
SM5	+3*	-14	-15	SM11	-21	-24	-157
SM6	+6*	-11	-14	SM12	+18	-4*	-119

* No obvious trend of movement shown. Typical data scatter is within ± 5 mm.

The results demonstrate the following trends :-

SM1 to SM6, located on top of the inert bund

With the exception of SM2, the markers have settled some 15mm to 20mm over the 2 years 8 months period of monitoring. When the data are plotted as a time series it is apparent that this movement has occurred steadily and gradually, at rates of 5mm to 7.5mm per year. The pattern of movement did not become apparent until the magnitude exceeded the scatter associated with survey error (approx ± 5 mm).

There has been a corresponding reduction in the northing values (ie movement towards the south) of some 10mm to 15mm. No obvious trend of change in easting values is apparent.

Interpretation

Although gradual and of minor magnitude, it is nevertheless important to try to understand the underlying mechanism of the movements exhibited by SM1 to SM6. Potential mechanisms include self-weight creep settlement, down-slope creep movement or the influence of the adjoining landfill mound, either settlement or stability-related.

Self-weight Creep Settlement

Long term creep settlement of coarse granular fills has been extensively studied, particularly in relation to large embankment dams. The magnitude of such settlement depends on the extent to which the fill has been compacted (Reference 5). For example, Charles and Watts (Reference 5, Table 6) show values of creep compression rate parameter, alpha, for a selection of engineered and non-engineered fills. These range from about 0.006% for sandy gravel fill compacted with heavy vibrating roller to 1.5% for sandstone/mudstone rockfill with no systematic compaction. (The lower of these values was calculated using the average vertical stress of the inert bund).

Using an alpha value of 1.5% and the maximum thickness of the inert bund (ie 14m), a creep settlement of about 15mm was calculated for the period 2003 to 2005 inclusive (ie 16

years to 19 years after bund construction), generally consistent with the measured results for SM1 to SM6. However, a much lower alpha value than 1.5% would be expected for the bund materials assuming the specified level of compaction had been achieved.

The inert bund was constructed in 1987 (Reference 1). Design drawings specify the use of granular material selected from demolition rubble and builder's waste and this general type of material was encountered by the investigation boreholes (Reference 1). The fill was specified to be placed in layers of thickness up to 0.5m and to be compacted with 4 passes of a vibratory roller of weight not less than 2 tonnes per metre width (Reference 1). This represents a reasonably heavy level of compaction, though less than the Highways Agency method specification for similar materials (SHW). For example, under SHW, Class 1C coarse granular materials placed in 0.4m thick layers (compacted thickness) should receive 5 passes of a vibratory roller of 1.8 to 2.3 tonnes per metre width (whilst increasing the layer thickness to 0.5m would require 5 passes of a vibratory roller of 2.3 to 2.9 tonnes per metre width).

No construction records are available for the inert bund to confirm the material types actually used and amount of compaction actually achieved. It is likely that some difficulty would have been experienced in the selection and separation of sufficient suitable granular material from the waste stream, given the considerable quantity of material that would have been needed to form the inert bund. Had a proportion of non-granular material (eg soil) been included, or had the compaction actually achieved been less than specified, the creep compression rate parameter, alpha, would be higher and the long term self-weight creep settlement would be greater, potentially of the magnitude observed.

It should be noted that the effective strength parameters selected for the inert bund materials for use in stability analyses are based on the borehole records and are conservative. They would remain applicable even if the materials and compaction of the inert bund are poorer than specified.

There is no obvious explanation for the apparent observed trend of southerly ground movements. It is possible that it relates to the survey procedure. This has not been investigated as part of the present assessment but should be checked as part of the future movement monitoring programme.

Down Slope Creep Movement

This type of creep movement would be expected to include a component in the down-slope direction, ie towards the east-north-east, with magnitude of lateral movement similar to or greater than the vertical settlement. The observed pattern does not fit with this pattern. Also, shallow down slope creep movement would be unlikely to be manifest at movement markers located some 7m back from the crest of the slope.

Influence of Landfill Settlement

At SM7 to SM12, located some 22m south-west of the line of SM1 to SM6, the landfill has settled some 200mm during the period 2003 to 2005 inclusive, see below. According to design drawings (Reference 1), there should be a vertical interface between the inert bund materials and the landfill materials, located some 10m south-west of the line of SM1 to SM6.

If the actual interface were closer to the line of SM1 to SM6 or had different geometry (eg diffuse, 'Christmas Tree', inclined), the markers could have experienced a component of landfill settlement and/or associated drag effects. It would be expected, however, that such effects would produce more irregular settlement, whereas the observed movements are relatively consistent.

Landfill Stability

At the movement markers, a gradually developing mass movement of the landfill would be expected to be characterised by predominantly lateral movement towards the east-north-

east, with a minimal vertical component. The recorded movements do not show this pattern and it is concluded that they are extremely unlikely to have been generated by any mechanism associated with overall instability of the landfill mound.

SM7 to SM12, located on the lower part of the 1 on 3 waste slope

Markers SM7 to SM12 are underlain by 15m to 20m of waste emplaced in about 1987 to 1990. Between March and September 2003, these markers settled progressively with the total settlement ranging from 19mm to 39mm. This was attributed to on-going degradation and settlement of the emplaced waste.

The same pattern of movement has continued to develop over the period September 2003 to November 2005. The settlements increased correspondingly, the overall totals ranging from 103mm to 191mm. Time series plots show logarithmic curves typical of published case histories for municipal waste. Based on the recorded data for SM9, a creep degradation factor of 12.7% is calculated. For refuse of similar age, Charles and Watts report creep degradation factors of up to 20% (Reference 5). It is concluded that the measured rates of settlement at SM7 to SM12 are not unusual.

At markers SM9, 10 and 11, there has been a trend of movement towards the south-west, with totals between March 2003 and November 2005 of up to about 30mm. Markers SM7, 8 and 12 show a different pattern, having moved mainly eastwards by up to about 20mm in total. It is considered that this inconsistent pattern of lateral movements is a function of local variability of the refuse, causing random effects as degradation settlement takes place.

The records show no evidence of any gradually developing mass movement of the landfill which would be expected to be manifested as consistent lateral movement towards the east-north-east.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The stability of the inert bund and adjacent landfill has been re-assessed following construction works in 2005. These extended the permanent engineered cap to the remainder of the landfill site.

On the basis of the site inspection, cap construction information and routine monitoring results, the inert bund and adjoining landfill mound have margins of stability that are more than adequate. There was no reason to undertake additional stability analyses as part of this assessment, beyond those of the 2003/2004 report (Reference 3).

The security of the landfill, inclusive of the inert bund, has been improved by completion of the permanent cap which includes a hydraulic barrier. This minimises infiltration of rainfall into the landfill and hence minimises any new leachate.

The cap includes a continuous geo-membrane, together with measures for the collection and removal of existing perched leachate, landfill gas (from gas wells and from the capped surface of the landfill) and surface water. In November 2005, erosion problems had developed at some of the surface water drainage channels and it was understood that remedial works were being planned.

At the western edge of the landfill mound, surface run-off collects and ponds within coarse, open, granular fill used during the 2005 works to infill a low-lying part of the adjoining site. This ponding at the uphill edge of the landfill is an unnecessary hazard, with potential for additional sub-liner seepage along the axis of the Nant-y-Gwyddon.

The results of routine monitoring of piezometers and movement markers, before, during and following the capping works, have been reviewed. No change in the response pattern of piezometers installed in the inert bund was apparent.

Piezometers installed in the upper 20m of the landfill have shown maximum leachate levels at similar or slightly lower elevations than those used in the stability analyses undertaken for the 2003/2004 update report (Reference 3). The piezometers have exhibited patterns of subdued response to rainfall and limited ranges of fluctuation, similar to previously. No obvious significant change in leachate level or response pattern was recorded following the capping works. As before, the piezometric data suggest that there are disparate leachate bodies in the upper 20m of the landfill, with poor vertical and lateral connectivity, rather than a single, hydrostatic profile.

Movement markers located on top of the inert bund settled gradually some 15mm to 20mm between March 2003 (commencement of monitoring) and November 2005 (latest data available during current review). Possible settlement mechanisms are reviewed in this report and it is considered that self-weight settlement of the bund fill material is the most likely cause of this movement.

Movement markers installed on the adjacent lower part of the 1 on 3 landfill slope have continued to show degradation settlement at rates and magnitudes typical for the age of refuse.

4.2 Recommendations

The 2005 capping works are likely to have obviated any future need for a leachate pumping scheme. Nevertheless, routine monitoring of leachate levels should be continued until post-capping leachate behaviour and trends are well established.

Routine monitoring of the standpipes, piezometers and manholes should be continued as follows:-

GMBH 5 to 8 and MHL5A	3 monthly
LMP1a, 1b, 6, 7 and 8	Monthly (Oct to Mar inclusive) and 3 monthly (Apr to Sep inclusive)

The readings should be reviewed annually as part of the stability assessment update.

Monitoring of these installations should be continued until at least April 2008 (ie inclusive of 3 winter seasons after completion of capping) when the monitoring requirements should be further reviewed.

The 2003/2004 update report (Reference 3) recommended that consideration should be given to methods of obtaining better information on the piezometric pressures in the area behind the chimney drains at the toe of the 1 on 3 slope. Because of practical difficulties, including a significant risk of damaging the permanent capping, this information was not obtained.

With the completion of capping, piezometric pressures would be expected to remain static or to gradually decline. It is considered satisfactory on balance to delete the (above) 2003/2004 recommendation, given the factors discussed and also given that conservative stability analyses undertaken for the 2003/2004 update report demonstrated more than adequate margins of stability.

It was recommended in the 2003/2004 update report (Reference 3) that designers should give appropriate consideration to the operation and management of the gas extraction system and to potential gas pressures beneath the cap under current conditions and as the performance of the gas extraction system declines. The design assumptions and calculations for the gas extraction and gas venting measures were not reviewed as part of the present stability assessment.

A suitable monitoring regime should be established to enable routine assessment of the impact of landfill settlement on the gas extraction and gas venting systems, the landfill cap and associated drainage systems. Any such impacts should be remediated before they become unacceptable.

The landfill leachate drainage systems should be routinely checked and maintained, as far as practicalities allow.

The erosion problems seen in November 2005 affecting some of the surface water drainage ditches should be rectified. The surface water drainage system should be regularly monitored until the vegetation cover has become well established and conditions have stabilised. Any defects should be remediated before becoming unacceptable.

The circumstances under which water is able to pond indiscriminately in coarse fill at the uphill margin of the landfill should be removed. Various options could be considered. One of these is the replacement of the coarse fill with compacted, well-graded, finer material. This should have a much lower permeability and so reduce the rate at which groundwater was available to seep beneath the landfill.

Stanpipe Reference		Water Level Readings			
Amgen-Rhondda Ref	Previous BH Ref	Range of Readings (mOD)			Previous Maximum (mOD)
		Apr 04 – Oct 05	Apr 02 – Mar 04	Jan 01 – Mar 02	
GMBH 5	NYG 3B	302.3 – 303.4	Dry (<302) – 303.4	302.1 – 302.85	302.2
GMBH 6	NYG 1B	Dry (<312.4) – Damp (312.4)	Dry (<312.4) – 314.1	Dry (<312.4) – 314.26	Dry (<312.4)
GMBH 7	OA1	Dry (<308) – 308.2	Dry (<308) – 308.3	Dry (<308) – 308.9	Dry (<308)
GMBH 8	OA2	Damp (306.5) – 308.1	Dry (<306.5) – 308.2	306.65 – 307.95	Dry (<306.5)

TABLE 1 SUMMARY OF DATA FOR PIEZOMETERS INSTALLED IN/NEAR THE INERT BUND.

Note: for locations of NYG and OA series boreholes, refer to Figure 7 of Report Serial No. 01/5098 (Reference 2).

Piezometer LMP series	Depth of Installation (m)	Length of Response Zone (m)	Depths to Leachate (m)	Maximum Leachate Level (mOD)	Maximum Head (m)
1a	19.0 {19.25} ¹	2.75	16.9-17.3 (16.8-18.0) ²	332.89 (332.99)	2.35 (2.45)
1b	12.05 {12.0}	2.5	11.6-12.0 (11.7-12.7)	338.2 (338.1)	0.4 (0.3)
2a ⁴	25.2 {24.5}	2.5	24.2-24.5	329.7	1.1
2b ⁴	16.4 {16.0}	2.5	12.7-13.1	341.4	4.0
3a ⁴	19.6 {20.0}	2.5	12.1-13.9 ³	343.0	7.5
3b ⁴	12.0 {12.0}	4.5	8.5-10.2 ³	347.7	4.6
4a ⁴	24.3 {24.5}	2.5	15.0-15.5	341.5	9.3
4b ⁴	12.2 {12.0}	3.5	9.7-10.4	346.8	2.5
5a ⁴	19.75 {19.5}	2.5	13.1-13.6	342.2	6.8
5b ⁴	13.15 {13.0}	2.5	11.0-11.6	344.2	2.2
6 ⁵	22.3 {27.8} ⁶	2.5	(19.3-19.9)	337.2	8.5
7 ⁵	13.8 – 21.4 ⁶ {22.0}	2.5	(10.2-12.5)	343.8	11.8
8 ⁵	20.7 – 21.88 {21.3}	2.5	(11.4-13.9)	344.6	9.9

**TABLE 2 SUMMARY OF DATA FOR PIEZOMETERS INSTALLED IN WASTE
(MONITORING FROM APRIL 2003 TO DECEMBER 2005)**

Notes

- Shows measured depth of installation and {instructed depth of installation}.
- Readings not in brackets are for monitoring from April 2003 to March 2004. (Readings in brackets are for monitoring during 2005, see Appendix ... for monitoring periods.
- Leachate levels in piezometers 3a and 3b reduced by 1.6m and 1.2m respectively following purging on 9 May 2003. Recorded leachate level in piezometer 3b was erratic during June 2003, with daily changes of 1.5m to 3m.
- Piezometers in BHs 2, 3, 4 and 5 suffered distortion of the riser tubes due to landfill settlement and eventually became blocked.
- Replacement piezometers 6, 7 and 8 installed in May 2004.
- It is suspected that depth of installation discrepancies are attributable to the probe catching on riser tube joints and giving some false, shallow depths.

REFERENCES

- [1] Amgen Rhondda Ltd Nant-y-Gwyddon Inert Bund. Stability Assessment Arup Report Serial No. 01/5098 dated March 2001
- [2] Nant-y-Gwyddon Inert Bund Stability Assessment. Letter from Arup to Amgen Rhondda Ltd dated 18th October 2002
- [3] Amgen Rhondda Ltd. Nant-y-Gwyddon Inert Bund. Stability Assessment – 2003/2004 Update Arup Report Serial No. 04/6329 dated July 2004
- [4] CQA Method Statement and Quality Plan. Phase 1 Capping and Restoration Works at Nant-y-Gwyddon Landfill Site. Encia Consulting Limited CQA Method Statement Reference: AM5474 dated February 2005.
- [5] Building on fill: geotechnical aspects. Second Edition 2001. JA Charles and KS Watts. BRE.

Appendix A

**Piezometer Readings -
Inert Bund**

Amgen Rhondda Ltd. - Nant-y-Gwyddon Landfill Site Inert Bund Water Level Monitoring 2004 - 2005

	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
GMBH 5	27/01/2004	06/02/2004	22/03/2004	02/04/2004	-	11/06/2004	06/07/2004	02/08/2004	13/09/2004	n/r	08/11/2004	08/12/2004	04/01/2005	03/02/2005	30.03.05	07.04.05	05.05.05	07.06.05	21.07.05	04.08.05	09.09.05	20.10.05		
Depth (m)	2.43	2.43	2.43	2.43	n/r	2.43	2.43	2.43	2.43	n/r	2.50	2.43	2.40	2.42	2.42	2.42	n/r	2.42	2.56	2.42	2.42	2.42		
Depth to WT (m)	1.58	1.12	1.4	1.82	n/r	2.07	1.7	2.18	1.14	n/r	18.6	1.85	1.60	1.86	1.48	1.39	n/r	1.54	2.03	1.71	2.05	1.46		
Comments	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c		

	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
GMBH 6	27/01/2004	06/02/2004	22/03/2004	02/04/2004	-	11/06/2004	06/07/2004	02/08/2004	13/09/2004	n/r	08/11/2004	08/12/2004	04/01/2005	03/02/2005	30.03.05	07.04.05	05.05.05	07.06.05	21.07.05	04.08.05	09.09.05	20.10.05		
Depth (m)	6.32	6.32	6.32	8.55	n/r	8.55	8.55	8.66	8.55	n/r	8.55	8.55	8.60	8.58	8.59	8.60	n/r	8.65	8.67	8.60	8.69	8.57		
Depth to WT (m)	DRY	DRY	DRY	DRY	n/r	DRY	DRY	DRY	DRY	n/r	Dry	DRY	DRY	DRY	DRY	DRY	n/r	8.63	8.64	DRY	8.63	DRY		
Comments	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c		

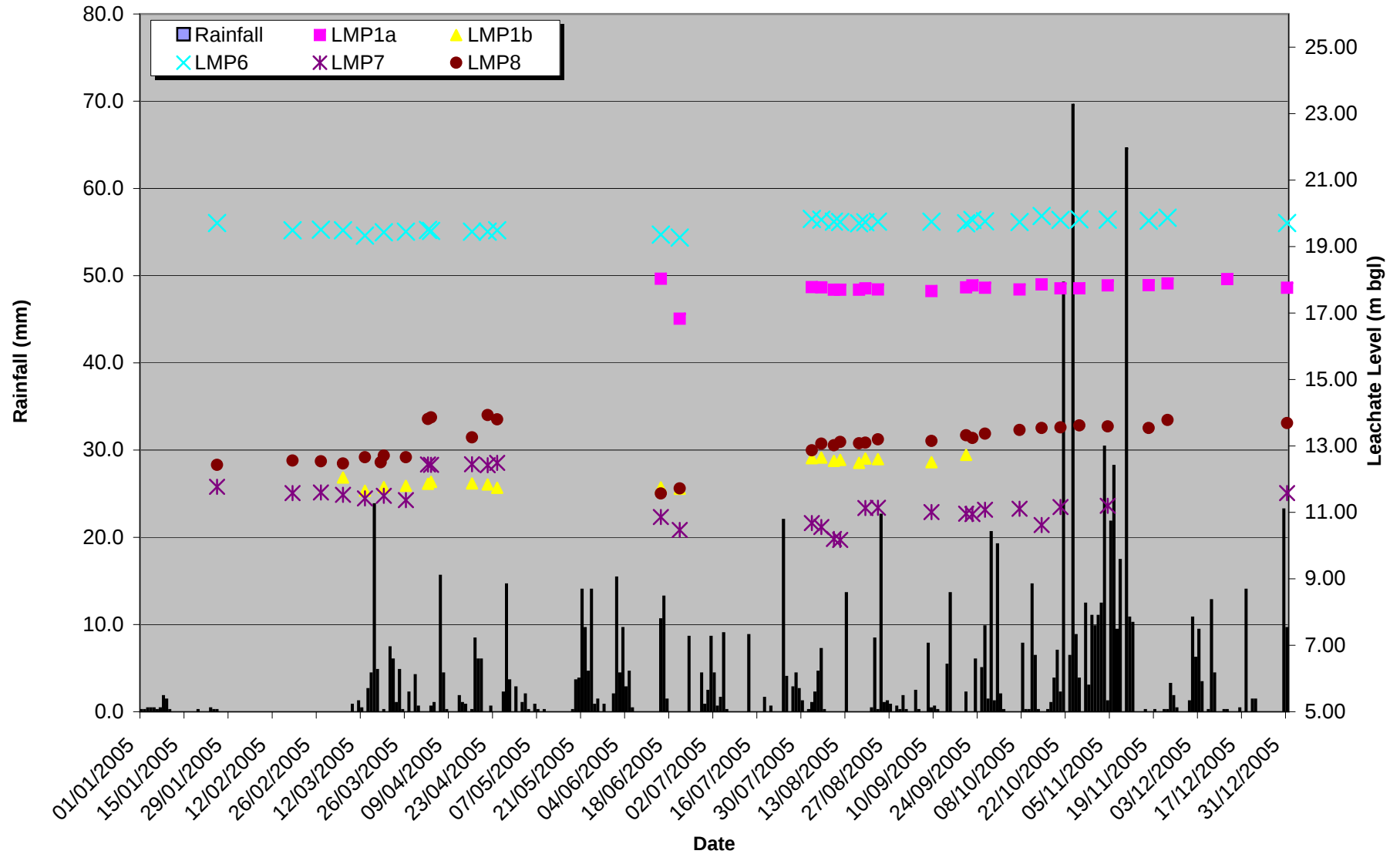
	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
GMBH 7	27/01/2004	06/02/2004	22/03/2004	02/04/2004	-	11/06/2004	06/07/2004	02/08/2004	13/09/2004	n/r	08/11/2004	08/12/2004	04/01/2005	03/02/2005	30.03.05	07.04.05	05.05.05	07.06.05	21.07.05	04.08.05	09.09.05	20.10.05		
Depth (m)	8.56	8.56	8.56	13.22	n/r	13.32	13.22	13.30	13.30	n/r	13.30	13.30	13.25	13.25	13.24	13.25	n/r	13.30	13.33	13.26	14.30	13.19		
Depth to WT (m)	DRY	DRY	DRY	DRY	n/r	DRY	DRY	DRY	DRY	n/r	DRY	DRY	DRY	DRY	DRY	DRY	n/r	DRY	13.31	DRY	DRY	DRY		
Comments	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c		

	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
GMBH 8	27/01/2004	06/02/2004	22/03/2004	02/04/2004	-	11/06/2004	06/07/2004	02/08/2004	13/09/2004	n/r	08/11/2004	08/12/2004	04/01/2005	03/02/2005	30.03.05	07.04.05	05.05.05	07.06.05	21.07.05	04.08.05	09.09.05	20.10.05		
Depth (m)	8.12	8.12	8.12	8.12	n/r	8.12	8.12	8.12	8.12	n/r	8.12	8.12	8.15	8.15	8.10	8.09	n/r	8.15	8.15	8.12	8.13	8.07		
Depth to WT (m)	6.32	6.58	6.46	6.71	n/r	7.04	6.6	7.14	6.45	n/r	6.6	6.7	6.62	8.15	6.54	6.53	n/r	6.52	6.66	6.61	6.72	6.48		
Comments	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c		

Appendix B

**Piezometer Readings -
Landfill**

NYG Landfill Site - Summary of Leacachte Level Monitoring 2005



Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Leachate Monitoring Piezometers Installed in
Waste Mass - Feb / Mar 2003

Installation Details

Piezometer ID	Date of Installation	Drilling Reference	Co-Ordinates			Depth of Hole	Response Zone	Piezometer Tip	Bentinite Seal	Piezo Height
			East	North	Height					
LMP 1a	2003	WT 2	8000.841	4018.379	349.786	20.0	20.0 - 17.25	19.25	17.25 - 12.50	0.21
LMP 1b	2003	WT 2	8000.841	4018.379	349.786	20.0	12.5 - 10.0	12.0	10.0 - 0.0	0.21
LMP 2a	2003	WT 4	7966.980	4004.516	353.750	25.5	25.0 - 22.5	24.5	22.5 - 16.50	
LMP 2b	2003	WT 4	7966.980	4004.516	353.750	25.5	16.5 - 14.0	16.0	14.0 - 0.0	
LMP 3a	2003	WT 3a	7940.128	3986.896	355.120	20.5	20.5 - 18.0	20.0	18.0 - 0.0	0.18
LMP 3b	2003	WT 3	7944.681	3983.940	355.145	26.0	13.5 - 9.0	12.0	9.0 - 0.0	0.18
LMP 4a	2003	WT 6a	7922.373	3959.609	356.518	25.0	25.0 - 22.5	24.5	22.5 - 13.0	
LMP 4b	2003	WT 6a	7922.373	3959.609	356.518	25.0	13.5 - 9.0	12.0	9.0 - 0.0	
LMP 5a	2003	WT 1	7980.245	3948.975	355.185	20.0	20.0 - 17.5	19.5	17.5 - 13.5	
LMP 5b	2003	WT 1	7980.245	3948.975	355.185	20.0	13.5 - 11.0	13.0	11.0 - 0.0	
LMP 6	.05.2004	LMP 6	7969.491	4001.768	353.130	23.0	23.0 - 19.5	22.3	19.5 - 0.0	0.77
LMP 7	.05.2004	LMP 7	7913.158	3981.590	354.950	14.0	14.0 - 10.5	13.8	10.5 - 0.0	1.26
LMP 8	.05.2004	LMP 8	7971.547	3939.395	355.260	21.5	21.5 - 18.0	20.7	18.0 - 0.0	1.27

Rainfall Summary 2005

Month	Rainfall (mm)	Comment
Jan-05	6.6	Weather Station Error
Feb-05	0	Weather Station Error
Mar-05	64.6	No data 01.3 - 08.03
Apr-05	69.8	
May-05	59.2	
Jun-05	78.6	
Jul-05	72.4	
Aug-05	66.2	
Sep-05	96.2	
Oct-05	219.8	
Nov-05	224.8	
Dec-05	97.6	
Total	1055.8	

[illegible]

[illegible]

[illegible]

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Leachate Levels Monitored in the Waste Mass at Nant-y-Gwyddon Landfill Site
May-05

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6		LMP7		LMP8	
		D	DtW	D	DtW	D	DtW	D	DtW	D	DtW
01-05-05	0.0										
02-05-05	1.0										
03-05-05	2.0										
04-05-05	0.2										
05-05-05	0.0										
06-05-05	0.8										
07-05-05	0.2										
08-05-05	0.0										
09-05-05	0.2										
10-05-05	0.0										
11-05-05	0.0										
12-05-05	0.0										
13-05-05	0.0										
14-05-05	0.0										
15-05-05	0.0										
16-05-05	0.0										
17-05-05	0.0										
18-05-05	0.2										
19-05-05	3.6										
20-05-05	3.8										
21-05-05	14.0										
22-05-05	9.6										
23-05-05	4.6										
24-05-05	14.0										
25-05-05	0.8										
26-05-05	1.4										
27-05-05	0.0										
28-05-05	0.8										
29-05-05	0.0										
30-05-05	0.0										
31-05-05	2.0										

59.2

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-06-05	15.4						
02-06-05	4.4						
03-06-05	9.6						
04-06-05	2.8						
05-06-05	4.6						
06-06-05	0.4						
07-06-05	0.0						
08-06-05	0.0						
09-06-05	0.0						
10-06-05	0.0						
11-06-05	0.0						
12-06-05	0.0						
13-06-05	0.0						
14-06-05	0.0						
15-06-05	10.6	19.00	18.03	12.05	11.75	22.30	19.36
16-06-05	13.2						
17-06-05	1.4						
18-06-05	0.0						
19-06-05	0.0						
20-06-05	0.0						
21-06-05	0.0	19.00	16.83	12.05	11.71	22.30	19.27
22-06-05	0.0						
23-06-05	0.0						
24-06-05	8.6						
25-06-05	0.0						
26-06-05	0.0						
27-06-05	0.0						
28-06-05	4.4						
29-06-05	0.8						
30-06-05	2.4						

78.6

Leachate Levels Monitored in the Waste Mass at Nant-y-Gwyddon Landfill Site

[illegible]

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Leachate Levels Monitored in the Waste Mass at Nant-y-Gwyddon Landfill Site
Jul-05

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6		LMP7		LMP8	
		D	DtW	D	DtW	D	DtW	D	DtW	D	DtW
01-07-05	8.6										
02-07-05	4.4										
03-07-05	0.6										
04-07-05	1.6										
05-07-05	9.0										
06-07-05	0.2										
07-07-05	0.0										
08-07-05	0.0										
09-07-05	0.0										
10-07-05	0.0										
11-07-05	0.0										
12-07-05	0.0										
13-07-05	8.8										
14-07-05	0.0										
15-07-05	0.0										
16-07-05	0.0										
17-07-05	0.0										
18-07-05	1.6										
19-07-05	0.0										
20-07-05	0.6										
21-07-05	0.0										
22-07-05	0.0										
23-07-05	0.0										
24-07-05	22.0										
25-07-05	4.0										
26-07-05	0.0										
27-07-05	2.8										
28-07-05	4.4										
29-07-05	2.6										
30-07-05	1.2										
31-07-05	0.0										

72.4

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-08-05	0.2						
02-08-05	1.0	19.97	2.19	12.93	0.30	22.97	3.14
03-08-05	2.2						
04-08-05	4.6						
05-08-05	7.2	19.95	2.18	12.93	0.28	22.95	3.14
06-08-05	0.2						
07-08-05	0.0						
08-08-05	0.0						
09-08-05	0.0	19.96	2.26	12.93	0.38	22.95	3.20
10-08-05	0.0						
11-08-05	0.0	19.96	2.26	12.91	0.33	22.95	3.21
12-08-05	0.0						
13-08-05	13.6						
14-08-05	0.0						
15-08-05	0.0						
16-08-05	0.0						
17-08-05	0.0	19.96	2.26	12.92	0.43	22.94	3.24
18-08-05	0.0						
19-08-05	0.0	19.96	2.22	12.92	0.30	22.94	3.21
20-08-05	0.0						
21-08-05	0.4						
22-08-05	8.4						
23-08-05	0.2	19.95	2.24	12.93	0.33	22.95	3.20
24-08-05	22.6						
25-08-05	1.0						
26-08-05	1.2						
27-08-05	0.8						
28-08-05	0.0						
29-08-05	0.6						
30-08-05	0.2						
31-08-05	1.8						

66.2

Leachate Levels Monitored in the Waste Mass at Nant-y-Gwyddon Landfill Site

[illegible]

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-09-05	0.2						
02-09-05	0.0						
03-09-05	0.0						
04-09-05	2.4						
05-09-05	0.2						
06-09-05	0.0						
07-09-05	0.0						
08-09-05	7.8						
09-09-05	0.4	19.94	2.28	12.93	0.42	22.94	3.19
10-09-05	0.6						
11-09-05	0.2						
12-09-05	0.0						
13-09-05	0.0						
14-09-05	5.4						
15-09-05	13.6						
16-09-05	0.0						
17-09-05	0.0						
18-09-05	0.0						
19-09-05	0.0						
20-09-05	2.2	19.99	2.22	13.00	0.27	22.96	3.26
21-09-05	0.0						
22-09-05	0.0	19.94	2.11	6.95 *	0.08	22.94	3.14
23-09-05	6.0						
24-09-05	0.0						
25-09-05	5.0						
26-09-05	9.8	19.94	2.18	6.93 *	0.08	22.95	3.19
27-09-05	1.4						
28-09-05	20.6						
29-09-05	1.2						
30-09-05	19.2						

96.2

Leachate Levels Monitored in the Waste Mass at Nant-y-Gwyddon Landfill Site
Sep-05

LMP7		LMP8	
D	DtW	D	DtW
21.17	10.16	21.82	8.67
21.24	10.28	21.86	8.54
21.22	10.27	21.82	8.58
21.23	10.15	21.83	8.46

* Stops. Gets stuck when reel in.

* Stops. Gets stuck when reel in.

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-10-05	2.0						
02-10-05	0.2						
03-10-05	0.0						
04-10-05	0.0						
05-10-05	0.0						
06-10-05	0.0						
07-10-05	0.0	19.94	2.23	6.90*	0.09	22.94	3.20
08-10-05	7.8						
09-10-05	0.2						
10-10-05	0.2						
11-10-05	14.6						
12-10-05	6.4						
13-10-05	0.2						
14-10-05	0.0	19.93	2.07	BLOCK	BLOCK	22.95	3.03
15-10-05	0.0						
16-10-05	0.2						
17-10-05	1.0						
18-10-05	3.8						
19-10-05	7.0						
20-10-05	2.2	19.94	2.20	6.52*	0.09 ^{*(1)}	22.94	3.14
21-10-05	49.2						
22-10-05	0.0						
23-10-05	6.4						
24-10-05	69.6						
25-10-05	8.8						
26-10-05	3.8	19.93	2.19	6.51*	0.09	22.94	3.12
27-10-05	0.0						
28-10-05	12.4						
29-10-05	3.0						
30-10-05	11.0						
31-10-05	9.8						

219.8

* Stops. Gets stuck when reel in.

^{*(1)} Bearing in mind that it often starts off (out of the borehole) at 00.07

Leachate Levels Monitored in the Was
Oct-05

LMP7		LMP8	
D	DtW	D	DtW
21.23	10.12	21.82	8.34
21.19	10.57	21.85	8.31
21.22	10.06	21.82	8.26
12.54 [*]	1.10	21.82	8.20

ste Mass at Nant-y-Gwyddon Landfill Site

||

||

||

||

||

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-11-05	11.0						
02-11-05	12.4						
03-11-05	30.4						
04-11-05	1.2	19.94	2.11	6.50	0.10	22.94	3.13
05-11-05	21.8						
06-11-05	28.2						
07-11-05	9.4						
08-11-05	17.4						
09-11-05	0.0						
10-11-05	64.6						
11-11-05	10.8						
12-11-05	10.2						
13-11-05	0.0						
14-11-05	0.0						
15-11-05	0.0						
16-11-05	0.2						
17-11-05	0.0	19.94	2.10	6.48	0.09	22.94	3.16
18-11-05	0.0						
19-11-05	0.2						
20-11-05	0.0						
21-11-05	0.0						
22-11-05	0.2						
23-11-05	0.2	19.93	2.04	6.48	0.04	22.94	3.07
24-11-05	3.2						
25-11-05	1.8						
26-11-05	0.4						
27-11-05	0.0						
28-11-05	0.0						
29-11-05	0.0						
30-11-05	1.2						

224.8

* Blocked. Gets stuck when reel in.

Leachate Levels Monitored in the Was
Nov-05

LMP7		LMP8	
D	DtW	D	DtW
21.22	10.02	21.82	8.23
12.54	1.10	21.82	8.28
12.54	0.68	21.82	8.04

ste Mass at Nant-y-Gwyddon Landfill Site

Some Blocked

||

Some Blocked

||

||

Some Blocked

||

||

Amgen Rhondda Ltd.
Nant-y-Gwyddon Landfill Site

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-12-05	10.8						
02-12-05	6.2						
03-12-05	9.4						
04-12-05	3.4						
05-12-05	0.0						
06-12-05	0.2						
07-12-05	12.8						
08-12-05	4.4						
09-12-05	0.0						
10-12-05	0.0						
11-12-05	0.2						
12-12-05	0.2	19.94	1.92				
13-12-05	0.0						
14-12-05	0.0						
15-12-05	0.0						
16-12-05	0.4						
17-12-05	0.0						
18-12-05	14.0						
19-12-05	0.0						
20-12-05	1.4						
21-12-05	1.4						
22-12-05	0.0						
23-12-05	0.0						
24-12-05	0.0						
25-12-05	0.0						
26-12-05	0.0						
27-12-05	0.0						
28-12-05	0.0						
29-12-05	0.0						
30-12-05	23.2						
31-12-05	9.6	19.94	2.18			22.97	3.26

97.6

Leachate Levels Monitored in the Was
Dec-05

[illegible]

ste Mass at Nant-y-Gwyddon Landfill Site

||

||

||

||

||

Date	Rainfall (mm)	LMP 1a		LMP1b		LMP6	
		D	DtW	D	DtW	D	DtW
01-01-05	0.2						
02-01-05	0.2						
03-01-05	0.4						
04-01-05	0.4						
05-01-05	0.4						
06-01-05	0.2						
07-01-05	0.4						
08-01-05	1.8						
09-01-05	1.4						
10-01-05	0.2						
11-01-05	n/r						
12-01-05	n/r						
13-01-05	n/r						
14-01-05	n/r						
15-01-05	n/r						
16-01-05	n/r						
17-01-05	n/r						
18-01-05	n/r						
19-01-05	0.2						
20-01-05	0.0						
21-01-05	0.0						
22-01-05	0.0						
23-01-05	0.4						
24-01-05	0.2						
25-01-05	0.2					22.30	19.71
26-01-05	0.0						
27-01-05	n/r						
28-01-05	n/r						
29-01-05	n/r						
30-01-05	n/r						
31-01-05	n/r						
01-02-05	0.0						
02-02-05	0.0						
03-02-05	n/r						
04-02-05	n/r						
05-02-05	n/r						
06-02-05	n/r						
07-02-05	n/r						
08-02-05	n/r						
09-02-05	n/r						
10-02-05	n/r						
11-02-05	n/r						
12-02-05	n/r						
13-02-05	n/r						
14-02-05	n/r						
15-02-05	n/r						
16-02-05	n/r						
17-02-05	n/r						
18-02-05	n/r					22.30	19.49
19-02-05	n/r						

20-02-05	n/r						
21-02-05	n/r						
22-02-05	n/r						
23-02-05	n/r						
24-02-05	n/r						
25-02-05	n/r						
26-02-05	n/r						
27-02-05	n/r					22.30	19.51
28-02-05	n/r						
01-03-05	n/r						
02-03-05	n/r						
03-03-05	n/r						
04-03-05	n/r						
05-03-05	n/r						
06-03-05	n/r			12.05	12.05	22.30	19.49
07-03-05	n/r						
08-03-05	n/r						
09-03-05	0.8						
10-03-05	0.0						
11-03-05	1.2						
12-03-05	0.4						
13-03-05	0.0			12.05	11.65	22.30	19.33
14-03-05	2.6						
15-03-05	4.4						
16-03-05	23.8						
17-03-05	4.8						
18-03-05	0.0						
19-03-05	0.2			12.05	11.76	22.30	19.43
20-03-05	0.0						
21-03-05	7.4						
22-03-05	6.0						
23-03-05	1.0						
24-03-05	4.8						
25-03-05	0.2						
26-03-05	0.0			12.05	11.80	22.30	19.45
27-03-05	2.2						
28-03-05	0.0						
29-03-05	4.2						
30-03-05	0.6						
31-03-05	0.0						
01-04-05	0.0						
02-04-05	0.0			12.00	11.86	22.30	19.50
03-04-05	0.6			12.00	11.92	22.30	19.47
04-04-05	1.0						
05-04-05	0.0						
06-04-05	15.6						
07-04-05	4.4						
08-04-05	0.2						
09-04-05	0.0						
10-04-05	0.0						
11-04-05	0.0						
12-04-05	1.8						
13-04-05	1.0						
14-04-05	0.8						
15-04-05	0.0						

16-04-05	0.2			12.00	11.87	22.30	19.45
17-04-05	8.4						
18-04-05	6.0						
19-04-05	6.0						
20-04-05	0.0						
21-04-05	0.0			12.00	11.84	22.30	19.45
22-04-05	0.6						
23-04-05	n/r						
24-04-05	n/r			12.00	11.74	22.30	19.49
25-04-05	n/r						
26-04-05	2.2						
27-04-05	14.6						
28-04-05	3.6						
29-04-05	0.0						
30-04-05	2.8						
01-05-05	0.0						
02-05-05	1.0						
03-05-05	2.0						
04-05-05	0.2						
05-05-05	0.0						
06-05-05	0.8						
07-05-05	0.2						
08-05-05	0.0						
09-05-05	0.2						
10-05-05	0.0						
11-05-05	0.0						
12-05-05	0.0						
13-05-05	0.0						
14-05-05	0.0						
15-05-05	0.0						
16-05-05	0.0						
17-05-05	0.0						
18-05-05	0.2						
19-05-05	3.6						
20-05-05	3.8						
21-05-05	14.0						
22-05-05	9.6						
23-05-05	4.6						
24-05-05	14.0						
25-05-05	0.8						
26-05-05	1.4						
27-05-05	0.0						
28-05-05	0.8						
29-05-05	0.0						
30-05-05	0.0						
31-05-05	2.0						
01-06-05	15.4						
02-06-05	4.4						
03-06-05	9.6						
04-06-05	2.8						
05-06-05	4.6						
06-06-05	0.4						
07-06-05	0.0						
08-06-05	0.0						
09-06-05	0.0						

10-06-05	0.0						
11-06-05	0.0						
12-06-05	0.0						
13-06-05	0.0						
14-06-05	0.0						
15-06-05	10.6	19.00	18.03	12.05	11.75	22.30	19.36
16-06-05	13.2						
17-06-05	1.4						
18-06-05	0.0						
19-06-05	0.0						
20-06-05	0.0						
21-06-05	0.0	19.00	16.83	12.05	11.71	22.30	19.27
22-06-05	0.0						
23-06-05	0.0						
24-06-05	8.6						
25-06-05	0.0						
26-06-05	0.0						
27-06-05	0.0						
28-06-05	4.4						
29-06-05	0.8						
30-06-05	2.4						
01-07-05	8.6						
02-07-05	4.4						
03-07-05	0.6						
04-07-05	1.6						
05-07-05	9.0						
06-07-05	0.2						
07-07-05	0.0						
08-07-05	0.0						
09-07-05	0.0						
10-07-05	0.0						
11-07-05	0.0						
12-07-05	0.0						
13-07-05	8.8						
14-07-05	0.0						
15-07-05	0.0						
16-07-05	0.0						
17-07-05	0.0						
18-07-05	1.6						
19-07-05	0.0						
20-07-05	0.6						
21-07-05	0.0						
22-07-05	0.0						
23-07-05	0.0						
24-07-05	22.0						
25-07-05	4.0						
26-07-05	0.0						
27-07-05	2.8						
28-07-05	4.4						
29-07-05	2.6						
30-07-05	1.2						
31-07-05	0.0						
01-08-05	0.2						
02-08-05	1.0	19.97	17.78	12.93	12.63	22.97	19.83
03-08-05	2.2						

04-08-05	4.6						
05-08-05	7.2	19.95	17.77	12.93	12.65	22.95	19.81
06-08-05	0.2						
07-08-05	0.0						
08-08-05	0.0						
09-08-05	0.0	19.96	17.70	12.93	12.55	22.95	19.75
10-08-05	0.0						
11-08-05	0.0	19.96	17.70	12.91	12.58	22.95	19.74
12-08-05	0.0						
13-08-05	13.6						
14-08-05	0.0						
15-08-05	0.0						
16-08-05	0.0						
17-08-05	0.0	19.96	17.70	12.92	12.49	22.94	19.70
18-08-05	0.0						
19-08-05	0.0	19.96	17.74	12.92	12.62	22.94	19.73
20-08-05	0.0						
21-08-05	0.4						
22-08-05	8.4						
23-08-05	0.2	19.95	17.71	12.93	12.60	22.95	19.75
24-08-05	22.6						
25-08-05	1.0						
26-08-05	1.2						
27-08-05	0.8						
28-08-05	0.0						
29-08-05	0.6						
30-08-05	0.2						
31-08-05	1.8						
01-09-05	0.2						
02-09-05	0.0						
03-09-05	0.0						
04-09-05	2.4						
05-09-05	0.2						
06-09-05	0.0						
07-09-05	0.0						
08-09-05	7.8						
09-09-05	0.4	19.94	17.66	12.93	12.51	22.94	19.75
10-09-05	0.6						
11-09-05	0.2						
12-09-05	0.0						
13-09-05	0.0						
14-09-05	5.4						
15-09-05	13.6						
16-09-05	0.0						
17-09-05	0.0						
18-09-05	0.0						
19-09-05	0.0						
20-09-05	2.2	19.99	17.77	13.00	12.73	22.96	19.70
21-09-05	0.0						
22-09-05	0.0	19.94	17.83			22.94	19.80
23-09-05	6.0						
24-09-05	0.0						
25-09-05	5.0						
26-09-05	9.8	19.94	17.76			22.95	19.76
27-09-05	1.4						

28-09-05	20.6						
29-09-05	1.2						
30-09-05	19.2						
01-10-05	2.0						
02-10-05	0.2						
03-10-05	0.0						
04-10-05	0.0						
05-10-05	0.0						
06-10-05	0.0						
07-10-05	0.0	19.94	17.71			22.94	19.74
08-10-05	7.8						
09-10-05	0.2						
10-10-05	0.2						
11-10-05	14.6						
12-10-05	6.4						
13-10-05	0.2						
14-10-05	0.0	19.93	17.86			22.95	19.92
15-10-05	0.0						
16-10-05	0.2						
17-10-05	1.0						
18-10-05	3.8						
19-10-05	7.0						
20-10-05	2.2	19.94	17.74			22.94	19.80
21-10-05	49.2						
22-10-05	0.0						
23-10-05	6.4						
24-10-05	69.6						
25-10-05	8.8						
26-10-05	3.8	19.93	17.74			22.94	19.82
27-10-05	0.0						
28-10-05	12.4						
29-10-05	3.0						
30-10-05	11.0						
31-10-05	9.8						
01-11-05	11.0						
02-11-05	12.4						
03-11-05	30.4						
04-11-05	1.2	19.94	17.83			22.94	19.81
05-11-05	21.8						
06-11-05	28.2						
07-11-05	9.4						
08-11-05	17.4						
09-11-05	0.0						
10-11-05	64.6						
11-11-05	10.8						
12-11-05	10.2						
13-11-05	0.0						
14-11-05	0.0						
15-11-05	0.0						
16-11-05	0.2						
17-11-05	0.0	19.94	17.84			22.94	19.78
18-11-05	0.0						
19-11-05	0.2						
20-11-05	0.0						
21-11-05	0.0						

22-11-05	0.2						
23-11-05	0.2	19.93	17.89			22.94	19.87
24-11-05	3.2						
25-11-05	1.8						
26-11-05	0.4						
27-11-05	0.0						
28-11-05	0.0						
29-11-05	0.0						
30-11-05	1.2						
01-12-05	10.8						
02-12-05	6.2						
03-12-05	9.4						
04-12-05	3.4						
05-12-05	0.0						
06-12-05	0.2						
07-12-05	12.8						
08-12-05	4.4						
09-12-05	0.0						
10-12-05	0.0						
11-12-05	0.2						
12-12-05	0.2	19.94	18.02				
13-12-05	0.0						
14-12-05	0.0						
15-12-05	0.0						
16-12-05	0.4						
17-12-05	0.0						
18-12-05	14.0						
19-12-05	0.0						
20-12-05	1.4						
21-12-05	1.4						
22-12-05	0.0						
23-12-05	0.0						
24-12-05	0.0						
25-12-05	0.0						
26-12-05	0.0						
27-12-05	0.0						
28-12-05	0.0						
29-12-05	0.0						
30-12-05	23.2						
31-12-05	9.6	19.94	17.76			22.97	19.71

[illegible]

[illegible]

[illegible]

[illegible]

21.42	10.56	21.82	13.07
21.42	10.20	21.81	13.02
21.22	10.17	21.85	13.12
		21.81	13.08
21.22	11.13	21.82	13.10
21.24	11.14	21.82	13.20
21.17	11.01	21.82	13.15
21.24	10.96	21.86	13.32
21.22	10.95	21.82	13.24
21.23	11.08	21.83	13.37

21.23	11.11	21.82	13.48
21.19	10.62	21.85	13.54
21.22	11.16	21.82	13.56
		21.82	13.62
21.22	11.20	21.82	13.59
		21.82	13.54

[illegible]

Appendix C

**Monitoring of
Movement Markers**

Point :	SM1					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8002.981	4142.024	327.251			
14/03/2003	8002.981	4142.027	327.248	0	0.003	-0.003
27/03/2003	8002.981	4142.027	327.252	0	0	0.004
03/04/2003	8002.982	4142.029	327.251	0.001	0.002	-0.001
14/05/2003	8002.981	4142.025	327.248	-0.001	-0.004	-0.003
30/07/2003	8002.986	4142.032	327.248	0.005	0.007	0
12/09/2003	8002.976	4142.029	327.251	-0.010	-0.003	0.003
10/02/2004	8002.978	4142.025	327.246	0.002	-0.004	-0.005
13/05/2004	8002.981	4142.036	327.242	0.003	0.011	-0.004
01/02/2005	8002.976	4142.022	327.239	-0.005	-0.014	-0.003
26/09/2005	8002.976	4142.021	327.239	0.000	-0.001	0
09/11/2005	8002.975	4142.018	327.236	-0.001	-0.003	-0.003

Diff To Date	-0.006	-0.006	-0.015
--------------	--------	--------	--------

Point :	SM2					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8037.469	4135.702	322.249			
14/03/2003	8037.462	4135.706	322.248	-0.007	0.004	-0.001
27/03/2003	8037.466	4135.699	322.252	0.004	-0.007	0.004
03/04/2003	8037.466	4135.703	322.250	0	0.004	-0.002
14/05/2003	8037.467	4135.697	322.249	0.001	-0.006	-0.001
30/07/2003	8037.472	4135.704	322.250	0.005	0.007	0.001
12/09/2003	8037.464	4135.701	322.249	-0.008	-0.003	-0.001
10/02/2004	8037.467	4135.700	322.245	0.003	-0.001	-0.004
13/05/2004	8037.462	4135.708	322.246	-0.005	0.008	0.001
01/02/2005	8037.465	4135.700	322.245	0.003	-0.008	-0.001
26/09/2005	8037.464	4135.697	322.246	-0.001	-0.003	0.001
09/11/2005	8037.466	4135.691	322.247	0.002	-0.006	0.001

Diff To Date	-0.003	-0.011	-0.002
--------------	--------	--------	--------

Point :	SM3					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8052.209	4110.075	323.655			
14/03/2003	8052.203	4110.074	323.653	-0.006	-0.001	-0.002
27/03/2003	8052.206	4110.074	323.655	0.003	0	0.002
03/04/2003	8052.204	4110.075	323.659	-0.002	0.001	0.004
14/05/2003	8052.207	4110.079	323.656	0.003	0.004	-0.003
30/07/2003	8052.201	4110.079	323.653	-0.006	0	-0.003
12/09/2003	8052.198	4110.074	323.654	-0.003	-0.005	0.001
10/02/2004	8052.203	4110.071	323.648	0.005	-0.003	-0.006
13/05/2004	8052.202	4110.074	323.650	-0.001	0.003	0.002
01/02/2005	8052.206	4110.072	323.641	0.004	-0.002	-0.009
26/09/2005	8052.200	4110.067	323.643	-0.006	-0.005	0.002
09/11/2005	8052.202	4110.059	323.639	0.002	-0.008	-0.004

Diff To Date	-0.007	-0.016	-0.016
--------------	--------	--------	--------

Point :	SM4					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8067.863	4078.468	324.601			
14/03/2003	8067.856	4078.469	324.597	-0.007	0.001	-0.004
27/03/2003	8067.857	4078.468	324.602	0.001	-0.001	0.005
03/04/2003	8067.858	4078.469	324.606	0.001	0.001	0.004
14/05/2003	8067.860	4078.472	324.603	0.002	0.003	-0.003
30/07/2003	8067.853	4078.474	324.596	-0.007	0.002	-0.007
12/09/2003	8067.849	4078.474	324.596	-0.004	0	0
10/02/2004	8067.855	4078.469	324.593	0.006	-0.005	-0.003
13/05/2004	8067.866	4078.467	324.589	0.011	-0.002	-0.004
01/02/2005	8067.852	4078.468	324.584	-0.014	0.001	-0.005
26/09/2005	8067.852	4078.459	324.585	0	-0.009	0.001
09/11/2005	8067.855	4078.459	324.580	0.003	0	-0.005

Diff To Date	-0.008	-0.009	-0.021
--------------	--------	--------	--------

Point :	SM5					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8081.955	4051.305	326.232			
14/03/2003	8081.944	4051.305	326.229	-0.011	0	-0.003
27/03/2003	8081.950	4051.300	326.234	0.006	-0.005	0.005
03/04/2003	8081.947	4051.301	326.233	-0.003	0.001	-0.001
14/05/2003	8081.950	4051.299	326.232	0.003	-0.002	-0.001
30/07/2003	8081.947	4051.309	326.234	-0.003	0.010	0.002
12/09/2003	8081.945	4051.305	326.234	-0.002	-0.004	0
10/02/2004	8081.948	4051.300	326.226	0.003	-0.005	-0.008
13/05/2004	8081.949	4051.309	326.226	0.001	0.009	0
01/02/2005	8081.954	4051.299	326.217	0.005	-0.010	-0.009
26/09/2005	8081.952	4051.298	326.219	-0.002	-0.001	0.002
09/11/2005	8081.958	4051.291	326.217	0.006	-0.007	-0.002

Diff To Date	0.003	-0.014	-0.015
--------------	-------	--------	--------

Point :	SM6					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8099.410	4018.254	327.617			
14/03/2003	8099.404	4018.254	327.615	-0.006	0	-0.002
27/03/2003	8099.413	4018.253	327.618	0.009	-0.001	0.003
03/04/2003	8099.409	4018.255	327.621	-0.004	0.002	0.003
14/05/2003	8099.414	4018.258	327.619	0.005	0.003	-0.002
30/07/2003	8099.407	4018.261	327.615	-0.007	0.003	-0.004
12/09/2003	8099.403	4018.257	327.616	-0.004	-0.004	0.001
10/02/2004	8099.406	4018.251	327.612	0.003	-0.006	-0.004
13/05/2004	8099.407	4018.249	327.613	0.001	-0.002	0.001
01/02/2005	8099.415	4018.262	327.601	0.008	0.013	-0.012
26/09/2005	8099.410	4018.250	327.604	-0.005	-0.012	0.003
09/11/2005	8099.416	4018.243	327.603	0.006	-0.007	-0.001

Diff To Date	0.006	-0.011	-0.014
--------------	-------	--------	--------

Point :	SM7					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8078.372	4010.557	333.221			
14/03/2003	8078.360	4010.558	333.217	-0.012	0.001	-0.004
27/03/2003	8078.368	4010.557	333.224	0.008	-0.001	0.007
03/04/2003	8078.364	4010.562	333.222	-0.004	0.005	-0.002
14/05/2003	8078.371	4010.558	333.217	0.007	-0.004	-0.005
30/07/2003	8078.368	4010.565	333.208	-0.003	0.007	-0.009
12/09/2003	8078.365	4010.563	333.202	-0.003	-0.002	-0.006
10/02/2004	8078.372	4010.561	333.183	0.007	-0.002	-0.019
13/05/2004	8078.368	4010.574	333.171	-0.004	0.013	-0.012
01/02/2005	8078.385	4010.593	333.140	0.017	0.019	-0.031
26/09/2005	8078.377	4010.560	333.120	-0.008	-0.033	-0.020
09/11/2005	8078.384	4010.559	333.118	0.007	-0.001	-0.002

Diff To Date	0.012	0.002	-0.103
--------------	-------	-------	--------

Point :	SM8					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8063.992	4036.165	332.122			
14/03/2003	8063.980	4036.166	332.117	-0.012	0.001	-0.005
27/03/2003	8063.989	4036.166	332.119	0.009	0	0.002
03/04/2003	8063.990	4036.171	332.120	0.001	0.005	0.001
14/05/2003	8063.988	4036.164	332.111	-0.002	-0.007	-0.009
30/07/2003	8063.991	4036.173	332.103	0.003	0.009	-0.008
12/09/2003	8063.984	4036.172	332.098	-0.007	-0.001	-0.005
10/02/2004	8063.991	4036.168	332.069	0.007	-0.004	-0.029
13/05/2004	8063.994	4036.174	332.055	0.003	0.006	-0.014
01/02/2005	8063.995	4036.153	332.024	0.001	-0.021	-0.031
26/09/2005	8064.000	4036.161	332.011	0.005	0.008	-0.013
09/11/2005	8064.005	4036.16	332.007	0.005	-0.001	-0.004

Diff To Date	0.013	-0.005	-0.115
--------------	-------	--------	--------

Point :	SM9					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8048.209	4061.376	331.668			
14/03/2003	8048.201	4061.383	331.665	-0.008	0.007	-0.003
27/03/2003	8048.204	4061.376	331.664	0.003	-0.007	-0.001
03/04/2003	8048.206	4061.381	331.663	0.002	0.005	-0.001
14/05/2003	8048.208	4061.379	331.653	0.002	-0.002	-0.010
30/07/2003	8048.204	4061.386	331.639	-0.004	0.007	-0.014
12/09/2003	8048.196	4061.379	331.630	-0.008	-0.007	-0.009
10/02/2004	8048.194	4061.372	331.584	-0.002	-0.007	-0.046
13/05/2004	8048.198	4061.374	331.567	0.004	0.002	-0.017
01/02/2005	8048.200	4061.375	331.515	0.002	0.001	-0.052
26/09/2005	8048.193	4061.363	331.489	-0.007	-0.012	-0.026
09/11/2005	8048.197	4061.36	331.477	0.004	-0.003	-0.012

Diff To Date	-0.012	-0.016	-0.191
--------------	--------	--------	--------

Point :	SM10					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8039.657	4086.210	329.980			
14/03/2003	8039.647	4086.204	329.977	-0.010	-0.006	-0.003
27/03/2003	8039.654	4086.203	329.981	0.007	-0.001	0.004
03/04/2003	8039.653	4086.206	329.977	-0.001	0.003	-0.004
14/05/2003	8039.655	4086.202	329.968	0.002	-0.004	-0.009
30/07/2003	8039.649	4086.207	329.960	-0.006	0.005	-0.008
12/09/2003	8039.642	4086.205	329.955	-0.007	-0.002	-0.005
10/02/2004	8039.640	4086.201	329.925	-0.002	-0.004	-0.030
13/05/2004	8039.638	4086.202	329.906	-0.002	0.001	-0.019
01/02/2005	8039.625	4086.190	329.872	-0.013	-0.012	-0.034
26/09/2005	8039.619	4086.187	329.853	-0.006	-0.003	-0.019
09/11/2005	8039.619	4086.185	329.845	0	-0.002	-0.008

Diff To Date	-0.038	-0.025	-0.135
--------------	--------	--------	--------

Point :	SM11					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	8022.002	4108.892	330.337			
14/03/2003	8021.997	4108.899	330.334	-0.005	0.007	-0.003
27/03/2003	8021.998	4108.894	330.334	0.001	-0.005	0
03/04/2003	8021.999	4108.892	330.332	0.001	-0.002	-0.002
14/05/2003	8022.002	4108.890	330.319	0.003	-0.002	-0.013
30/07/2003	8021.996	4108.892	330.306	-0.006	0.002	-0.013
12/09/2003	8021.992	4108.889	330.298	-0.004	-0.003	-0.008
10/02/2004	8021.988	4108.880	330.262	-0.004	-0.009	-0.036
13/05/2004	8021.987	4108.880	330.240	-0.001	0	-0.022
01/02/2005	8021.982	4108.875	330.199	-0.005	-0.005	-0.041
26/09/2005	8021.983	4108.874	330.186	0.001	-0.001	-0.013
09/11/2005	8021.981	4108.868	330.180	-0.002	-0.006	-0.006

Diff To Date	-0.021	-0.024	-0.157
--------------	--------	--------	--------

Point :	SM12					
	Observed			Diff. / Period		
Date	Easting	Northing	Level	Easting	Northing	Level
03/03/2003	7994.817	4117.210	332.262			
14/03/2003	7994.816	4117.218	332.258	-0.001	0.008	-0.004
27/03/2003	7994.816	4117.212	332.258	0	-0.006	0
03/04/2003	7994.817	4117.211	332.257	0.001	-0.001	-0.001
14/05/2003	7994.822	4117.212	332.252	0.005	0.001	-0.005
30/07/2003	7994.825	4117.215	332.240	0.003	0.003	-0.012
12/09/2003	7994.820	4117.217	332.234	-0.005	0.002	-0.006
10/02/2004	7994.826	4117.216	332.213	0.006	-0.001	-0.021
13/05/2004	7994.832	4117.226	332.198	0.006	0.010	-0.015
01/02/2005	7994.842	4117.237	332.161	0.010	0.011	-0.037
26/09/2005	7994.838	4117.211	332.146	-0.004	-0.026	-0.015
09/11/2005	7994.835	4117.206	332.143	-0.003	-0.005	-0.003

Diff To Date	0.018	-0.004	-0.119
--------------	-------	--------	--------

Diff / Period 26/09/05 to 09/11/05

<u>Point Id.</u>	<u>Easting m</u>	<u>Northing m</u>	<u>Level m</u>
SM1	0	-0.003	-0.003
SM2	0.002	-0.006	0.001
SM3	0.002	-0.008	-0.004
SM4	0.003	0	-0.005
SM5	0.006	-0.007	-0.002
SM6	0.006	-0.007	-0.001
SM7	0.007	-0.001	-0.002
SM8	0.005	-0.001	-0.004
SM9	0.004	-0.003	-0.012
SM10	0	-0.002	-0.008
SM11	-0.002	-0.006	-0.006
SM12	-0.003	-0.005	-0.003

Diff / To Date 03/03/03 to 09/11/05

<u>Easting m</u>	<u>Northing m</u>	<u>Level m</u>
-0.006	-0.006	-0.015
-0.003	-0.011	-0.002
-0.007	-0.016	-0.016
-0.008	-0.009	-0.021
0.003	-0.014	-0.015
0.006	-0.011	-0.014
0.012	0.002	-0.103
0.013	-0.005	-0.115
-0.012	-0.016	-0.191
-0.038	-0.025	-0.135
-0.021	-0.024	-0.157
0.018	-0.004	-0.119