APPENDIX 1

Applicant Company Details

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Fagan Lynch Donnellan
Chartered Accountants & Registered Auditors

Our Ref: VL/LL

23rd March 2009

Environmental Protection Agency,
McCumiskey House,
Richview,
Clonskeagh Road,
Dublin 14.

Re: Nurendale Ltd – T/A Panda Waste.

Dear Sir,

We act as Auditors and Taxation Agents for the above and have acted in this capacity in excess of 10 years.

We wish to confirm as follows:

1. Statutory Accounts have been filed for all years up to 31.12.2007 with Companies Office.

   Accounts and Tax Returns have also been filed with Inspector of Taxes for all years to 31st December 2007.

2. The company trades profitably and is on a very sound financial footing.

Further information is available on request.

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Yours faithfully,

FAGAN LYNCH DONNELLAN

Newbridge House, Athlumney, Navan, Co. Meath
Tel: (046) 9023021 Fax: (046) 9029341 e-mail: info@fld.ie

John Fagan FCA Vincent Lynch FCA Mark McCartney FCCA

Authorised by the Institute of Chartered Accountants in Ireland to carry out Investment Business

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NURENDALE LIMITED

FINANCIAL STATEMENTS

FOR THE YEAR ENDED

31ST DECEMBER 2007

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COMPANY REGISTRATION NUMBER 115425

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NURENDALE LIMITED

FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

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The directors have pleasure in presenting their report and the financial statements of the company for the year ended 31st December 2007

PRINCIPAL ACTIVITIES AND BUSINESS REVIEW

The principal activity of the company during the year was waste disposal.

RESULTS, DIVIDENDS AND RETENTION

The profit for the year, after taxation, amounted to €2,114,531. The directors have not recommended a dividend.

The balance of the profits for the year amounting to €2,114,531 will be added to reserves and carried forward to the following year.

FINANCIAL RISK MANAGEMENT OBJECTIVES AND POLICIES

Financial risk management objectives and policies

the financial risk management objectives and policies of the company including the policy for hedging each major type of forecasted transaction for which hedge accounting is used, and

the exposure of the company to price risk, credit risk, liquidity risk and cash flow risk,

unless such information is not material for the assessment of the assets, liabilities, financial position and profit or loss of the company.

IMPORTANT EVENTS SINCE THE YEAR END

There have been no significant events affecting the company since the year end

THE DIRECTORS AND SECRETARY AND THEIR INTERESTS IN THE SHARES OF THE COMPANY

The directors and secretary who served the company during the year together with their beneficial interests in the shares of the company were as follows:

	Ordinary Shares of €1.269738 each	
	At 31 December 2007	At 1 January 2007
Mr Eamonn Waters	99	99
Mr Noel Waters	1	1

DIRECTORS' RESPONSIBILITIES

The directors are responsible for preparing the Annual Report and the financial statements in accordance with applicable Irish law and Generally Accepted Accounting Practice in Ireland including the accounting standards issued by the Accounting Standards Board and published by The Institute of Chartered Accountants in Ireland.

Irish company law requires the directors to prepare financial statements for each financial year which give a true and fair view of the state of affairs of the company and of the profit or loss of the company for that year. In preparing these financial statements, the directors are required to

select suitable accounting policies and then apply them consistently;

make judgements and estimates that are reasonable and prudent; and

prepare the financial statements on the going concern basis unless it is inappropriate to presume

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that the company will continue in business.

The directors confirm that they have complied with the above requirements in preparing the financial statements.

The directors are responsible for keeping proper books of account that disclose with reasonable accuracy at any time the financial position of the company and enable them to ensure that the financial statements are prepared in accordance with accounting standards generally accepted in Ireland and comply with Irish Statute comprising the Companies Acts 1963 to 2006. The directors are also responsible for safeguarding the assets of the company and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

BOOKS OF ACCOUNT

The directors are aware of their responsibilities under Section 202 of the Companies Act 1990 to keep proper books of account. The directors have discharged this responsibility by ensuring that sufficient and appropriate company resources were allocated to this task. The books of account are maintained at

AUDITOR

The auditor, Fagan Lynch Donnellan, will continue in office in accordance with section 160(2) of the Companies Act 1963.

Registered office: Signed on behalf of the directors

Rathdrinnagh
Beauparc
Navan
Co. Meath

MR.EAMONN WATERS MR.NOEL WATERS

Approved by the directors on 1st May 2008

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NURENDALE LIMITED

INDEPENDENT AUDITOR'S REPORT TO THE MEMBERS OF NURENDALE LIMITED

FOR THE YEAR ENDED 31ST DECEMBER 2007

We have audited the financial statements of Nurendale Limited for the year ended 31 December 2007, which have been prepared on the basis of the accounting policies set out on page

RESPECTIVE RESPONSIBILITIES OF DIRECTORS AND AUDITOR

As described in the Statement of Directors' Responsibilities the company's directors are responsible for the preparation of the financial statements in accordance with applicable law and Generally Accepted Accounting Practice in Ireland including the accounting standards issued by the Accounting Standards Board and published by the Institute of Chartered Accountants in Ireland.

Our responsibility is to audit the financial statements in accordance with relevant legal and regulatory requirements and International Standards on Auditing (UK and Ireland).

This report is made solely to the company's members, as a body, in accordance with Section 193 of the Companies Act, 1990. Our audit work has been undertaken so that we might state to the company's members those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the company and the company's members as a body, for our audit work, for this report, or for the opinions we have formed.

We report to you our opinion as to whether the financial statements give a true and fair view, in accordance with Generally Accepted Accounting Practice in Ireland, and are properly prepared in accordance with the Companies Acts, 1963 to 2006. We also report to you whether in our opinion: proper books of account have been kept by the company; whether, at the balance sheet date, there exists a financial situation requiring the convening of an extraordinary general meeting of the company; and whether the information given in the directors' report is consistent with the financial statements. In addition, we state whether we have obtained all the information and explanations necessary for the purposes of our audit and whether the financial statements are in agreement with the books of account.

We also report to you if, in our opinion, any information specified by law regarding directors' remuneration and directors' transactions is not disclosed and, where practicable, include such information in our report.

We read the Directors' Report and consider the implications for our report if we become aware of any apparent misstatements within it.

BASIS OF AUDIT OPINION

We conducted our audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgements made by the directors in the preparation of the financial statements, and of whether the accounting policies are appropriate to the company's circumstances, consistently applied and adequately disclosed.

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NURENDALE LIMITED

INDEPENDENT AUDITOR'S REPORT TO THE MEMBERS OF NURENDALE LIMITED *(continued)*

FOR THE YEAR ENDED 31ST DECEMBER 2007

We planned and performed our audit so as to obtain all the information and explanations which we considered necessary in order to provide us with sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement, whether caused by fraud or other irregularity or error. In forming our opinion we also evaluated the overall adequacy of the presentation of information in the financial statements.

OPINION

In our opinion the financial statements:

give a true and fair view, in accordance with Generally Accepted Accounting Practice in Ireland, of the state of the company's affairs as at 31st December 2007 and of its profit and cash flows for the year then ended; and

have been properly prepared in accordance with the requirements of the Companies Acts, 1963 to 2006.

We have obtained all the information and explanations we consider necessary for the purposes of our audit. In our opinion proper books of account have been kept by the company. The financial statements are in agreement with the books of account.

In our opinion the information given in the Directors' Report on pages 3 to 4 is consistent with the financial statements.

The net assets of the company, as stated in the Balance Sheet on page 9, are more than half of the amount of its called up share capital and, in our opinion, on that basis there did not exist at 31st December 2007 a financial situation which under Section 40(1) of the Companies (Amendment) Act 1983, would require the convening of an extraordinary general meeting of the company.

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FAGAN LYNCH DONNELLAN
CHARTERED ACCOUNTANTS
& REGISTERED AUDITORS

Newbridge House
Athlumney
Navan
Co. Meath

st May 2008

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NURENDALE LIMITED

PROFIT AND LOSS ACCOUNT

FOR THE YEAR ENDED 31ST DECEMBER 2007

	Note	2007 €	2006 €
GROSS PROFIT		**12,137,821**	9,951,684
Administrative expenses		**8,532,250**	5,953,412
Other operating income		**(24,000)**	–
OPERATING PROFIT	2	**3,629,571**	3,998,272
Loss on disposal of fixed assets	5	**(225,303)**	–
		3,404,268	3,998,272
Interest receivable		**10,877**	2,876
Interest payable and similar charges	6	**(933,658)**	(557,428)
PROFIT ON ORDINARY ACTIVITIES BEFORE TAXATION		**2,481,487**	3,443,720
Tax on profit on ordinary activities	7	**366,956**	431,849
PROFIT FOR THE FINANCIAL YEAR		**2,114,531**	3,011,871

All of the activities of the company are classed as continuing.

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These financial statements were approved by the directors on the 1st May 2008 and are signed on their behalf by:

MR.EAMONN WATERS
Director

MR.NOEL WATERS
Director

The notes on pages 13 to 19 form part of these financial statements.

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NURENDALE LIMITED

STATEMENT OF TOTAL RECOGNISED GAINS AND LOSSES

FOR THE YEAR ENDED 31ST DECEMBER 2007

	2007	2006
	€	€
ro fit for the financial year attributable to the shareholders	**2,114,531**	3,011,871
n ealised profit on revaluation of certain fixed assets	-	1,946,426
·ral gains and losses recognised since the last annual eport	**2,114,531**	4,958,297

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The notes on pages 13 to 19 form part of these financial statements.

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NURENDALE LIMITED

BALANCE SHEET

AS AT 31ST DECEMBER 2007

	Note	2007 €	2007 €	2006 €	2006 €
FIXED ASSETS					
Tangible assets	8		**32,476,521**		29,196,850
Financial assets	9		**100**		225,303
			32,476,621		29,422,153
CURRENT ASSETS					
Debtors	10	**11,954,706**		8,451,557	
Cash at bank		**415,183**		658,375	
		12,369,889		9,109,932	
CREDITORS: Amounts falling due within one year	11	**12,845,008**		10,645,646	
NET CURRENT LIABILITIES			**(475,119)**		(1,535,714)
TOTAL ASSETS LESS CURRENT LIABILITIES			**32,001,502**		27,886,439
CREDITORS: Amounts falling due after more than one year	12		**14,829,428**		12,818,872
			17,172,074		15,067,567
CAPITAL AND RESERVES					
Called-up equity share capital	15		**127**		127
Revaluation reserve	16		**3,437,237**		3,447,261
Profit and loss account	17		**13,734,710**		11,620,179
SHAREHOLDERS' FUNDS	18		**17,172,074**		15,067,567

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These financial statements were approved by the directors and authorised for issue on 1st May 2008, and are signed on their behalf by:

MR.EAMONN WATERS

MR.NOEL WATERS

The notes on pages 13 to 19 form part of these financial statements.

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NURENDALE LIMITED

CASH FLOW STATEMENT

FOR THE YEAR ENDED 31ST DECEMBER 2007

	2007		2006	
	€	€	€	€
NET CASH INFLOW FROM OPERATING ACTIVITIES		3,108,722		7,471,719
RETURNS ON INVESTMENTS AND SERVICING OF FINANCE				
Interest received	10,877		2,876	
Interest paid	(587,595)		(294,579)	
Interest element of finance leases	(346,063)		(262,849)	
NET CASH OUTFLOW FROM RETURNS ON INVESTMENTS AND SERVICING OF FINANCE		(922,781)		(554,552)
TAXATION		(254,145)		(481,642)
CAPITAL EXPENDITURE AND FINANCIAL INVESTMENT				
Payments to acquire tangible fixed assets	(9,424,778)		(10,389,830)	
Receipts from sale of fixed assets	1,827,652		549,425	
Acquisition of own shares	(100)		(175,000)	
Disposal of investment own shares	225,303		125,000	
NET CASH OUTFLOW FOR CAPITAL EXPENDITURE AND FINANCIAL INVESTMENT		(7,371,923)		(9,890,405)
CASH OUTFLOW BEFORE FINANCING		(5,440,127)		(3,454,880)
FINANCING				
Increase in bank loans	1,982,437		1,063,980	
Net inflow from other short-term creditors	413,417		172,414	
Capital element of finance leases	1,387,364		1,218,819	
NET CASH INFLOW FROM FINANCING		3,783,218		2,455,213
DECREASE IN CASH		(1,656,909)		(999,667)

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The notes on pages 13 to 19 form part of these financial statements.

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NURENDALE LIMITED

CASH FLOW STATEMENT *(continued)*

FOR THE YEAR ENDED 31ST DECEMBER 2007

RECONCILIATION OF OPERATING PROFIT TO NET CASH INFLOW FROM OPERATING ACTIVITIES

	2007	2006
	€	€
Operating profit	**3,629,571**	3,998,272
Depreciation	**4,482,330**	3,556,923
Profit on disposal of fixed assets	**(390,178)**	(104,077)
Increase in debtors	**(3,503,149)**	(1,583,632)
(Decrease)/increase in creditors	**(1,109,852)**	1,604,233
Net cash inflow from operating activities	**3,108,722**	7,471,719

RECONCILIATION OF NET CASH FLOW TO MOVEMENT IN NET DEBT

	2007		2006	
	€	€	€	€
Decrease in cash in the period	**(1,656,909)**		(999,667)	
Net cash (inflow) from bank loans	**(1,982,437)**		(1,063,980)	
Net (inflow) from other short-term creditors	**(413,417)**		(172,414)	
Cash outflow in respect of finance leases	**(1,387,364)**		(1,218,819)	
		(5,440,127)		(3,454,880)
Change in net debt		**(5,440,127)**		(3,454,880)
Net debt at 1 January 2007		**(17,518,033)**		(14,063,153)
Net debt at 31 December 2007		**(22,968,184)**		(17,518,033)

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NURENDALE LIMITED

CASH FLOW STATEMENT *(continued)*

FOR THE YEAR ENDED 31ST DECEMBER 2007

NALYSIS OF CHANGES IN NET DEBT

	At 1 Jan 2007 €	Cash flows €	At 31 Dec 2007 €
et cash:			
sh in hand and at bank	658,375	(243,192)	415,183
erdrafts	(2,087,783)	(1,423,741)	(3,511,524)
	(1,429,408)	(1,666,933)	(3,096,341)
ebt:			
ebt due within 1 year	(567,151)	(1,083,660)	(1,650,811)
ebt due after 1 year	(6,633,232)	(1,312,194)	(7,945,426)
ance lease agreements	(8,888,242)	(1,387,364)	(10,275,606)
	(16,088,625)	(3,783,218)	(19,871,843)
debt	(17,518,033)	(5,450,151)	(22,968,184)

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NURENDALE LIMITED

NOTES TO THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

1 ACCOUNTING POLICIES

Basis of accounting

The financial statements are prepared in accordance with generally accepted accounting principles under the historical cost convention, as modified by the revaluation of certain fixed assets and comply with financial reporting standards of the Accounting Standards Board, as promulgated by the Institute of Chartered Accountants in Ireland, and Irish statute comprising the Companies Acts 1963 to 2006.

Fixed assets

All fixed assets are initially recorded at cost.

Depreciation

Depreciation is calculated so as to write off the cost of an asset, less its estimated residual value, over the useful economic life of that asset as follows:

Buildings	4% Straight Line
Plant & Machinery	12.5%/20% Reducing Balance
Leased Assets	Over the life of the lease
Motor Vehicles	25% Reducing Balance
Office Equipment	12.5%/20% Reducing Balance
Skips & Bins	12.5% Straight Line /20% Reducing Balance

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Finance lease agreements

Where the company enters into a lease which entails taking substantially all the risks and rewards of ownership of an asset, the lease is treated as a finance lease. The asset is recorded in the balance sheet as a tangible fixed asset and is depreciated in accordance with the above depreciation policies. Future instalments under such leases, net of finance charges, are included within creditors. Rentals payable are apportioned between the finance element, which is charged to the profit and loss account on a straight line basis, and the capital element which reduces the outstanding obligation for future instalments.

Operating lease agreements

Rentals applicable to operating leases where substantially all of the benefits and risks of ownership remain with the lessor are charged against profits on a straight line basis over the period of the lease

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2. OPERATING PROFIT

Operating profit is stated after charging/(crediting):

	2007	2006
	€	€
Depreciation of owned fixed assets	**960,175**	3,556,923
Depreciation of assets held under finance lease agreements	**3,522,155**	–
Profit on disposal of fixed assets	**(390,178)**	(104,077)
Auditor's remuneration		
- as auditor	**54,123**	43,347
Hire of plant and machinery	**212,091**	80,850
Operating lease costs:		
Other	**272,893**	175,001

3. PARTICULARS OF EMPLOYEES

The average number of staff employed by the company during the financial year amounted to:

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	2007	2006
	No	No
Number of staff	**186**	127

The aggregate payroll costs of the above were:

	2007	2006
	€	€
Wages and salaries	**8,183,374**	5,181,246
Other pension costs	**65,066**	42,565
Directors Pension costs	**3,005**	-
	8,251,445	5,223,811

4. DIRECTORS' EMOLUMENTS

The directors' aggregate emoluments in respect of qualifying services were:

	2007	2006
	€	€
Aggregate emoluments	**56,697**	42,855

5. LOSS ON DISPOSAL OF FIXED ASSETS

	2007	2006
	€	€
Loss on disposal of fixed assets	**(225,303)**	–

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NURENDALE LIMITED

NOTES TO THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

6 INTEREST PAYABLE AND SIMILAR CHARGES

	2007	2006
	€	€
Interest payable on bank borrowing	189,708	68,248
HP/Finance lease charges	346,063	262,849
Loan Interest	397,887	226,331
	933,658	557,428

TAXATION ON ORDINARY ACTIVITIES

Analysis of charge in the year

	2007	2006
	€	€
Current tax:		
Irish Corporation tax based on the results for the year at 12.50% (2006 - 12.50%)	367,552	434,741
Over/under provision in prior year	(596)	(2,892)
Total current tax	366,956	431,849

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8 TANGIBLE FIXED ASSETS

	Land & Buildings	Plant & Machinery	Leased Assets	Motor Vehicles	Office Equipment	Skips & Bins	Total
	€	€	€	€	€	€	€
COST OR VALUATION							
At 1 Jan 2007	16,704,235	3,069,900	14,795,740	329,206	273,664	2,437,095	37,609,840
Additions	3,197,977	635,544	5,011,948	195,000	17,610	366,699	9,424,778
Disposals	(302,194)	(679,769)	(298,193)	(82,237)	-	(756,930)	(2,119,323)
At 31 Dec 2007	19,600,018	3,025,675	19,509,495	441,969	291,274	2,046,864	44,915,295
DEPRECIATION							
At 1 Jan 2007	459,824	806,698	6,012,081	151,550	88,482	894,355	8,412,990
Charge for the year	295,777	356,999	3,522,155	45,506	31,867	230,026	4,482,330
On disposals	(19,535)	(91,665)	(230,169)	(20,560)	-	(94,617)	(456,546)
At 31 Dec 2007	736,066	1,072,032	9,304,067	176,496	120,349	1,029,764	12,438,774
NET BOOK VALUE							
At 31 Dec 2007	18,863,952	1,953,643	10,205,428	265,473	170,925	1,017,100	32,476,521
At 31 Dec 2006	16,244,411	2,263,202	8,783,659	177,656	185,182	1,542,740	29,196,850

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NURENDALE LIMITED

NOTES TO THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

8. TANGIBLE FIXED ASSETS *(continued)*

The company operates from buildings sited on land owned by Eamon Waters, Director.

Finance lease agreements

Included within the net book value of €32,476,521 is €10,205,428 (2006 - €8,783,659) relating to assets held under finance lease agreements. The depreciation charged to the financial statements in the year in respect of such assets amounted to €3,522,155 (2006 - €2,575,126).

9. FINANCIAL FIXED ASSETS

	Total
	€
COST	
At 1st January 2007	**225,303**
Additions	**100**
Disposals	**(225,303)**
At 31st December 2007	**100**
NET BOOK VALUE	
At 31st December 2007	**100**
At 31st December 2006	225,303

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10. DEBTORS

	2007	2006
	€	€
Trade debtors	**8,890,889**	6,971,185
VAT recoverable	–	263,030
Other debtors	**259,882**	1,217,342
Inter Group Loan	**2,396,998**	
Directors current accounts	**362,018**	–
Prepayments and accrued income	**44,919**	–
	11,954,706	8,451,557

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11 CREDITORS: Amounts falling due within one year

	2007		2006	
	€	€	€	€
Bank loans and overdrafts		4,338,182		2,244,198
Trade creditors		3,566,594		4,423,621
Other creditors including taxation and social welfare:				
Corporation tax	227,552		114,741	
PAYE and social welfare	163,708		153,365	
VAT	12,325		-	
Finance lease agreements	3,391,604		2,702,602	
Other creditors	824,153		410,736	
Directors current accounts	-		553,360	
		4,619,342		3,934,804
Accruals and deferred income		320,890		43,023
		12,845,008		10,645,646

12 CREDITORS: Amounts falling due after more than one year

	2007	2006
	€	€
Bank loans	7,945,426	6,633,232
Other creditors:		
Finance lease agreements	6,884,002	6,185,640
	14,829,428	12,818,872

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13 COMMITMENTS UNDER FINANCE LEASE AGREEMENTS

Future commitments under finance lease agreements are as follows:

	2007	2006
	€	€
Amounts payable within 1 year	3,391,604	2,702,602
Amounts payable between 2 to 5 years	6,884,002	6,185,640
	10,275,606	8,888,242

14 RELATED PARTY TRANSACTIONS

(a) Directors Loan

	2007	2006
	€	€
Opening Balance	553,360	(203,036)
Advanced	211,811	1,738,091
	765,171	1,535,055
Repaid	(1,127,188)	(981,695)
Closing Balance	(362,017)	553,360

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NURENDALE LIMITED

NOTES TO THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

(b) Rent paid by the company to Eamon Waters, Director, in respect of lands at Rathdrinnagh, Beauparc, Navan, Co. Meath. for the year amounts to € 120,000, there was also a payment for a additional back rent due from previous years for € 125,000

(c) The company had inter group transactions with its subsidiary company Irish Packaging Recycling Ltd during the year. At 31st December 2007 there was a balance owed to Nurendale Limited for the sum of € 2,396,998.

15. **SHARE CAPITAL**

Authorised share capital:

	2007	2006
	€	€
100,000 Ordinary shares of €1.269738 each	**126,974**	126,974

Allotted, called up and fully paid:

	2007		2006	
	No	€	No	€
Ordinary shares of €1.269738 each	100	127	100	127

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NURENDALE LIMITED

NOTES TO THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31ST DECEMBER 2007

16 REVALUATION RESERVE

There was no movement on the revaluation reserve during the financial year

17 PROFIT AND LOSS ACCOUNT

	2007	2006
	€	€
Balance brought forward	**11,620,179**	8,608,308
Profit for the financial year	**2,114,531**	3,011,871
Balance carried forward	**13,734,710**	11,620,179

18 RECONCILIATION OF MOVEMENTS IN SHAREHOLDERS' FUNDS

	2007	2006
	€	€
Profit for the financial year	**2,114,531**	3,011,871
Other net recognised gains and losses	–	1,946,426
Net addition to shareholders' funds	**2,114,531**	4,958,297
Opening shareholders' funds	**15,057,543**	10,109,270
Closing shareholders' funds	**17,172,074**	15,067,567

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NURENDALE LIMITED

MANAGEMENT INFORMATION

FOR THE YEAR ENDED 31ST DECEMBER 2007

The following pages do not form part of the statutory financial statements which are the subject of the independent auditor's report on pages 5 to 6.

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NURENDALE LIMITED

DETAILED PROFIT AND LOSS ACCOUNT

FOR THE YEAR ENDED 31ST DECEMBER 2007

	2007		2006	
	€	€	€	€
TURNOVER		32,624,533		23,963,913
COST OF SALES				
Materials	97,398		36,557	
Dump Charges	6,822,427		5,[illegible]17,240	
Direct wages	6,163,394		4,[illegible]25,817	
Directors salaries	56,694		42,855	
Contract Work	1,381,892		816,909	
Repairs & Renewals	1,496,507		1,300,676	
Motor & Travel & Subsistence	1,317,300		721,633	
Diesel & Fuel Oil	2,179,065		1,550,814	
Haulage	653,841		154,343	
Licensing and Permits	72,906		46,777	
Discount allowed	8,807		6,549	
Wheelie Bin Tags	24,390		11,209	
Hire of plant and machinery	212,091		80,850	
		20,486,712		14,012,229
GROSS PROFIT		12,137,821		9,951,684
OVERHEADS				
Administrative expenses		8,532,250		5,953,412
		3,605,571		3,998,272
OTHER OPERATING INCOME				
Management charges receivable		24,000		-
OPERATING PROFIT		3,629,571		3,998,272
Loss on disposal of fixed assets		(225,303)		
		3,404,268		3,998,272
Bank interest receivable		10,877		2,876
		3,415,145		4,001,148
Interest payable		(933,658)		(557,428)
PROFIT ON ORDINARY ACTIVITIES		2,481,487		3,443,720

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NURENDALE LIMITED

NOTES TO THE DETAILED PROFIT AND LOSS ACCOUNT

FOR THE YEAR ENDED 31ST DECEMBER 2007

	2007		2006	
	€	€	€	€
ADMINISTRATIVE EXPENSES				
Personnel costs				
Directors pensions	3,005			
Administrative staff salaries	1,963,286		1,012,574	
Staff pension contributions	65,066		42,565	
		2,031,357		1,055,139
Establishment expenses				
Rent	272,893		175,001	
Rates	31,452		25,029	
Light and heat	180,055		119,614	
Insurance	170,847		191,533	
		655,247		511,177
General expenses				
Telephone	220,274		83,566	
Advertising, stationery & postage	754,618		391,663	
Staff training	29,031		14,972	
Staff Welfare Expenses	232,879		74,917	
Sundry expenses	23,180		34,535	
Protective Clothing	58,524		14,550	
Professional Fees	421,265		329,676	
Accountancy & Audit	54,123		13,347	
Depreciation-Buildings	295,777		237,622	
Depreciation of plant and machinery	356,999		367,625	
Depreciation of leased assets	3,522,155		2,575,126	
Depreciation of motor vehicles	45,506		64,375	
Depreciation of office equipment	261,893		342,175	
Profit on disposal of fixed assets	(390,178)		(104,077)	
		5,886,046		4,460,072
Financial costs				
Bad debts		(40,400)		(72,976)
		8,532,250		5,953,412
INTEREST RECEIVABLE				
Bank interest receivable		10,877		2,876
INTEREST PAYABLE				
Bank interest & charges		189,708		68,248
HP/Finance lease charges		346,063		262,849
Loan Interest		397,887		226,331
		933,658		557,428

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APPENDIX 2

CCS Process Description

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1.1 Dry Anaerobic Digestion System Utilising Percolation

Dry digestion is well suited to dealing with stackable bio-waste with lower moisture levels, i.e. >20% total solids (TS) and above. These stackable materials can also have high levels of physical contamination and as a result is ideally suited to the processing of co-mingled brown bin material and MSW fines. In this system the incoming feedstock is loaded into “garage” like gas tight biocells using a loading shovel with little or no pre-processing required. These biocells are referred to as fermentation chambers. A summary schematic of the dry fermentation process is illustrated in Fig.1. In brief, bio-waste or biomass is loaded into a sealed, gas tight concrete vessel and this is activated through the spraying of activated anaerobic percolate. This percolate is kept in circulation through an external percolate storage system. The biomass is heated to 37-40°C and biogas production is facilitated. This biogas is drawn off the tunnels and stored prior to use as fuel in a CHP gas engine.

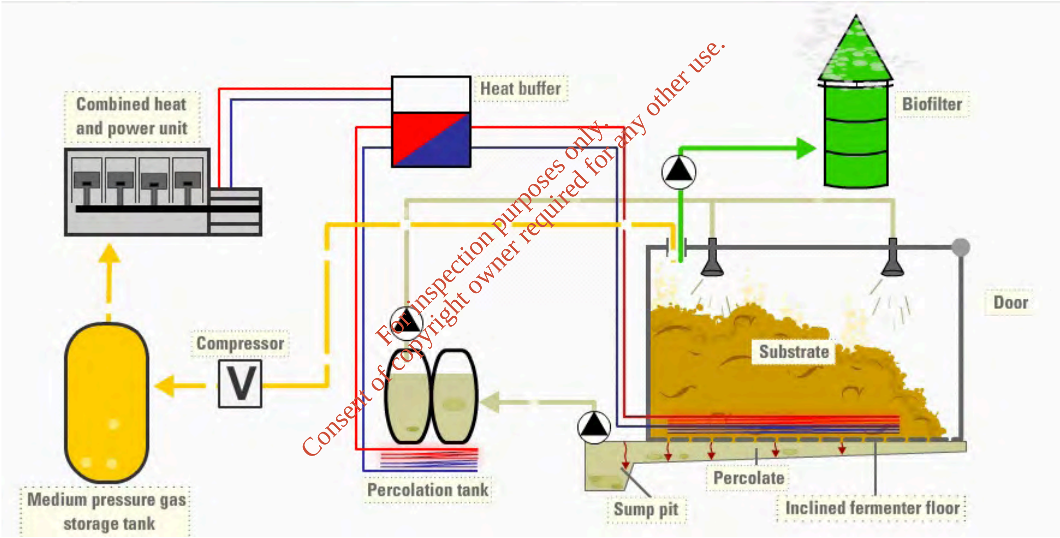

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Fig. 1. Schematic of Bioferm dry fermentation system.

The system is modular with increasing tonnages of material being managed by additional fermenters. The fermenters are typically 30m long, 7m wide with an internal stacking height of 3.5m. Each fermenter can typically process 2,500 tonnes of bio-waste per year. Due to the cyclical nature of the biogas production process, the minimum number of fermenters is three. This ensures that there is always biogas available to feed the CHP (Fig. 2).

The process of dry fermentation is based on the following procedural steps:

1. Supply and storage of biomass
2. Fermentation
3. Extraction of digestate
4. Ventilation system
5. Gas utilization

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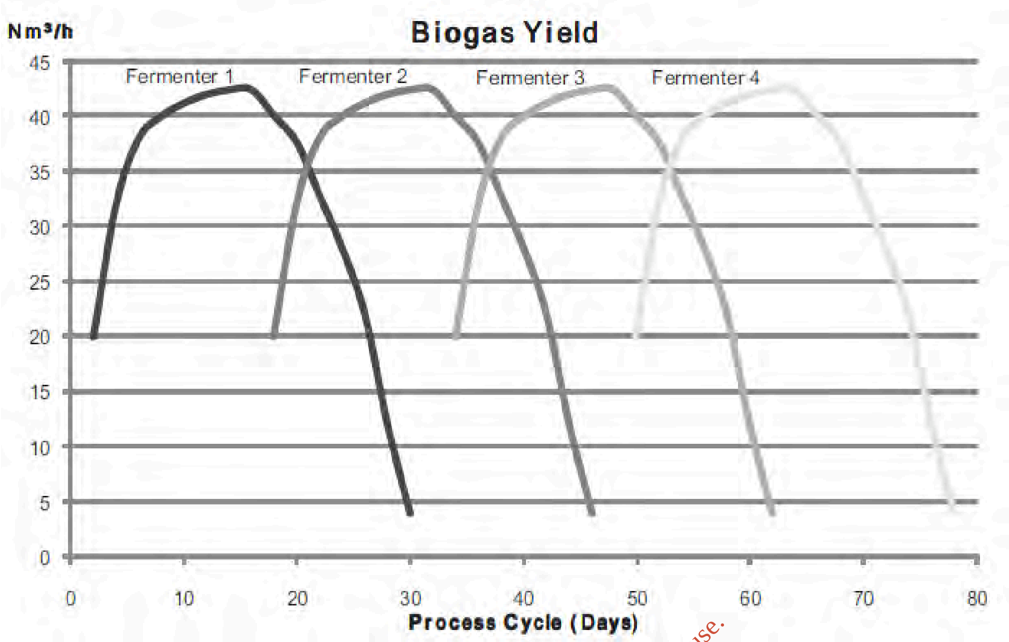

Fig. 2. Typical biogas production cycle from a four fermenter facility.

1.1.1 Supply and Storage of Biomass

When the plant is operational, the supply of biomass to the fermentation chamber is based on a 28 day cycle. When a chamber is ready for fresh biomass the first step of the exchange requires the extraction of the partially fermented biomass within the chamber. One portion of the extracted biomass is kept on the building floor and then mixed in an approximate ratio with fresh biomass using a front loader (Fig. 3). This ratio will be dictated by the tonnage of material being delivered to the facility and may fluctuate to accommodate seasonal peaks but is expected to be a 50-50 split.

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Fig. 3. Filling of a fermentation chamber with Bio-waste.

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1.1.2 The Fermentation Chambers

Each of the individual fermentation chamber units has an inner floor area of 7m x 30m with an internal height of 5m (Fig. 4). The height of the stacked biomass however, must not exceed 4.0 meters and this is typically managed at 3.5m. The reinforced concrete fermentation chamber is gas tight to prevent the infiltration of oxygen (the presence of which would cause the methane producing bacteria to become inactive). This also prevents the leakage of biogas. An in-floor heating system holds the biomass at a constant temperature of 37-40°C. The plant engineering components are located in a dedicated technology section housed above the fermenters, the capture and storage of biogas is managed through a stainless steel piped biogas ventilation system while short to medium term gas storage bags are also located above the fermentation chambers. The percolate from the fermenters is stored in two insulated and heated tanks.

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Fig. 4. Interior of fermenter prior to filling (left) and with bio-waste prior to fermenter sealing.

To insure that the fermentation chamber is not opened before the methane gas is completely drawn from the chamber and safe atmospheric levels of CO_2 and H_2S are reached, the air inside the chamber is continuously measured and analysed. The values are communicated to the computerized security system controlling the chamber doors. With the exception of loading and unloading biomass from the fermentation chambers, the entire plant is fully automated by PLC. Interruptions are immediately recognised and documented.

1.1.3 Percolate Cycle

The dry fermentation process is facilitated by the "percolate cycle". This involves the spraying of the biomass with an activated anaerobic sludge that is developed in a separate heated tank. This percolate inoculates the biomass while keeping it moist (>70% moisture). While the process of hydrolysis (discruption of cellular walls) is initiated during storage of the fresh biomass within the reception building, both acidogenisis and methanogenesis steps

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occur simultaneously within the fermenter. The bathing of the biomass in this activated percolate is key to the process.

In order to drain off excess percolate, a series of stainless steel gutters of 1 m length each with grating are built into the fermentation chamber floor. They absorb excess liquid from percolate sprinkling and route it in a controlled way to a gas tight pipe collection system. From the collection pipes the percolate is routed to the insulated covered transfer pump duct (10 m^3) utilising the following equipment:

- Fill level sensor to switch the lift pump
- Transfer pump (mix pump) with pressure pipe to the percolate storage unit
- Ventilated air pipe
- Temperature sensors
- Access door
- Limit Switch

From the transfer pump duct, which is already equipped with a 3-layer coating and a leakage detection system, the fermentation liquid is pressure pumped into an insulated percolate storage unit (Drawing CBE/job 24/008). The entire piping system is routed in a frost-proof zone outside the fermentation chamber area. The percolate storage unit consists of the following parts:

- Inlet pipe end
- Filling level sensor to switch the pump
- Transfer pump (mix pump) with pipes to the chamber sprinkling system
- Water tank for excess pressure safety
- Heating (Wall heating, system REHAU)
- Temperature sensor
- Pressure sensor
- Access door
- Limit switch
- Fermentation chamber connection unit

This percolate storage unit is installed with capacity to hold enough percolate for the entire fermentation process (even in the case of dry or highly structured material) where excess water may need to be added. The percolate storage unit is heated via a heat exchanger attached to the CHP unit. A temperature meter is located in the storage unit and takes real time percolate temperature measurements. By doing this, the heat circulation pump can be controlled and when necessary turned on/off.

The percolate is pumped to the individual fermentation chambers via HDPE pressure pipes. The percolate pipes route to the sprinkling unit of the fermentation chambers through gas tight ceiling ducts. A time sensitive control system determines the maximum percolate sprinkling requirement of the biomass. The cycle comes to an end when the percolate has seeped through the biomass. The remaining bacterial fluid is collected, siphoned and then

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transported using the transfer pump duct. This is to ensure that the percolate cannot leave the system in an uncontrolled manner. The percolate tanks and pumping chambers are monitored by the facility SCADA system which monitors flow and is equipped with level alarms (Fig. 5).Should the gauge in the percolator storage unit fall below the minimum level required for fermentation of exceptionally dry biomass, fresh water or suitable effluents can be added to the percolation tanks. As a general rule the percolate level should be balanced as the percolate is recycled and stored in the final storage chamber. Excessively wet input substrates may result in the production of excess percolate. This excess would be pumped to the adjacent effluent tank No. 1.

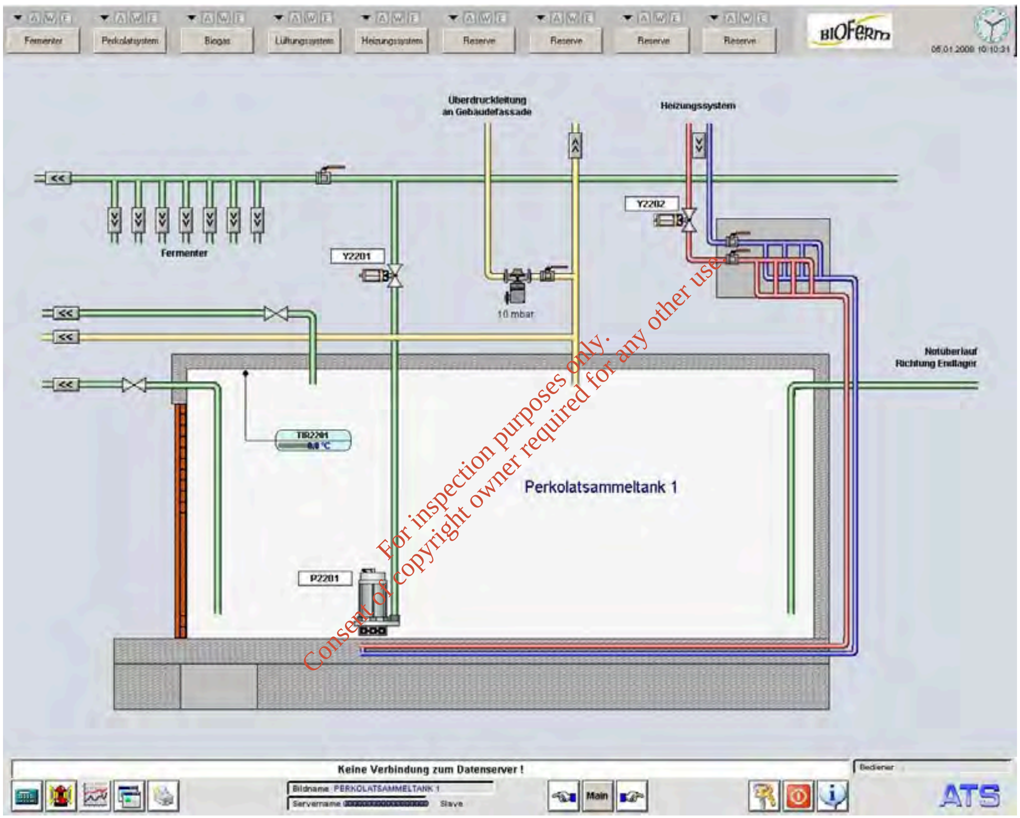

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Fig. 5. Siemens SCADA control of the percolate tank at the Moosdorf facility in Bavaria.

1.1.4 Heating

Less than 5% of the heat ngenerated from the CHP engine is utilised to maintain the working temperature within the fermenters; the rest can be used for external purposes. The thermal energy from the CHP engine is passed to a heat-exchanging device whose operating temperature averages around 85°C. By means of turnouts and heating pumps, warm water is channeled though the heating system of the biogas plant. The fermentation system is conducted at mesophilic temperatures of around 37-40° C. Heat is transported through stainless steel pipes. The fermentation chamber floor is equipped with heat piping so that the temperature of the fermenting material is

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maintained at 37-40° C. The placement of the heat distributor alongside the heat in-feed of the percolate storage units ensures against excess heat exchanges.

1.1.5 Pneumatic Controls

The compressor produces the required compressed air to activate all pneumatic valves and it is regulated with an on/off switch. The air pressure lines are routed to a distribution manifold to facilitate individual valve requirements. In the case of pressure loss or a controlled emergency stop, all pneumatic valves are depressurised automatically through a closing mechanism, using the spring-break principle, thus securing the plant in a safe operating state and preventing uncontrolled gas leaks. Pneumatic valves are activated by the air pressure from the respective chambers: The chamber door is manually opened and closed. When the door is closed, it is pneumatically locked. Compression couplings generate the necessary surface pressure and use it to assure the chamber remains gas tight. In order to open the fermentation chamber door, clamping screws require loosening and a pneumatic release device needs to be operated by hand. Only when gas quantities of ≤ 3 % CH_4, < 0.5 % CO_2 and > 18 % O_2 are measured in the fermentation chamber is approval to open the door given via the PLC system (green indicator on control panel). The pneumatic lock on the chamber door can then only be opened with a key. There is a finite time limit within which the chamber door must be opened. If the door is not opened during the allowed time a new approval sequence must be given by the PLC control system based on the content of methane and oxygen in the fermentation chamber.

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1.1.6 Gas Measurement and Storage

After loading the fermentation chambers, the biomass is kept undisturbed for a period of approximately four weeks, during which time the biomass is anaerobically fermented and biogas is produced. The gas quality (CH_4, CO_2, H_2S and O_2) is determined with a gas analysis device and communicated to the PLC system and the Siemens SCADA software interface (Figs. 6 & 7). The plant operating parameters such as temperature, pressure, gas quantity and quality are stored in a database. Percolate quantity, valve and plant conditions (fermentation chamber, gas storage, CHP) are monitored via the PLC.

The biogas is extracted from the chamber with an explosion and leak proof ventilation mechanism and it is routed into the gas storage unit located on top of the fermentation chambers (Fig. 8). The internal pressure of the gas storage unit under normal operating conditions is maintained at a maximum of 5 mbar. For safety reasons the internal pressure of the gas storage unit must never exceed 25 mbar. This is controlled by the PLC with a further mechanical pressure relief valve that routes the excess biogas to a flare. The gas storage bag is designed with enough capacity to buffer the biogas even

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during offline maintenance works on the degasification units of the plant or the CHP unit. When the degasification unit or the CHP unit comes back online the buffered gas can be reprocessed. Under normal operation the gas storage units are loaded to a maximal of 30 - 40 % of capacity via the level control sensor to guarantee enough buffer capacity for operational disturbances.

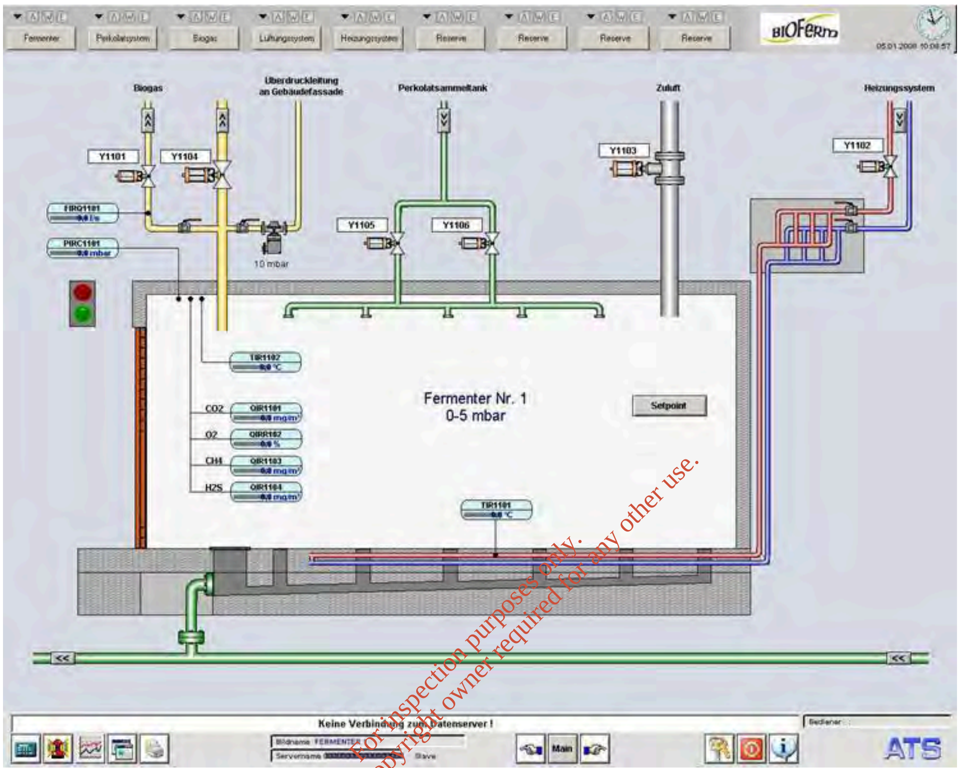

Fig. 6. Siemens SCADA control of fermenter. No.1 at the Moosdorf facility in Bavaria.

By mixing the streams of gas from different fermentation chambers a gas with consistent methane content is produced. Due to this process the methane content of the mixed gas will be the average of the combined fermentation chambers thus achieving higher process stability. A minimum mixed gas methane content of 57% aspired to. The desulphurisation of the gas is achieved automatically by the PLC control system. A hydrogen sulfide level of less than ≤ 100 ppm is desired. The moist biogas stays in the gas storage unit for a period of time while cooling to ambient temperature. During this process the water in the gas condenses and is transferred via a siphon water duct (150 mm) from the deepest point of the gas storage unit to the fermentation chamber below. This is process is referred to as passive condensation extraction. Further biogas production takes place in the percolate storage tank. A connection to a fermentation chamber is installed on the ceiling of the percolate storage tank and the biogas is exhausted via a gas compressor. The gas is condensed and routed to the gas storage unit.

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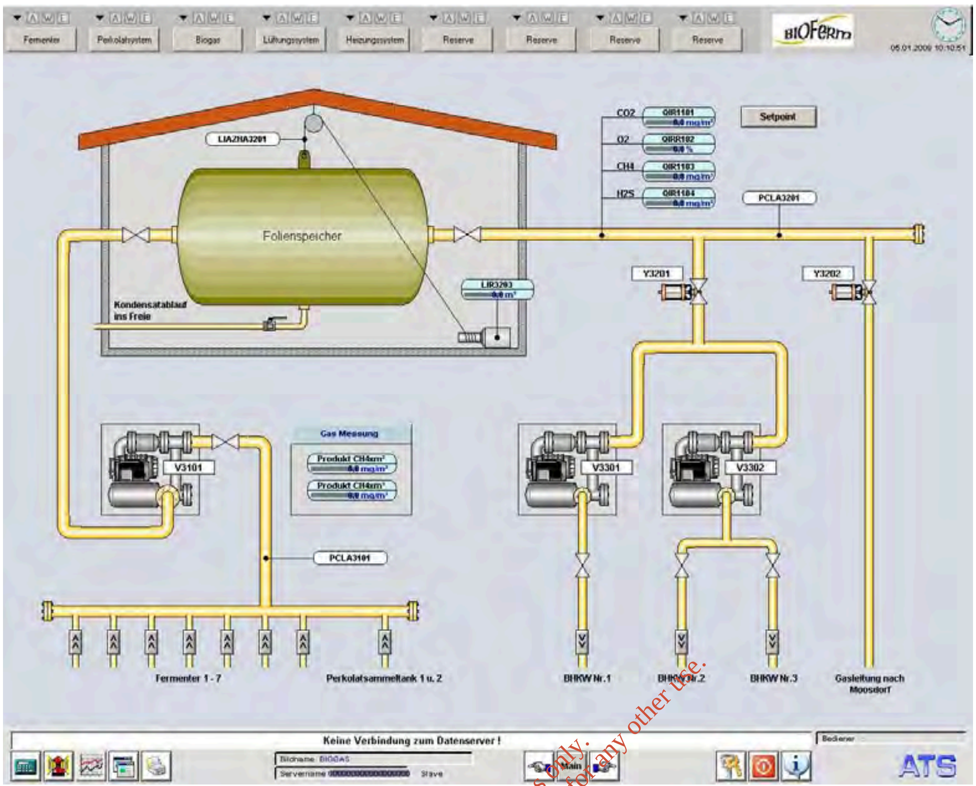

Fig. 6. Siemens SCADA control of gas storage at the Moosdorf facility in Bavaria.

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Continuous measurement of CH_4, CO_2, H_2S and O_2 levels and gas volume for each individual fermentation chamber as well as the volume and composition of the mixed gas in the gas storage unit is carried out to monitor the line operation. This is essential for optimal control of all processes and any interruptions can be detected and prevented at an early stage.

Fig. 8. The pneumatic gas collection system on the roof of the fermenters (left) and the gas transfer blower to the gas bag (right).

A fermentation chamber gas extraction unit consisting of the following components is attached to each fermentation chamber on a gas tight ceiling conduit:

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- Valve to the CHP
- Valve for the gas collection pipes with gas meter.
- Hydraulic safety valve for vacuum and pressure gauge

1.1.7 Fermenter Ventilation System

The ventilation system provides sufficient ventilation for the fermenter chamber opening process. Ventilation is accomplished with a controlled piping system (stainless steel, resistant to methane gas and electrical conductivity), backpressure valves and ventilation units. The exhaust air within both the fermentation chamber is combined with compost exhaust and the building air which is ultimately discharged to the atmosphere via a bio-filter.

1.2 CHP

The biogas from the dry fermentation system is mixed with the biogas generated from wet fermentation. The CHP unit is supplied with biogas from the gas storage unit via an individual gas control valve and gas compressor. The CHP units are installed in a separate, noise dampened containerised unit (Fig. 9). The electricity produced by the CHP units is fed into the public grid and/or used for internal consumption. The thermal energy generated by the CHP units is needed in small amounts as process heat (approx. 5 %) in the plant (in-floor heating of wet and dry fermentation chambers, heating of buildings etc.). In cases where the thermal energy is not used, the CHPs are equipped with a standard emergency cooling mechanism.

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Fig.9. Containerised CHP at the Decker biogas plant in Northern Germany

The accessories to the gas engines include the compressors, fire and smoke detectors within the room, a separate electrical control cabinet and remote control that enable the supplier to check the biogas engines on a daily basis or according to requirements. Exhaust gas emissions will be in accordance with European standards. Details can be adjusted for local requirements. Noise and exhaust gas quality are based on European regulations. All the safety design is according to German Safety Regulations for Agricultural Biogas Plants. In a situation where the gas engines are out of operation due to maintenance or repair, an emergency flare burns the surplus biogas. The emergency flare has a fully covered flame and is automatically turned on by the level control of the gas holder. It burns biogas at about 800 – 850 °C and follows international standards for this duty.

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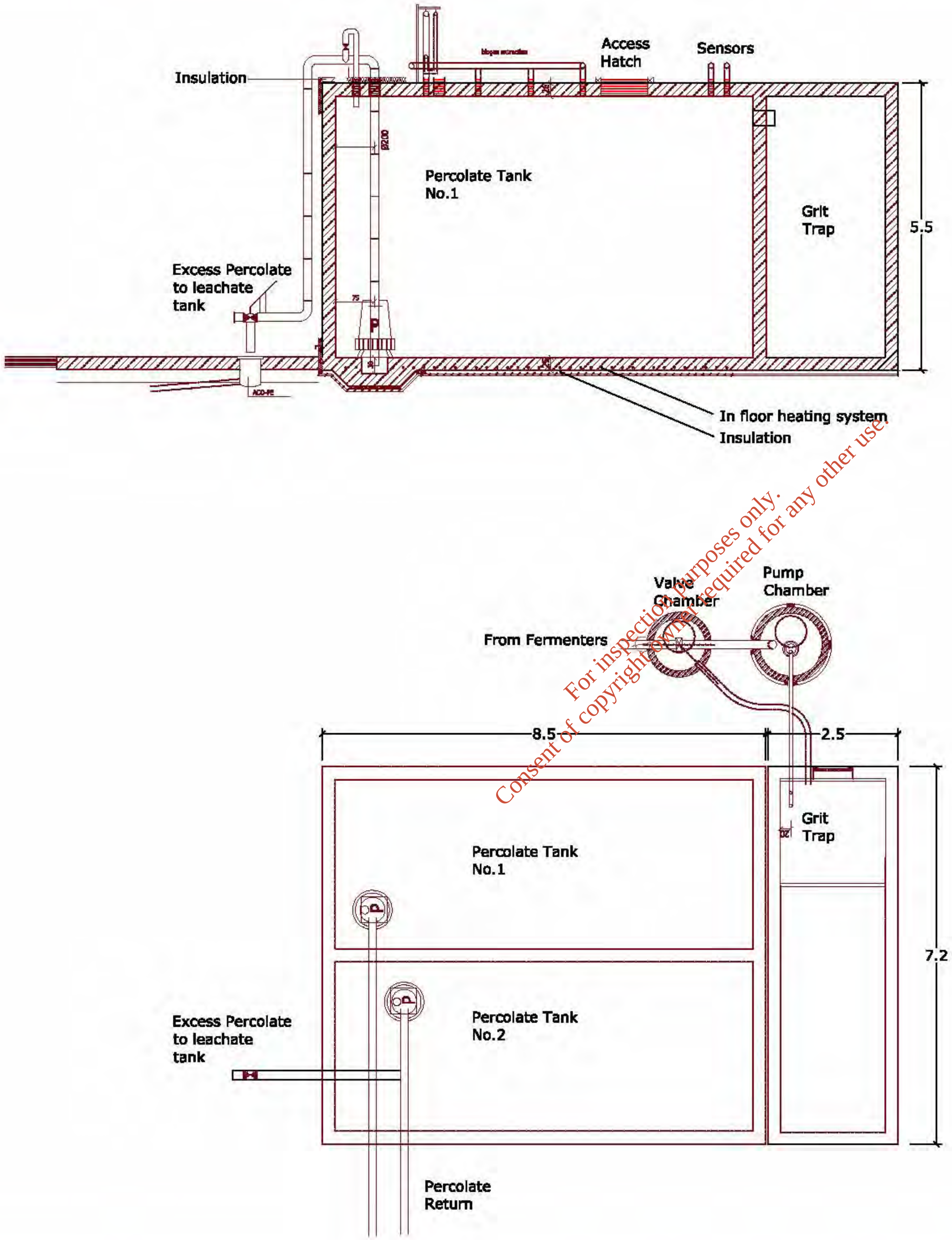

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REV.	DATE	BY	DESCRIPTION

ISSUE FOR:
PLANNING

Client: PANDA WASTE

Project: EFFLUENT MANAGEMENT

Project Reference:

Title of Drawing: PERCOLATE TANKS

Prepared by: A. HICKEY | Checked: A. WALSH | Checked:

Project Director: A.WALSH

Part: CSD | Scales Used: NTS | Paper Size: A3

Drawing No: 008 | Revision: A | Date: 03/07/09

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APPENDIX 3

Odour Assessment Report

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ODOUR & Environmental Engineering Consultants

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ODOUR IMPACT ASSESSMENT AND APPRAISAL OF ODOUR CONTROL TECHNIQUES TO BE IMPLEMENTED ON THE DRY FERMENTATION AND REFUSE DERIVED FUEL FACILITY TO BE LOCATED IN PANDA WASTE LTD, BAUPARC BUSINESS PARK, NAVAN, CO. MEATH.

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PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF PANDA WASTE LTD.

PREPARED BY:	Dr. Brian Sheridan
DATE:	14th Sept 2009
REPORT NUMBER:	2009A319(1)
DOCUMENT VERSION:	Document Ver. 001
REVIEWERS:	

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DOCUMENT AMENDMENT RECORD

Client: *Panda Waste Ltd.*

Title: Odour impact assessment and appraisal of odour control techniques to be implemented in the Dry fermentation and Refuse derived fuel facility to be located in Panda Waste Ltd, Bauparc Business Park, Navan, Co. Meath.

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Project Number: 2009A319(1)			**Document Reference:** Odour impact assessment and appraisal of odour control techniques to be implemented in the Dry fermentation and Refuse derived fuel facility to be located in Panda Waste Ltd, Bauparc Business Park, Navan, Co. Meath.		
2009A319(1)	Document for review	B.A.S.	JWC	BAS	14/09/2009
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

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EXECUTIVE SUMMARY

Odour Monitoring Ireland was commissioned by Panda Waste Ltd to carry out an odour impact assessment and design of the odour control techniques to be implemented on the proposed Dry fermentation and Refuse derived fuel facility to be located in Bauparc Business Park, Navan, Co. Meath. The purpose of this assessment was to design odour minimisation, management and mitigation techniques for the proposed facilities and to ascertain compliance of such a design with internationally recognised odour impact criteria.

Emission point guarantees for odours were established within the appraisal in order to allow for assessment of compliance of the overall designs with such odour impact criterion in order to eliminate odour risks associated with the facilities.

AERMOD Prime (07026) was used to construct the basis of the odour impact assessment in accordance with national and international odour impact criterion. Seven consecutive years of meteorological data (Dublin airport 2000 to 2006 inclusive) was used within the dispersion model.

Each aspect of the odour control equipment and management procedures were examined and used to construct the basis of an odour management plan for the site. Specific key stress points in the overall odour control system were identified and included into the overall process verification procedure to ensure the installation of effective containment and end of pipe control technologies. The overall structure of an odour management plan was developed for the facility operations to allow for efficient management and control of the odour management system.

Each odour control management system will be fitted with a SCADA system to ensure continuous monitoring of key parameters such as temperature, pH, liquid flow rate, % consumables remaining, static and differential pressure, operation hours, etc. This integrated SCADA system will facilitate the assessment and control of the overall odour management system to ensure effective operation. Alarm tagging of process specific values such as differential pressure, pH and flow rate, etc. will ensure the overall odour management system operates at optimal capacity to ensure no odour impact in the vicinity of the facility.

The overall design of the odour control and management system for the Dry fermentation and Refuse derived fuel facility considered containment, minimisation and treatment of odours generated within the facility. All facility operations including reception, handling, processing and treatment will be carried out indoors. The facility buildings will be fitted with a building fabric in order to provide near 100% odour containment within the facility buildings. The cladding techniques including joint taping and double skin clad will provide excellent odour containment techniques to ensure the efficient capture of odours within the enclosed facilities. Rapid roller doors and air curtains where necessary will be fitted to the access doors of the facilities. Double containment and zoned ventilation will be incorporated where required into the overall design so as to ensure efficient capture and extraction of odours to the treatment system.

For the Dry fermentation facility, all high load odours are self-contained within enclosed composting tunnels. Extraction air from these composting tunnels will receive two stages of odour treatment. First stage treatment will consist of acid scrubbing for the removal of biofiltration system poisons Ammonia and Amines. This Ammonia and Amine free airstream will then be directed to a biotrickling filtration system providing approximately 50 seconds empty bed retention time. Following this acid scrubbing treatment this air stream will be mixed with general low odour load ventilation air from the waste reception hall, mixing and screenings hall and processing hall of the dry fermentation facility. All treated air will be directed to a single emission stack for dispersion with a finished height of 15 m above ground level. As part of the overall odour treatment system, an integrated CEMS and SCADA monitoring system will be incorporated into the design to allow for continuous monitoring of physical performance of the odour control equipment.

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The overall design of the facility odour control system incorporates proven design elements on other reference facilities. The design considered contingency for media changeout and preventative maintenance so as to ensure optimal performance. The inlet air distribution plenum floor chosen will provide homogenous airflow throughout the biofilter bed medium. The biotrickling bed medium chosen is inorganic based and of uniform particle size. The bed medium is lightweight, will not degrade, is free draining, has excellent structural integrity and low headloss. The design life of the bed medium is in excess of 10 years therefore reducing downtime associated with changeout. The medium can be sucked out and blown in to the biotrickling filter. The operation of the biotrickling filter with a continuous moving liquid film will ensure contaminant building up will be minimised within the biotrickling bed and allow for the continuous control and addition of nutrients, minerals, pH and biofilm development. The exhaust stack of the biotrickling filter will achieve an odour threshold concentration less than 700 Ou_E/m^3 as a stack guarantee.

For the Refuse derived fuel facility, the exhaust air from the thermal dryer will be directed to a cyclone for the removal of large particulate load. Following this treatment step, the air stream will be polished for Particulate using additional cyclones before entry into the Regenerative thermal oxidiser (RTO). The RTO will be operated at a temperature of between 800 and 850 deg C. A total retention time of approximately 1.20 seconds will be achieved within the combustion zone to ensure complete odour removal. All treated air will be directed to a single emission stack for dispersion with a finished height of 20 m above ground level. The exhaust gas will be treated to an odour level of less than or equal to 1,000 Ou_E/m^3 as a stack guarantee. The Refuse derived fuel facility building will be maintained under negative pressure as a result of make up air required for the thermal dryer and combustion air for the thermal oxidiser.

Following completion of the odour impact assessment, it was concluded and demonstrated that the overall Dry fermentation and Refuse derived fuel facility design will prevent odour impacts on the surrounding area. These key design elements and conclusions included:

1. This document provides the structure and methodologies for the development of an overall odour management, minimisation and mitigation procedure for the relevant operating entities at the Panda Waste Dry fermentation and Refuse derived fuel facility.

2. The overall proposed odour mitigation techniques are based on sound engineering principles and proven design. All such technologies are in operation for the management of odours at many facilities throughout the world (references included with documentation). The overall incorporation of robust preventative maintenance procedures, containment measures, focused extraction, zoned ventilation, SCADA control, monitoring, trending and data-logging and multiple stages of treatment will ensure that odours will not cause impact on the surrounding area and that the odour control systems (biotrickling filter and Regenerative thermal oxidiser) will operate at optimal capacity.

3. The Dry fermentation and RDF facility design will ensure that all ground level concentration of odours at the nearest sensitive receptors will be less than 1.50 and 3.0 Ou_E/m^3 at the 98^{th} and 99.5^{th} percentile of hourly averages for seven years of hourly sequential meteorological data in the vicinity of the facility. The implementation of odour management, minimisation and mitigation techniques and technologies outlined in the overall facilities operation will achieve the specified odour impact criterion to prevent nuisance odours at nearest residential and business neighbours (*see Figures 8.2 and 8.3*).

4. This overall document provides a strategy and engineering design for the implementation of odour minimisation, mitigation and control of odour emissions from the facility operations and provides the backbone development of an odour management and preventative maintenance plan for the processes. The guaranteed emission rates of odours from the overall facility operations will provide compliance with the odour impact criterion contained in *Section 5* of this document.

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5. The implementation of key odour minimisation, mitigation and management techniques, that all residential and business receptors in the vicinity of the proposed facility will not experience nuisance odours with all receptors perceiving an odour concentration less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages for 7 years of hourly sequential meteorological data. The implementation of an odour management system and plan for the operating site will ensure that this is maintained throughout the life of the facility.

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1. Introduction and scope

This section will describe in brief the overall assessment and the scope of the works.

1.1 Introduction

Panda Waste Ltd commissioned Odour Monitoring Ireland to perform odour control system design and dispersion modelling assessment, odour minimisation, management and mitigation strategies for the proposed Dry fermentation (DF) and Refuse derived fuel (RDF) facility design to be located in Bauparc Business Park, Navan, Co. Meath. An independent odour impact assessment and overall appraisal was performed for facility odour control system designs in order to determine the potential risks of odour in the vicinity of the facility. Since the proposed facility will be fully enclosed, only scheduled emission(s) from odour control system exhaust point will occur. Realistic specific odour emission limit guarantees were developed from library-based data and through extensive experience in such technologies in Ireland and abroad.

This odour emission data including source characteristics was utilised in conjunction with dispersion-modelling techniques (i.e. AERMOD Prime 07026) to assess any odour impact on the surrounding area in accordance with international and national odour impact criteria (*see Section 5*). Odour dispersion modelling was performed in accordance with the recommendations contained within the Irish and UK EPA guidance documents "Odour impacts and odour emission control measures for intensive agriculture, EPA, 2001 and H Horizontal Guidance notes Parts 1 and 2, UK Environment Agency. AERMOD Prime was used to perform dispersion modelling assessment due to the significant probability of on site building wake effects (i.e. large buildings and low stacks). AERMOD Prime will provide more conservative dispersion estimates and thereby provide even more conservative predicted ground level concentrations of odour thereby providing greater protection for the local area. In addition, AERMOD Prime is the model mechanism preferred by the Environmental Agency and USEPA. Seven years of consecutive meteorological data (Dublin Airport 2000 to Dublin Airport 2006 inclusive) was used within the dispersion modelling assessment to provide statistically significant prediction over 7 years. Inexperienced dispersion modellers have a tendency not to use meteorological data in this format but instead use a single worst-case year. Such practice will provide more attractive results in terms of predicted ground level concentration and may lead to reduce abatement plant installation, unsuitable for the conditions likely to be experienced.

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Various scenarios as specified within *Section 5* of this document were utilised to ensure no odour impact at the nearest sensitive receptors. These overall odour emission rates and specified source characteristics were inputted into AERMOD Prime in order to determine any overall impact in the vicinity of the facility.

This document provides on overview of the odour management system to be implemented within the facility design and provides assurance for the regulator that the facility will not result in any odour impact in the vicinity of the facility.

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1.2 Scope of the works

The main aims of this assessment include:

- Development and design of odour control management and mitigation techniques for the proposed Dry fermentation and RDF facility.
- Ascertain the average and maximum ground level concentration of odours at the 98th and 99.5th percentile of hourly averages based on 7 years of meteorological data in the vicinity of the facility odour control system design.
- Ascertain whether the proposed facility will be in compliance with the 1-hour 98th and 99.5th percentile limit values of 1.50 and 3.0 Ou_E/m^3 ground level concentration of odours for 7 years of meteorological data at the nearest sensitive receptors in the vicinity of the facility.
- Ascertain whether the proposed odour management, minimisation and mitigation techniques for the facility are robust and sufficiently design to eliminate associated odours with these operations.
- Provide an overview of the overall odour management and mitigation strategies to be implemented at the facility.
- Provide assurance and guarantees to the regulator that such the assessment was performed in accordance with Irish and UK EPA guidance documents "Odour impacts and odour emission control measures for intensive agriculture, EPA, 2001 and H Horizontal Guidance notes Parts 1 and 2, UK Environment Agency.

1.3 Key assessment criteria used in this report

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The following key assessment criteria were used throughout the development of this report. This will provide the regulator with assurances that the facility will be design and operated to ensure no odours impacts in the vicinity of the facility. These include:

1. AERMOD Prime dispersion model *Version 07026* was used throughout the dispersion modelling assessment. In using the AERMOD Prime account was taken of building wake effects that could occur within the facility. AERMOD without the Prime algorithm will not take accurate account of building wake effects.
2. Cumulative meteorological data (i.e. seven years) allowed for the development of worst case 98th and 99.5th percentile hourly ground level concentrations of odours, over the 7 years (i.e. worst case 44 and 175 hours of ground level concentration of odours for the cumulative 7 years as opposed to a single year). In addition a 7 years percentile file was assessed as opposed to a single year file. This provided worst-case assessment of odours and provides statistical averages over seven years of meteorological data.
3. All data was geo referenced to Irish Grid Coordinated system to allow for greatest accuracy in assessing plume distance and spread. This is in accordance with Irish EPA guidance.
4. All building height structures and dimensions were utilised in the dispersion-modelling scenario to take account of building wake effects.
5. All source characteristics were taken account of in the dispersion model including stack height, temperature, efflux velocity, total mass emission rate, volumetric airflow and stack base height level.
6. The odour emission rates used in the dispersion modelling are achievable for the presented technologies and as measured on similar processes. Only proven technologies with high reliability are proposed to be utilised as end of pipe abatement.
7. The cumulative impacts from both emission points was utilised within the odour dispersion model in order to ascertain the extent of any odour impact.
8. All assessment works was performed in accordance with the Guidance documents - Irish and UK EPA guidance documents "Odour impacts and odour emission control measures for intensive agriculture, EPA, 2001 and H Horizontal Guidance notes Parts 1 and 2, UK Environment Agency and International experience taken from Odour Monitoring Irelands database.

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1.4 Key decision-making processes in designing the odour management system

The following key decision making process was used in the design of the odour control and management systems for the proposed facility designs. These included:

1.4.1 Dry fermentation and RDF facility

1. The prevention of generation and release of odours from the process is key to ensure no odour impact in the vicinity of the facility. These include the implementation of odour management procedures, which will take account of daily operations to reduce the overall generation of odours from the facility. These include:
    - Responsible operation and handling of waste.
    - Closed-door management strategy and interlocks on door access.
    - Facility management and cleaning procedures for surfaces in contact with waste.
    - Waste acceptance procedures to include enforcement of acceptance of enclosed waste loads, type of waste accepted into the facility and the procedures in handling waste within the facility (100% organic only).
    - Other elements include the implementation of an odour management plan and operation and maintenance management plans for the odour control systems.
2. Containment of odours within the facility buildings is essential to effective capture and treatment. Proposed containment measures to be use within this Odour Management system design include:
    - The installation of a high integrity building fabric. This will eliminate the leakage of odours from the building skins. The absence of such a high integrity fabric could lead to positive leakage of odours from the facility even with high volume negative ventilation as a result of wind pressure. The inclusion of a high integrity fabric in this design will prevent this occurrence.
    - Within this design, high risk and high load odour processes are double contained which is in keeping with best practice and BAT (DF Facility only). By doubly containing the high risk high odour load processes, the release and build up of such odours in the headspace of the building is prevented. This will ensure that the specification of compliance to all relevant legislative requirements of odour management are achieved. These high risk high strength odours will then received two stages of treatment while building ventilation air (i.e. low risk low odour load) will receive one stage of treatment (DF Facility only). For the RDF facility, general building air will be used as make up air for the thermal dryer and RTO combustion fan. All process air will be directly vented to the RTO for deodorisation at between 800 to 850 degC.
    - The Facility buildings access doors will be fitted with rapid roller doors and high efficiency air curtains where necessary to prevent the release of odours through the access doors of the facilities.
    - The facility will be fitted with self-closing louvers, which will open and close depending on door opening. This ensures fresh air entry into the building is controlled so that when doors are closed the fresh air will enter the building through the louvers and when doors open the fresh air will enter through the open doors (i.e. DF facility only).
    - The facility building will be divided into dedicated independent zones of extraction to include the waste reception hall, screening and processing areas, in vessel composting tunnels and the access corridor through the facility (i.e. DF facility only).
3. Treatment of odours using end of pipe technologies is essential to ensure no odour impact in the vicinity of the facility. For these two separate processes, three technologies will be used for end of pipe treatment. Fort he DF facility, acid scrubbing

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will be utilised to remove Ammonia and Amines from the high risk high strength odours from the in vessel tunnels and secondary cleaning using a biotrickling filter of low strength odours from the acid scrubber and building ventilation headspace. This will significantly reduce the risk of escape of untreated odours and also significantly reduce any associated risk of odour control failure through air stream preparation and the removal of ammonia. Ammonia will poison traditional biofilters and biofilter medium and lead to acidification through the production of nitric acid. Subsequent nitrate build up within the bed medium leads to Oxygen transfer difficulties within the biofilm of the biofilter. Acid scrubbers are in operation in many facilities to include:

- Two composting facilities, Bioorganix PLC, UK.
- Ringsend Waste water treatment plant, Ringsend, Dublin 3.
- Sutton Pumping Station, Sutton Cross, Dublin.
- Carrickgrehan Waste water treatment plant, Cork.
- Portlaw Composting facility, Waterford.

For the RDF facility, all process air will be dedusted using high efficiency cyclones and deodorised using a three canister regenerative thermal oxidiser operated on either natural or biogas. The system will achieve approx between 800 to 850 degC and approx. 1.20 seconds retention time within the combustion zone only (as in this does not include the ceramic packing). The ceramic packing chosen is of structured type and chosen to minimise blockage to siloxanes formation (i.e. if biogas is used). In addition media beam design will ensure equal flow distribution within the system and the fitting of twin burners to the combustion chamber will ensure equal temperature application to the influent airstream. The inlet to the system is fitted with air tight switching valves under induced vacuum in order to prevent odourous air short circuiting to the exhaust stack. This system has been successfully proven in the area of deodorising dryer odours in a number of countries throughout Europe to include, Ireland, England, France, Greece and Germany. An exhaustive tendering and information gathering process has been completed for the three canister thermal oxidation system and detailed design will commence shortly.

4. For the DF facility biotrickling filter, the proposed design incorporates a self-supporting air distribution plenum, which is proven in the area of large biofiltration systems such as the one proposed in this design. The design ensures that the pressure distribution of air under the floor will facilitate homogenous flow throughout the biofilter bed. In addition, the design of the inlet air distribution system will facilitate operation of individual zones within the biofiltration bed. This is a very important design parameter in order to ensure equal air distribution throughout the biofilter bed and also to ensure equal empty bed retention time for maximum biofiltration capacity gas treatment. Frequently, such design elements are overlooked and this can lead to significant heterogeneity within the biofilter bed medium and the release of untreated gases. In addition, the plenum can be driven upon which facilitates easy emptying of the bed if required. The biofilters are positioned at the edge of the first floor level of the dry fermentation tunnel, which during biofilter bed emptying will allow for the pushing of the biofilter bed medium over the edge of the first floor to the ground floor below.
5. For the DF facility biotrickling filter, the proposed design includes a proven inorganic bed medium for incorporation into the biofiltration system. We have chosen this medium for the following reasons:
    - Proven in the treatment of odours at many facilities (see reference list) to include use in biofilters in Ireland, UK, France and Norway.
    - Inorganic based and hence will not breakdown or rot like woodchip/root based medium.
    - Engineered uniform particle size, which is essential for homogenous flow through the bed. This will not be achieved using wood chip based medium.
    - Excellent pore porosity of up to 83%, which ensures sufficient surface area for microbial consortium habitation.
    - Excellent surface roughness for microbial surface attachment.
    - Excellent structural integrity, which will prevent the biofiltration bed medium from compacting and minimising pressure loss throughout the bed medium

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over its lifetime, and ensures homogenous airflow throughout the biofilter bed medium.
- Long lifetime of up to 10 to 15 years. Wood chip based medium will only achieve 2 to 4 years lifetime before full changeout is required.
- Light weight which allows the bed medium to be blown and sucked out of position.
- Excellent free draining characteristics, which will allow the biofiltration system to be operated in biotrickling mode. This will allow for the delivery of essential vitamins and nutrients to the microbial consortium to ensure high activity. It ensures that no dry zones will form within the biofilter bed medium. This can also be used to supplement food stock to the microbial consortium during periods of shut down so thereby eliminating any start-up lag period (i.e. glucose dosing). In addition, acid derivatives and salts will be easily washed from the bed in this mode ensuring excellent Oxygen transfer into the microbial consortium and the washing away of poisons from the bed, which would result in odour treatment failure. Automated pH adjustment and biomass control can be achieved easily in this mode.
- Inert and non hazardous.
- Easy to handle.

6. The selected Continuous emission monitoring (CEMS) and SCADA system for the monitoring of the odour control systems is based on key design elements and requirements which include:
    - Static differential pressure and temperature monitoring, trending, alarming and reporting.
    - Combustion fuel consumption rate
    - Liquid flow rate monitoring, trending, alarming and reporting
    - pH monitoring, trending, alarming and reporting,
    - Automated dosing for pH and nutrients,
    - VSD controlled pump sets and fanset to ensure sufficient volume extraction and liquid addition.

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2. General overview of formation and odour emissions at Biological treatment and Refuse derived fuel facilities

Unlike a mechanical process, the breakdown of organic materials is very difficult to stop. When the necessary components for a particular biological process are not present in adequate amounts, the microbial population will develop to favour micro organisms capable of capitalizing on the existing conditions. For example, when adequate oxygen is available, aerobic micro organisms will dominate the population. However a lack of oxygen will cause organisms that do not require oxygen (anaerobic micro organisms) to take over as the dominant group. These different micro organism types use alternative processes to degrade organic material. This diversity of options is very healthy for our planet as it ensures that most nutrients will be recycled through some biological pathway.

From a facility operation point of view, some of the microbial degradation processes are definitely preferable to others particularly because of the associated odours generated. Microbes utilizing odour-producing processes commonly take over when conditions are:

Anaerobic: processes occurring without adequate oxygen often release strong-smelling gases that many people find objectionable. Many of these odourous compounds are pervasive and likely to be noticed off-site. Within this facility all anaerobic gases will be contained within gas tight vessels and directed to the existing site for the production of electricity.

Low carbon/nitrogen ratio (C:N): a composting mixture that has a low C:N ratio will often release ammonia as part of the degradation process. Ammonia is not a pervasive odour and disperses easily, and so is more likely to be noticed on-site than by neighbours. It is, however,

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a signal that nitrogen is being lost from your mixture, which will lower the nutritive value of the final composted product.

There are two main stages at which material in a Facility may be exposed to these odour-producing conditions: before entering the facility, and/or when in the active composting phase.

For the RDF facility, the input waste material will be mechanically separated to remove organic material which will be immediately directed to the DF facility for treatment. The resulting waste plastic / paper will be separated further using various separation and shredding equipment where it will enter the thermal dryer for the evaporation of water vapour. The resulting finished product will be shredded further to the suitable fraction size before been bulk stored or baled for transport for use as a fuel. Through the installation of a high efficient building fabric (near 100%) and negative pressure in and around the organic separation section of the process the release of odours will be prevented. The stored finished product will be less than 10% moisture content and therefore will not be odourous in nature as experience demonstrates.

2.1 Characterisation of odour.

The sense of smell plays an important role in human comfort. The sensation of smell is unique to each human, varies with the physical condition of the person, the odour emission conditions and the individual's odourous education or memory. The smell reaction is the result of a stimulus created by the olfactory bulb located in the upper nasal passage. When the nasal passage comes in contact with odourous molecules, signals are sent via the nerve fibres in the olfactory bulb in the brain where the odour impressions are created and compared subjectively with stored memories which help form an individual's perceptions and social values. Since the smell is subjective some people will be hypersensitive and some will be less sensitive (anosmia). Therefore, the sense of smell is the most useful detection technique available as it specialises in synthesising complex gas mixtures sensation to the human nose rather than analysing the individual chemical compound (Sheridan, 2000).

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2.2 Odour qualities

An odour sensation, which may lead to a complaint, consists of a number of inter-linked factors. These include:

- Odour threshold/concentration.
- Odour intensity.
- Hedonic tone.
- Quality/Characteristics.
- Component characteristics.

The odour threshold concentration dictates the concentration of the odour in Ou_E m^{-3}. The odour intensity dictates the strength of the odour. The Hedonic quality refer to the determination of pleasantness/unpleasantness. Odour quality/characteristics indicated similarity to of the odour to a known smell (such as turnip, like dead fish, flowers, etc.). Individual chemical component identity determines the individual chemical components that constitute the odour (i.e. hydrogen sulphide, methyl mercaptan, carbon disulphide, etc.). Once odour qualities are determined, the overall odour impact can be assessed. Odour impact assessment can then be used to determine if an odour minimisation strategy is to be required and if so, the most suitable technology. Furthermore, by suitably characterising the odour through complaint logs, the most likely source of the odour can be determined, enabling the implementation of immediate odour mitigation techniques to prevent such emission in the future.

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2.3 Perception of emitted odours.

Complaints are the primary indicators that odours are a problem in the vicinity of any facility. Perceptions of odours vary from person to person, with several conditions governing a person's perception of odour:

Control: A person is better able to cope with an odour if they feel it can be controlled.

Understanding: A person can better tolerate an odour impact if they understand its source.

Context: A person reacts to the context of an odour much as they do to the odour itself (i.e. waste odour source).

Exposure: When a person is constantly exposed to an odour: They may lose their ability to detect that odour. For example, a plant operator who works in the facility may grow immune to the odour *or* their tolerance to the odour reduces and they complain more frequently.

Based on these criteria, we can predict that odour complaints are more likely to occur when:

- A new facility is located areas where people are unfamiliar with facility's purposes;
- The establishment of a new process within a facility (i.e. composting plant, etc.);
- Or when an urban population encroaches on an existing facility.

The ability to characterise odours emitted from a facility will help to develop a better understanding of the impact of the odour on the surrounding vicinity. It will also help to implement and develop better techniques to minimise/abate odours using available technologies and engineering design. The correct recording of odour complaints data is very important to resolving any odour impact.

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2.4 Characteristics of Waste and composting odours

Odours from dry fermentation and RDF facilities arise mainly from the following sources:

- The uncontrolled anaerobic biodegradation of proteins and carbohydrates to produce unstable intermediates in the waste inlet stream,
- Directly from the accepted materials and bad material handling/management practices,
- Incorrect processing of waste and composting material,
- Positive wind pressure on buildings, open doors and temperature increases will increase positive pressure within biological treatment facilities and may cause the fugitive release of odour from such facilities. Incorporating efficient air extraction systems maintaining negative ventilation and appropriate treatment of extracted air within an odour control system will reduce/eliminate odour impact.

Odours are generated by a number of different components, the most significant being the sulphur containing compounds (thiols, Mercaptans, hydrogen sulphide), volatile fatty acids (butyric acid, valeric acid), amines (methylamine, Dimethylamine), phenols (4-methylphenol), chlorinated hydrocarbons (trichloroethylene, etc), etc. (Dawson et al. 1997). Most of these compounds have very low odour threshold concentrations as illustrated in *Table 2.1*.

Most of these compounds have hedonically offensive characters as illustrated in *Table 2.1*. Different concentrations and mixtures of these compounds can intensify or reduce odour threshold concentration, determined as synergism and antagonism respectively. Hobbs et al., (2002) performed studies on various odours commonly found in pig odour. This study concluded that 4-methyl phenol had a negative effective (reduced the overall odour threshold concentration) on perceived odour concentration when mixed with other odourants.

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Table 2.1. Commonly encountered odour precursors in air stream from

Chemical component	Odour character
Ammonia	Pungent, sharp, irritating
Methylamine	Fishy, Putrid Fishy
Trimethylamine	Fishy, Pungent fishy
Dimethylamine	Putrid fishy
Ethylamine	Ammonia like
Triethylamine	Fishy
Pyridine	Sour, putrid fishy
Indole	Faecal, nauseating
Skatole	Faecal, nauseating
Hydrogen Sulphide	Rotten eggs
Methyl mercaptan	Rotten cabbage
Ethyl mercaptan	Decaying cabbage/flesh
Propyl mercaptan	Intense rotten vegetables, Unpleasant
Allyl mercaptan	Garlic, coffee
Benzyl mercaptan	Skunk, unpleasant
Thiocresol	Skunk
Dimethyl disulphide	Rotten vegetables
Carbon disulphide	Rubber, intense sulphide
Acetic acid	Vinegar
Butyric acid	Rancid
Valeric acid	Sweaty, rancid
Propionic acid	Rancid, pungent
Hexanoic acid	sharp, sour, rancid odour, goat-like odour
Formaldehyde	Pungent, medicinal
Acetone	Pungent, fruity, sweet
Butanone	Sweet, solventy
Acetophenone	Sweet pungent odour of orange blossom or jasmine
Limonene	Intense orange/lemons
Alpha Pinene	Intense pine, fresh
THN Tetrahydronaphthalene	Meat

O'Neill & Phillips et al. (1992) and Suffet at al., 2004.

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Although gases are only indicators of odour emission from various processes within a facility, knowing which compound precursors are responsible for odour is useful in designing control techniques to minimise and abate any potential odours. Technologies such as carbon filtration rely on the binding efficiency of the carbon (Van der Waals forces and molecular sieving) and knowing the gas constituents will help determine the best form of carbon to perform the task. For example, Hydrogen sulphide, because of its molecular size will not bind efficiently to activated carbon. By impregnating the carbon with potassium/sodium hydroxide, chemisorption can be used to efficiently bind and hold on to the Hydrogen sulphide. The technology chemical scrubbers are good for low concentration VOC steady stream processes while high VOC concentration non-steady stream processes, as encountered in composting will not be as affectively treated with chemical scrubbers although many stages of treatment can be provided to buffer out the cyclic loading (but at greater expense). In addition, non water-soluble compounds such as Aldehydes, Ketone and Terpenes which are always present in composting odour air streams are not effectively removed by oxidant based chemical scrubbers. Such chemical scrubbers will not attain the strict stack emission levels required in this facility. The roughing of the main gaseous components using an acid scrubber can lead to more efficient overall treatment of emissions in terms of Operational expenditure. Roughing out the main emission constituents, the more expensive polishing stage media can be protected to ensure long-term operation with minimal media changeout.

2.5 Odourous compound formation in Dry fermentation plants

Material coming onto a site may already have developed a strong odour due to the nature of the material itself or to the way it has been stored. For example:

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Material stored under anaerobic conditions: fresh organic material stored in plastic bags or insufficiently ventilated containers. The potential for odour increases if the organic material has high moisture content, has been kept in an anaerobic state for a number of days, and/or has been subjected to high temperature and direct sunlight. (e.g. grass clippings, fresh plant material, wet leaves, food waste, etc).

Material that has a low C:N ratio: this can be a particular problem if the material also has high moisture content. (e.g. sewage sludge or other high nitrogen sludge's, fish processing or slaughterhouse residuals, food waste, etc).

MANAGEMENT STRATEGIES

Such feedstock is often invaluable because of the nitrogen and moisture they provide to the composting recipe. Proactive management strategies can help you to capitalize on the benefits moist low C:N ratio material offer while minimising the potential for offensive odour release, the following strategy should be considered at minimum:

- Knowledge of delivery schedule or pattern: Knowing when a potentially odorous load is likely to arrive facilitates readiness to deal with the material immediately, minimising the likelihood for potential odours to escape off-site.
- An implementable plan in place for dealing with materials likely to be offensive. Such a plan should include the following:
    - Incorporate the material quickly. Have a stock of porous, high-carbon material on hand, which can be mixed immediately with the incoming material. Examples, currently being used with success include wood chips, wood shavings, or sawdust, dry leaves and straw. This helps to balance the C:N ratio, absorb the moisture in wet materials and add porosity so that the mixture can remain aerobic.
    - Handle loads of potentially offensive feedstock inside an enclosed work area ventilated by an odour control system.
    - If the material must be stored before blending/handling, add a blanket of saw dust or overs to cover the material to minimise potential odourous emissions.
    - Ensure the facility can process the organic material as soon as or within a short time frame (e.g. 24 hrs) it enters the facility.

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OPTIMISING THE COMPOSTING PROCESS

The following basic elements:

1. Check your carbon to nitrogen ratio (C:N) when preparing the composting mix: recipes with a C:N ratio of less than 25 are likely to lose nitrogen in the form of ammonia. A ratio of 25-40 is better, with 30 being considered ideal for most materials.
2. Check the moisture content of the composting recipe: while too little moisture will slow the composting process, too much moisture will cause anaerobic conditions—as all of the small spaces in the material will be filled with water and not enough space is available for the air required by aerobic micro organisms. Moisture content between 40 and 60% is considered a good air/moisture balance to support aerobic processes.
3. Above neutral pH recipe. Basic mixtures above pH 8.50 will release nitrogen as ammonia.
4. Porosity is important in formulating the composting mix: a mixture consisting of nothing but fine textured materials will likely become compacted as the composting process develops, preventing air from penetrating the pile. To maintain porosity when composting include some coarser material (such as wood shavings or chips) so that air can continue to move freely through the material as it breaks down. This is particularly important in systems where the material will not be turned during active composting.

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5. Ensure that material is aerated to maintain aerobic conditions. The continuous monitoring of interstitial Oxygen within the composting mix will help ensure maintenance of appropriate Oxygen levels within the material.
6. Appropriate pile size, which is not too deep: air will not be able to infiltrate the compost pile homogenously. If the pile is too deep, this results in various maturation rates for the composting process.

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3. Materials and methods

This section describes the materials and methods use for the odour dispersion modelling assessment and appraisal of odour mitigation measures. This section will also include the backbone odour management methodology to be used at Panda Waste to ensure no odour impact occurs during operation in the vicinity of the facility buildings.

3.1 Odour management plan

The Odour Management Plan (OMP) is a core document detailing operational and control measures appropriate to management and control of odour at a site. The format of the OMP provides sufficient detail to allow operators and maintenance staff to clearly understand the odour management operational procedures for both normal and abnormal conditions.

The OMP includes sufficient feedback data to enable site management (and local authority inspectors) to audit site operations on odour management. An example of some of the issues to be considered are summarised as follows.

- A summary of the site , odour sources and the location of receptors,
- Details of site management responsibilities and procedures for reporting faults, identifying maintenance needs, replenishing consumables and complaints procedure,
- Odour management equipment operation procedures (e.g. correct use of equipment, process, materials, checks on equipment performance, maintenance and inspection (*see Section 3.4*),
- Operative training,
- Housekeeping,
- Maintenance and inspection of plant (both routine and emergency response),
- Spillage/contaminated surface management procedures,
- Record keeping – format, responsibility for completion and location ,
- Emergency breakdown and incident response planning including responsibilities and mechanisms for liaison with the local authority.
- Public relations.

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The Odour Management Plan will be regularly reviewed and upgraded. It should form the basis of a document Environmental and Odour Management system for the operating site. The Odour Management System (OMS) documentation defines the roles of the Plant Operator and staff and sets out templates in relation to the operating of the facility and reporting procedures to be employed. Requirements for the Odour management plan should be implemented thought-out the site with a branched management system implemented in order to share responsibility around the site. The site manager will ensure all works are performed in accordance with the OMP. The OMP will be integrated in the overall Environmental Management/Performance System for the site.

Panda Waste will develop in agreement with the authority / regulator and implement a detailed odour management plan for the actual as built plant before commencement of treatment of waste at either facility building.

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3.2 General rules for reduction of odour emissions during the operation of the each facility.

The following minimum design features for the control of odours will be provided. These include:

3.2.1 Dry fermentation Facility

- The Dry Fermentation Facility will be fitted with a high integrity building skin to ensure near 100% building skin integrity.
- The access doors of the facility will be fitted with rigid rapid roller doors with an opening speed of approx. 2.60 m/s minimum. Each door will also be fitted with a high efficiency air curtain where deemed necessary. Computational fluid dynamic modelling performed on a similar facility has demonstrated greater than 90% containment efficiency on open doors. Coupled with the negative air extractions system, it is anticipated that no odours will escape through door openings.
- The proposed facility odour management system will allow for gas extraction from individual zones within the dry fermentation and composting process. Independent negative air extraction will be provided to the composting tunnels, waste reception hall and finished compost and screening and processing hall. The overall ventilation and odour treatment system will have 2 individual fanset feeding air into the odour treatment system. This will provide 100% duty and 50% standby.
- The significant odourous processes within the Facility will be doubly contained and negatively ventilated to two stages of odour control. The composting tunnels will be enclosed within their own enclosed structures within the sealed building. This will prevent the release of high strength odours to the headspace of the building and also ensure no odour impact at nearest sensitive receptors. Furthermore, this significantly reduces the risk of odour escape from the building and provides significant comfort in terms of odour minimisation and management.
- The odour control system will consist of acid scrubbing of ammonia and amines and second stage polishing biofiltration of all odours. This will ensure preparation and sufficient treatment of this high strength and high-risk odourous air stream. The main aim of acid scrubbing will ensure that ammonia poisoning of the biofiltration bed medium will not occur. In addition the biofiltration bed medium will operate in biotrickling mode which will ensure all contaminants that could build up within a traditional fixed phase biofiltration system will be minimal as contaminants will be washed from the biofiltration bed media. This is only possible through the use of the high efficiency, free draining inorganic medium proposed in this design. In addition, the use of the inorganic medium will ensure no increases in headloss through settlement and the medium will maintain its structural integrity. Wood chip based medium will settle, rot over time (2 to 4 years) which will lead to heterogeneous (i.e. unequal) air flow through the bed and inefficient treatment (Sheridan, 2002).
- The proposed air introduction plenum for the biofiltration system is based on proven air introduction techniques. The air introduction plenum will be divided into 4 separate cells to allow for the zoned treatment of odours within the second stage polishing biofiltration system.
- The recirculation system for the biofiltration system will allow for the focused addition of essential nutrients and minerals to ensure high microbial activity within the biofiltration bed medium. As wood chip bed medium is not free draining, nutrient addition to this bed medium will result in build up at the upper application surface and therefore result in poor distribution within the biofilter bed. Therefore frequent bed medium turning is required to ensure homogenous nutrient addition for wood chip and root based biofilter beds.
- The bed medium proposed will ensure trouble free operation over 10 to 15 years. The bed medium is light weight and can be easily blown and sucked from the biofiltration beds. In addition, the use of the plenum floor will allow for small diggers/bobcats to enter the biofilter to remove the bed medium in emergency conditions. Since the biofilter bed is divided into 4 zones, each individual zone can be cleaned out

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separately therefore allowing biofiltration bed operation during partial biofilter bed medium cleanout. Wood chip/root based bed medium will require cleanout every 2 to 4 years possibly (i.e. cleanout occurs when the bed medium settles to a point where heterogeneity in flow occurs and back pressure becomes excessive). The use of this proven medium will reduce the downtime associated with bed medium clean out from 2.5 to 5 times based on a conservative 10 year clean out cycle. The proposed plenum floor is designed with equal air distribution in mind to ensure homogenous flow through the biofilter bed.

- The odour control system will be fitted with sensors and monitoring analysers to allow for preventative maintenance and alarm tagging through the SCADA system. In addition, hours of operation will be recorded and preventative maintenance will be scheduled on a runtime basis as recommended by the equipment manufacturers.
- All rough debris and organic matter will be cleaned from the surface of the waste reception hall floor at the end of each day's operation. This will be recorded into a check sheet and incorporated into the overall odour management plan.
- All surfaces contaminated with odourous material will be washed down as required as part of the clean up schedule for the waste reception hall and finished compost screenings hall. This will be recorded into a check sheet and incorporated into the overall odour management plan.
- ***No putricable waste will be stored outdoors at any time. All operations will be carried out indoors.***
- Training and pre planned maintenance works will be organised using a check sheet approach. All staff will be trained in the execution of the Odour management plan. An annual check sheet will be used to ensure preventative maintenance is performed upon the odour management system for the Facility.

3.2.2 Refuse derived fuel Facility

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- The RDF Facility will be fitted with a high integrity building skin to ensure near 100% building skin integrity.
- The access doors of the facility will be fitted with rigid rapid roller doors with an opening speed of approx. 2.60 m/s minimum. Each door will also be fitted with a high efficiency air curtain where deemed necessary. Computational fluid dynamic modelling performed on a similar facility has demonstrated greater than 90% containment efficiency on open doors. Coupled with the negative air extractions system, it is anticipated that no odours will escape through door openings.
- All organic waste will be removed from the facility building before the end of each working day and placed in the waste reception hall of the Dry fermentation facility for treatment.
- All process air from the thermal dryer will be dedusted and deodorised using high efficiency cyclones and a three canister thermal oxidiser. The exhaust odour threshold concentration will be less than 1,000 Ou_E/m^3.
- Make up air required for the thermal dryer air heater and the combustion fan of the thermal oxidiser will be taken from the initial mechanical separation process of the RDF facility. The initial phase of this process provides organic separation and has the greatest potential for odour generation. By ensuring near 100% building fabric and negative ventilation, odours will be captured and treated.
- The finished RDF material will contain less than or equal to 10% moisture content and therefore will not have any potential to cause odours inside or outside the facility building.
- All waste material will be stored indoor at all times.

3.3 Complaints management and recording

It is generally accepted that all waste management facilities must deal with odour complaints. A systematic response to odour complaints will minimise the amount of effort spent dealing with complaints and minimise the potential for litigation and other potential negative

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outcomes. Odour Monitoring Ireland has significant experience in dealing with odour complaints. As part of an Environmental Management System (EMS), a dedicated recording system will be put in place to allow for the management of odour complaints. This EMS, quickly accessible records will be available and enable efficient and effective handling of complaints in a comprehensive manner. The odour complaint investigation begins as soon as the complaint is received. Gathering information from the complainant is a crucial step in determining the source of the offending odour. Staff who can understand and will act on the information received will immediately handle the investigation, typically this will be a lead operator or manager. Any staff handling a complaint will show a professional and compassionate demeanour. It is important not to take offence to the complaint and expect the complainant will be upset, odours can elicit strong emotional responses. Professionalism by the staff members handling the complaint can go a long way to ensure an acceptable outcome for nuisance odour.

In order to analyse complaints, accurate complaints recording will be performed. The most important factors associated with odour complaint recording include:

- Easily contactable phone number or web page for complainant to discuss their complaint. A free phone number is preferable. During normal working hours, an experienced person who is familiar with the processes should answer the phone. Only during out of hours should an answer phone be used. The answer phone should clearly state the information required of the complainant. The complainant should always be contacted back if a message is recorded. The least desirable means of receiving a complaint is via an elected official or governing body. If someone has used this method to complain, it probably means one of the methods noted above was not available or easy to use. No matter what method is used to receive odour complaints, it is important that the system provide prompt feedback.

- Clearly established questions and format of recording in order to isolate the most relevant information. This includes:
- Date and time of complaint (very important)
- Name of complainant
- Location of complainant
- Duration of odour
- Where and when odour was detected
- How strong the odour was/is (Intensity on a scale of 0 to 5 where 0 is not perceptible, 1 is very weak, 2 is weak, 3 is distinct, 4 is strong and 5 is very strong)?
- What did the odour smell like - A number of random descriptors should be proposed by the facility representative or offered by the resident (saying that the odour smells bad is not sufficient) (*see Tables 3.2, 3.3 and Figure 3.1*).
- Details of the responses made to the complainant.

- Continuous monitoring of meteorological data onsite using a met station recording data in accordance with World Meteorological Organization (WMO). Wind speed, wind direction, solar irradiance, barometric pressure, temperature and relative humidity. Minutely data should be recorded including, average, minimum, maximum, standard deviation, and max 3-second gust. The WXT 510 Visalia multi sensor fulfils all these criteria. The meteorological data for 30 minutes before and after the recorded odour duration should trended and added to the complaint register. Notes regarding precipitation and cloud cover can be used to help with the understanding of atmospheric stability and odour dispersion. This information will be useful later in the investigation if atmospheric dispersion modelling is used to diagnose odour transport and impact.

- The person responsible for complaint recording if not exposed to the odour should visit the complainant location immediately and perform subjective analysis of the immediate area. The most important of these tools are the investigators own nose, eyes and ears. If appropriate (i.e. characteristic rotten eggs odour detected), continuous monitors should be put in place at the location. The complainant location should also be geo referenced and relative direction to north from the facility should be calculated

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and added to the complaint register. Monitoring odours in the field can be a difficult task. The odours detected by the complainant may have significantly or completely abated by the time the investigator arrives on the scene. Brief interaction with the complainant should be performed. Additionally, the personnel responsible for field inspections should be familiar with all major site odour sources and characteristics.

- Complaints should be assessed taking into account the following factors:
- The context of the complaint (hypersensitive individuals, vexatious complaints, organised campaigns, whether there are other complainants, etc)
- The number of complaints against the alleged nuisance;
- The frequency of complaints, e.g. is it a one-off event or a regular occurrence?
- The person responsible for complaint recording should contact processes operators/maintenance personnel and record any process anomalies, upsets or maintenance activities that may have lead to the release of odours from your system. All data pertaining to abatement equipment operation should be assessed in order to isolate any operational issues with abatement equipment (this will be addressed in more detail in *Section 3.4*).

- All complainant handling procedures and responses will be maintained on file and available for inspection by the relevant regulatory body.

Table 3.1 illustrates a typical odour complaint recording form for use within an EMS. This will be used in conjunction with the Odour abatement equipment management procedures/system. *Tables 3.2, 3.3 and Figure 3.1* illustrate basic odour descriptors, hedonic scores and an odour wheel which will facilitate the easy characterisation of any odours downwind or within the facility boundaries.

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Table 3.1. Odour complaint recording form.

Record No.:____________	Odour complaint recording form		
Complainant details			
Complainant name		Date of complaint	
Complainant location (grid reference - N & E)		Time of complaint (24hr clock)	
Duration of complaint (minutes)		Type of complaint (i.e. odour, noise,)	
Name of person logging complaint		How was complaint received (phone, etc)	
How long till complainant contacted back (minutes)		Complainant address:	
Notes:			

Odour characteristics			
Odour intensity (0 to 5)	Please tick one	Odour hedonic tone (0 to 4)	Please tick one
No odour (0)		Neutral odour (0)	
Very weak odour (1)		Mildly unpleasant (-1)	
Weak odour (2)		Moderately Unpleasant odour(-2)	
Distinct (they can clearly recognise the odour) (3)		Unpleasant odour (-3)	
Strong odour (4)		Very unpleasant odour (-4)	
Very strong odour (5)			
What did the odour smell like-Descriptor? Please refer to *Section 1.10*			
Is/was the odour fluctuating or constant?			
Is/wasthe complainant a resident (R) of commercial receptor (C)?			
Notes:			

Weather condition *Please append historical records from met station to this record*			
Wind speed (m/s)		Temperature (^{0}C)	
Wind direction (from plant to complainant)		Relative humidity (%)	
Solar irradiance (W/m^2)		Cloud cover (0 to 8)	
Precipitation & Rainfall (mm/m^2)		Cloud height (low, medium, high)	
Notes:			

Complaint logging personnel only			
Name of personnel:		Did you detect an odour?	
Have you received training (Y/N)		What did it smell like - Descriptor?	
How fast was your response time (minutes)		Distance of odour detection to facility as crow flies (m)	
Odour Intensity (0 to 5)		Odour hedonic tone (0 to – 4)	
Is the odour fluctuating?		Are there any other odour sources in the immediate location	
Odour plume extent - graphically map odour area using mapping	*Please append to this record*		

Plant operation synopsis *Please append odour abatement plant overview*			
Waste flow into facility (tonnes per day)		Abnormal conditions	
Quantity of waste in facility on day		Are/were there any deviations (Y/N)	
Describe deviations			
Are all odour abatement equipment operating correctly	Please refer to *Section 3.4* for verification procedure.		
Notes:			

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Odour descriptors

Descriptors can help to establish the source of an odour and therefore it is useful, when recording information from a complainant, to seek their description of the odour.

Table 3.2. Odour descriptors for commonly encountered compounds.

Substance	Odour	Substance	Odour
Acetaldehyde	Apple, stimulant	Dimethyl sulphide	Rotten vegetable
Acetic acid	sour vinegar	Diphenylamine	Floral
Acetone	chemical/sweetish/solvent	Diphenyl sulphide	Burnt rubber
Acetonitrile	Ethereal	Ethanol	Pleasant, sweet
Acrylaldehyde	Burning fat	Ethyl acetate	Fragrant
Acrolein	Burnt sweet, pungent	Ethyl acrylate	Hot plastic, earthy
Acrylonitrile	Onion, garlic, pungent	Ethylbenzene	Aromatic
Aldehydes C9	Floral, waxy	Ethyl mercaptan	Garlic/onion, sewer, decayed cabbage, earthy
Aldehydes C10	Orange peel	Formaldehyde	Disinfectant, hay/straw-like, pungent
Allyl alcohol	Pungent, mustard like	Furfuryl alcohol	Ethereal
Allyl chloride	Garlic onion pungent	n-Hexane	Solvent
Amines	Fishy, pungent	Hydrogen sulphide	Rotten eggs
Ammonia	Sharp, pungent odour	Indole	Excreta
Aniline	Pungent	Iodoform	Antiseptic
Benzene	Solvent	Methanol	Medicinal, sweet
Benzaldehyde	Bitter almonds	Methyl ethyl ketone	Sweet
Benzyl acetate	Floral (jasmine), fruity	Methyl isobutyl ketone	Sweet
Benzyl chloride	Solvent	Methyl mercaptan	Skunk, sewer, rotten cabbage
Bromine	Bleach, pungent	Methyl methacrylate	Pungent, sulphide like
Sec-Butyl acetate	Fruity	Methyl sulphide	Decayed vegetables
Butyric acid	Sweat, body odour	Naphthalene	Moth balls
Camphor	Medicinal	Nitrobenzene	Bitter almonds
Caprylic acid	Animal like	Phenol	Sweet, tarry odour, carbolic acid
Carbon disulphide	Rotten vegetable	Pinenes	Resinous, woody, pine-like
Chlorine	Irritating, bleach, pungent	Propyl mercaptan	Skunk
Chlorobenzene	Moth balls	Putrescine	Decaying flesh
2-Chloroethanol	Faint, ethereal	Pyridine	Nauseating, burnt
Chloroform	Sweet	Skatole	Excreta, faecal odour
Chlorophenol	Medicinal	Styrene	Penetrating, rubbery, plastic
p-Cresol	Tar-like, pungent	Sulphur dioxide	Pungent, irritating odour
Cyclohexane	Sweetish when pure, pungent when contaminated	Thiocresol	Rancid, skunklike odour
Cyclohexanol	Camphor, methanol	Toluene	Floral, pungent, moth balls
Cyclohexanone	Acetone-like	Trichloroethylene	Solventy
Diamines	Rotten flesh	Triethylamine	Fishy, pungent
1,1-Dichloroethane	Ether-like	Valeric acid	Sweat, body odour, cheese
1,2-Dichloroethylene	Chloroform-like	Vinyl chloride	Faintly sweet
Diethyl ether	Pungent	Xylene	Aromatic, sweet
Dimethylacetamide	Amine, burnt, oily		

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Hedonic Scores

These scores are also referred to as "Dravnieks" and are derived from laboratory-based experiments. They give an indication of the relative pleasantness or unpleasantness of one odour compared to another. When considering odours from industrial activities, the descriptors given in Table 3.2 can be used.

Use of Hedonic scores

The higher the positive "score", the more "pleasant" the odour descriptor, and the greater the negative figure the more "unpleasant" the odour descriptor. The terms pleasant and unpleasant are used to indicate relative response rather than a sign of a positive or negative level of satisfaction. Zero cannot be considered to be neutral.

Table 3.3. Hedonic scores

Description	Hedonic Score	Description	Hedonic Score	Description	Hedonic Score
Cadaverous (dead animal)	-3.75	Fishy	-1.98	Wet paper	-0.94
Putrid, foul, decayed	-3.74	Musty, earthy, mouldy	-1.94	Medicinal	-0.89
Sewer odour	-3.68	Sooty	-1.69	Chalky	-0.85
Cat urine	-3.64	Cleaning fluid	-1.69	Varnish	-0.85
Faecal (like manure)	-3.36	Kerosene	-1.67	Nail polish remover	-0.81
Sickening (vomit)	-3.34	Blood, raw meat	-1.64	Paint	-0.75
Urine	-3.34	Chemical	-1.64	Turpentine (pine oil)	-0.73
Rancid	-3.15	Tar	-1.63	Kippery-smoked fish	-0.69
Burnt rubber	-3.01	Disinfectant, carbolic	-1.60	Fresh tobacco smoke	-0.66
Sour milk	-2.91	Ether, anaesthetic	-1.54	Sauerkraut	-0.60
Stale tobacco smoke	-2.83	Burnt, smoky	-1.53	Camphor	-0.55
Fermented (rotten) fruit)	-2.76	Burnt paper	-1.47	Cardboard	-0.54
Dirty linen	-2.55	Oily, fatty	-1.41	Alcoholic	-0.47
Sweaty	-2.53	Bitter	-1.38	Crushed weeds	-0.21
Ammonia	-2.47	Creosote	-1.35	Garlic, onion	0.17
Sulphurous	-2.45	Sour, vinegar	-1.26	Rope	-0.16
Sharp, pungent, acid	-2.34	Mothballs	-1.25	Beery	-0.14
Household gas	-2.30	Gasoline, solvent	-1.16	Burnt candle	-0.08
Wet wool, wet dog	-2.28	Animal	-1.13	Yeasty	-0.07
Mouse-like	-2.20	Seminal, sperm-like	-1.04	Dry, powdery	-0.07
Burnt milk	-2.19	New rubber	-0.96		
Stale	-2.04	- Metallic	0.94		

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Table 3.3 continued. Hedonic scores.

Description	Hedonic Score	Description	Hedonic Score	Description	Hedonic Score
Cork	0.19	Crushed grass	1.34	Maple syrup	2.26
Black pepper	0.19	Celery	1.36	Pear	2.26
Musky	0.21	Green pepper	1.39	Caramel	2.32
Raw potato	0.26	Tea leaves	1.40	Coffee	2.33
Eggy (fresh eggs)	0.45	Aromatic	1.41	Meaty (cooked, good)	2.34
Mushroom	0.52	Raisins	1.56	Melon	2.41
Beany	0.54	Cooked vegetables	1.58	Popcorn	2.47
Geranium leaves	0.57	Clove	1.67 Minty, peppermint	2.50	
Grainy (as grain)	0.63	Nutty	1.92	Lemon	2.50
Dill	0.87	Coconut	1.93	Fragrant	2.52
Woody, resinous	0.94	Grapefruit	1.95	Fried chicken	2.53
Soapy	0.96	Perfumery	1.96	Cinnamon	2.54
Laurel leaves	0.97	Peanut butter	1.99	Cherry	2.55
Eucalyptus	0.99	Spicy	1.99	Vanilla	2.57
Molasses	1.00	Banana	2.00	Pineapple	2.59
Incense	1.01	Almond	2.01	Apple	2.61
Malty	1.05	Sweet	2.03	Peach	2.67
Caraway	1.06	Buttery, fresh butter	2.04	Violets	2.68
Soupy	1.13	Grape juice	2.07	Fruity, citrus	2.72
Bark, birch bark	1.18	Honey	2.08	Chocolate	2.78
Anise (liquorice)	1.21	Cedarwood	2.11	Floral	2.79
Oak wood, cognac	1.23	Herbal, green, cut grass	2.14	Orange	2.86
Seasoning (for meat)	1.27	Cologne	2.16	Strawberry	2.93
Leather	1.30	Fresh green vegetables	2.19	Rose	3.08
Raw cucumber	1.30	Fruity, other than citrus	2.23	Bakery (fresh bread)	3.53
Hay	1.31	Lavender	2.25		

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Odour wheel

The odour wheel is useful in characterizing the odour in the field and facilitating interaction with the complainant. It is also useful in identifying compounds that may be responsible for the odour.

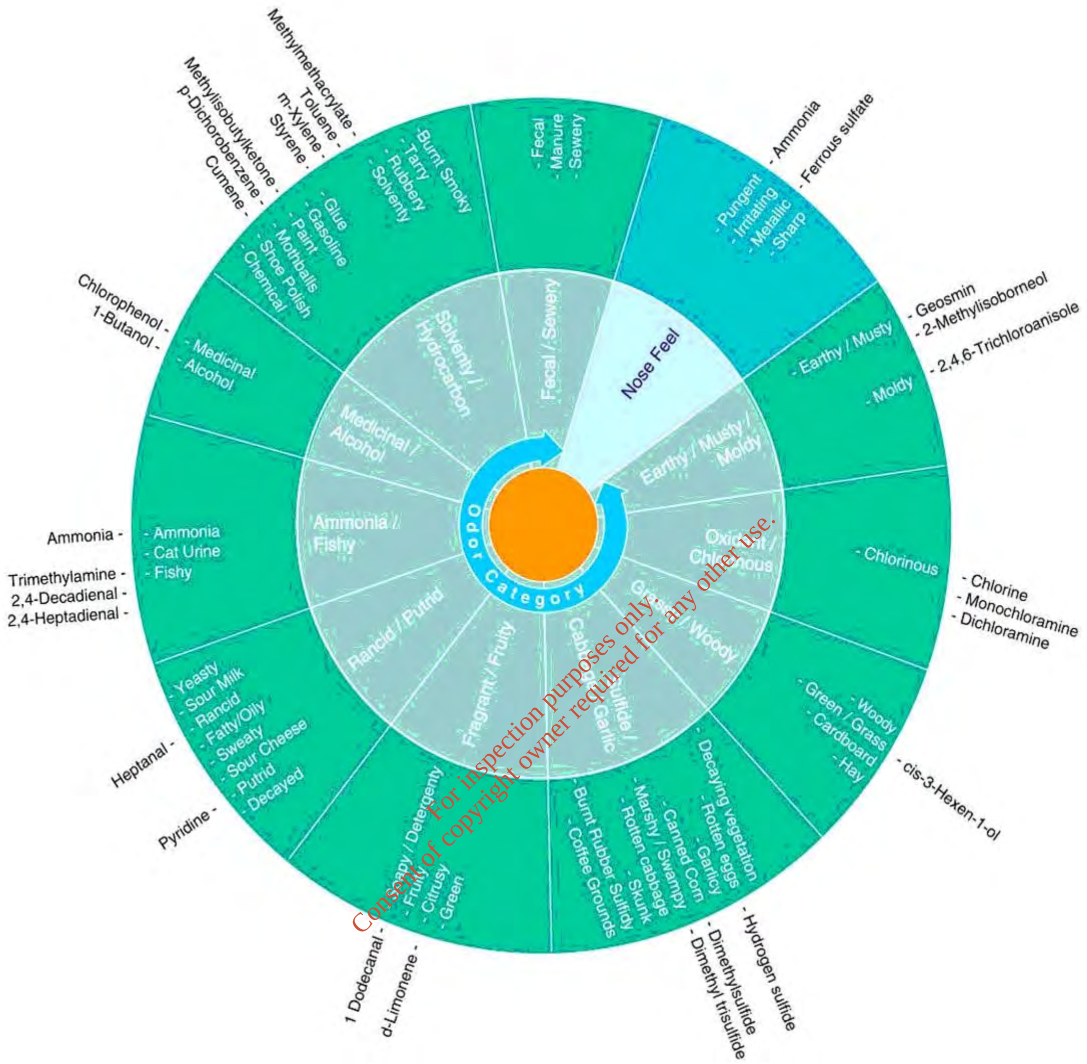

Figure 3.1. Odour wheel for odour descriptors. Suffet, M (1999).

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Notes

1. Dravnieks A, Masurat T, Lamm R A, "Hedonics of Odours and Odour Descriptors": in *Journal of the Air Pollution Control Association,* July 1984, Vol. 34 No. 7, pp 752-755

2. Guidance for the Regulation of Odour at Waste Management Facilities under the Waste Management Licensing Regulations, July 2001, Version 2.

3. IPPC H4 guidance, Horizontal guidance for odour, Part 1-Regulation and Permitting (2002).

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3.4 Odour abatement management system/procedures

Odour abatement/minimisation systems are installed with the aim of mitigating odours from the particular process(s). In some circumstances odour abatement system can become significant sources of odour especially if inappropriately maintained. This may results in insufficient treatment, poisoning of media, exhaustion of media, insufficient gas removal volume, broken doors, building fabric, etc. There is a tendency in many facility environments that once installed the odour control system requires very little system checking, especially if SCADA controlled. A simple management system incorporated into site operations can significantly reduce the risk of odour control equipment failure and also provide a valuable picture for operations and maintenances schedules.

The overall odour control equipment management system will vary for various technologies. For the proposed facility, the following odour control/minimisation equipment is/will be installed to control odours emanating from specific processes within the equipment. These include:

- Rapid roller doors and air curtains where necessary on the facility,
- First stage acid scrubbing of in vessel composting tunnel odours,
- Polishing biofiltration system for general building ventilation odours and acid scrubbed in vessel composting odours.
- Access doors to in vessel composting tunnels
- Extraction ductwork located throughout each facility,
- High efficiency cyclones for dedusting the thermal dryer process air,
- Three canister thermal oxidiser for deodorising thermal dryer process air,
- High efficiency building fabric for odour containment,
- Sensors, controls and CEMS for the overall odour control system,

For each aspect of the odour control technologies, an operational verification procedure should be performed physically visiting each piece of equipment. For sensitive mechanical odour control equipment, such as cyclones, RTO, chemical scrubbers and biofilters, a daily check will be performed. Small changes in operational parameters could lead to significant impact on equipment performance.

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For odour control/minimisation equipment such as rapid doors, air curtains, odour control ductwork, etc., which are less susceptible to breakdown, a daily observation and weekly mechanical check will be performed. All system checks will be documented and available for viewing by odour complaints verification personnel, chief maintenance personnel and equipment manager. Response/Action plans will be established for system repair where by a repair team trained in the operation and maintenances (O&M) of this specific equipment are available to perform dedicated repair work. O&M manuals will always be available and a spares inventory will be maintained.

Any recording of system performance will be compared to design specification and performance as outlines within a P&ID flow diagrams developed for each facility.

Table 3.4 illustrates a typical odour control equipment daily/weekly checking procedure for odour abatement equipment such as chemical scrubber, biotrickling filters, cyclones and RTO. Certain parameters such as subjective and objective assessment checks (airflow rate, static/differential pressures etc) will be performed daily while other parameters such as odour threshold concentration will be performed quarterly which is in compliance with EPA recommendations for similar facilities. *Table 3.5 & 3.6* illustrates a typical odour minimisation equipment system checking procedure for doors, odour control ductwork, air curtains, etc.

All static pressure sensor readings will be verified using a handheld pressure sensor on a weekly basis while all sensors requiring calibration will be performed in accordance with manufacturers requirements. Frequent span checks will also be incorporated into the schedule.

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Table 3.4. Odour Control Unit (OCU) checking procedure and recording.

Odour Abatement equipment process data sheet			
OCU name		**Location (NE coordinate)**	
OCU P&ID ref. No.		**Time of check (24 hr)**	
Date of check:		**Commissioning date:**	
QA/QC by:		**Next service date:**	
Supplier and contact details:			
Emergency contact No.			
OCU description			
Notes:			

Process description **SENSOR CALIBRATION DATES**		
Chemical/BTF/	**Liquid flow sensor**	
Chemical/BTF/RTO/Cyclone	**Differential/static pressure**	
Chemical/BTF/ RTO/Cyclone	**Temperature**	
Cyclone	**Particle concentration**	
Outlet of Cyclone	**Airflow rate/ Dust sensor**	
Outlet stack-BTF / RTO	**Mercaptans**	
Outlet stack- BTF / RTO	**Odour**	
Outlet stack- BTF / RTO	**Amines**	
Outlet stack- BTF / RTO	**Hydrogen sulphide**	
Notes:		

Subjective process verification	
Is the fan running and sounding OK (Y/N comments)?	
Is liquid recirculating within the recirculating line of the biofilter/scrubber (Y/N comments)? Please record value	
Is dump liquor flowing freely from overflow sump (Y/N comments)?	
Is liquid distributed equally over packing media and is there evidence of settlement in biofilter/scrubbing media (Y/N comments)?	
Is recirculating liquor clear or cloudy (Y/N comments)	
Are all liquid distribution nozzles/gate clear (Y/N comments)	
Notes:	

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Table 3.4 continued. Odour Control Unit (OCU) checking procedure and recording.

Objective process verification					
Parameter	**Average**	**Min**	**Max**	**Design value as per P&ID**	**Action**
Air flow rate (m3/hr)					
Temperature (^{0}C)					
Inlet ductwork Static pressure (mm WG)					
Differential pressure across system components (mm WG)					
CEMS outlet conc. (mg/m3)					
Inlet dust load (mgN/m3)					
Odour character: (Descriptor)					
Notes:					
Treated airflow	**Average**	**Min**	**Max**	**Design value as per P&ID**	**Action**
Airflow rate (Nm^3/hr)					
Temperature (^{0}C)					
Outlet static pressure (mm WG)					
Outlet odour conc. (Ou_E/m^3)					
CEMS outlet conc. (mg/m3)					
Outlet odour emission rate (Ou_E/s)					
Outlet odour character: Descriptor					
Irrigation recirculation	**Average**	**Min**	**Max**	**Design value as per P&ID**	**Action**
Recirculation flow (m^3/hr)					
Temperature (^{0}C)					
Conductivity (μs)					
PH (0 to 14)					
Redox if appropriate (mv)					
Stability on Redox/pH historically					
Irrigation drainage	**Average**	**Min**	**Max**	**Design value as per P&ID**	**Action**
Dump volume (m^3/hr)					
Conductivity (μs)					
Batch dumping frequency (weeks)					

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Table 3.5 illustrates a typical odour minimisation equipment system weekly checking procedure for odour control ductwork, etc.

Odour Abatement Plant process data sheet			
Equipment name		**Location (NE coordinate)**	
Equipment P&ID ref. No.		**Time of check (24 hr)**	
Date of check:		**Commissioning date:**	
QA/QC by:		**Next service date:**	
Supplier and contact details:			
Emergency contact No.			
Equipment description			
Notes:			

Process description		
Item description	**Parameter**	**Compliant/Actions**
Ductwork	**Static pressure P&ID location No 1**	
	Static pressure P&ID No location 2	
	Static pressure P&ID No location 3	
	Static pressure P&ID No location 4	
Volume control dampers (VCD)	**P&ID No. 1 Damper setting/head loss**	
	P&ID No. 2 Damper setting/ head loss	
	P&ID No. 3 Damper setting/ head loss	
	P&ID No. 4 Damper setting/ head loss	
Are all condensate drip points free flowing and unblocked?		
Notes:		

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Table 3.6 illustrates a typical odour minimisation equipment system weekly checking procedure for building louvers, doors, air curtains, etc.

Odour Abatement Plant process data sheet			
Equipment name		Location (NE coordinate)	
Equipment P&ID ref. No.		Time of check (24 hr)	
Date of check:		Commissioning date:	
QA/QC by:		Next service date:	
Supplier and contact details:			
Emergency contact No.			
Equipment description			
Notes:			

Process description		
Item description	Parameter	Compliant/Actions
Static pressure in tunnel and volume flow on fresh air intake vents	Static pressure/volume flows P&ID location No 1	
	Static pressure/volume flows P&ID location No 2	
	Static pressure/volume flows P&ID location No 3	
	Static pressure/volume flows P&ID location No 4	
Rapid roller doors-Building static pressure to ensure building skin integrity	P&ID No. 1 Door 1 opened/closed	
	P&ID No. 2 Door 2 opened/closed	
	P&ID No. 3 Door 3 opened/closed	
	P&ID No. 4 Door 4 opened/closed	
Are all flexible sealants in position on tunnel doors?		
Notes:		

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The implementation of such quality checking procedures will provide both system confidence and preventative maintenance thereby mitigating any risk associated with odour control/minimisation equipment.

The frequency and planning of sampling depend on the type of process. When the parameters are expected to develop gradual trends like RTO / Cyclone systems rather than sudden changes like chemical scrubbers, the frequency of checking can be low (monthly, biweekly). If the system is more susceptible to cyclic loads, weekly or even daily monitoring may be required, depending on the history and the consequences that may arise from not realising an issue. More importantly seasonal changes in odour loads on equipment can affect the overall performance of the system and combined with the behaviour of people on the receptor side

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during changing weather conditions (i.e. warm summer days could result in higher odour loads due to higher metabolic activity of bacteria coupled with people enjoying outdoor activities, etc.) For some processes, continuous monitoring may be useful, especially when the consequences of failure are significant. Risk assessment of plant failure is important to define key operational and maintenance parameters for the odour control unit (OCU). On the basis of this risk assessment measures will be defined to reduce the probability of high consequence events or to mitigate their impact.

The public will remember unscheduled emission episodes with great tenacity. It is therefore important to not fully rely on the environmental performance of odour mitigation under normal operational conditions but also consider them under unscheduled emission events. It is therefore crucial to consider and manage risks of odour emissions during:

- Odour Control Unit (OCU) commissioning
- Start-up and shutdown of odour abatement units with consideration for duty standby on particularly odour processes (which has been implemented into the proposed design)
- Management of highly odorous materials
- OCU servicing, and unscheduled shutdown.

In assessing these risks, it must be taken into account that response to odours is almost immediate. In order to manage these odour detection and complaint risks, a number of actions may be considered:

- Plan high-risk activities in periods where receptor sensitivity to annoyance is low like during wet weather when people are indoors, or during colder winter months, or during early morning/late evenings during periods of low atmospheric turbulence, etc.
- Consider providing standby capacity, etc.

If all else fails, inform potentially affected residents of the probability of temporarily increased odours and explain the reasons for these possible increases (i.e. maintenance of OCU, etc.)

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4. Dispersion modelling of odours for the overall facilities design – DF and RDF facilities.

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of odours for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the odour emission rate from the source is known, (Ou_E s^{-1}, g/s), the impact on the vicinity can be estimated. These models can effectively be used in three different ways:

- Firstly, to assess the dispersion of odours and to correlate with complaints
- Secondly, in a "reverse" mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring
- Thirdly, to determine which process is contributing greatest to the odour impact and estimate the amount of required abatement to reduce this impact to acceptable levels (McIntyre et al. 2000).

In this latter mode, models have been employed for imposing emission limits on industrial processes, odour control systems and composting processes (Sheridan et al., 2002).

Any dispersion modelling approach will exhibit variability between the predicted values and the measured or observed values due to the natural randomness of the atmospheric environment. A model prediction can, at best, represent only the most likely outcome given the apparent environmental conditions at the time. Uncertainty depends on the completeness of the information used as input to the model as well as the knowledge of the atmospheric environment and the ability to represent that process mathematically. Good input information (emission rates, source parameters, meteorological data and land use characteristics) entered into a dispersion model that treats the atmospheric environment simplistically will produce equally uncertain results as poor information entered into a dispersion model that seeks to simulate the atmospheric environment in a robust manner. It is assumed that odour emission rates are representative of maximum odour events, source parameters accurately define the point of release and surrounding structures, meteorological conditions define the local atmospheric environment and land use characteristics describe the surrounding natural environment. These conditions are employed within the dispersion modelling assessment therefore providing good confidence in the generated predicted exposure concentration values.

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4.1 AERMOD Prime

The AERMOD model (07026) was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling and concepts; treatment of both surface and elevated sources, simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modelling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence

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theories are not based on sampling data or a specific averaging period. AERMOD was designed to support the U.S. EPA's regulatory modelling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, but without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002).

4.2 Brief comparison between previously used ISCST3 and AERMOD predicted values from other research studies

Many comparisons have been made between dispersion models. A comparison of the ISCST3, AERMOD, and CALPUFF models has shown that maximum predicted impact from a typical process was similar for ISCST3 and CALPUFF run in the refined mode (Diosey, Hess, and Farrell, 2002). Predicted impacts for AERMOD were a factor of 24 lower than ISCST3 and a factor of 2 lower for CALPUFF run in the screening model. Sheridan et al., (2002) (2005) performed a comparison between ISC ST3 and AERMOD Prime for a typical emission process. It was concluded that AERMOD Prime predicted a higher 1-hour ground level concentration and impact area (approx. 2 times area) in comparison to ISCST3 but when percentile exceedence were applied to the 1 hour concentration value, the plume spread was similar with both dispersion models predicting similar impact areas. Porter et al., (2004) reported that predicted ground level concentrations from AERMOD (i.e. not Prime version) are lower than those of ISCST3 for point sources and higher than ISCST3 for area sources. Although the magnitude of the difference is not large, the result for an odour control perspective is that impacts from area sources will appear greater than those from process vents or stacks using AERMOD instead of ISCST3 (Porter et al., 2004). The advanced model AERMOD provides improvements in the way the pollutant dispersion is characterised. The benefits derived are partly due to dispersion algorithms and partly due to improved characterisation of the atmospheric environment. Keeping in mind that under proposed operations in the facility, all odour sources will be contained and only residual odours from the end of pipe technique will be emitted through an elevated stack with high efflux velocity. Therefore in order to conservatively assess the ground level impacts from the proposed processes, **AERMOD Prime** as opposed to AERMOD was used in order to accurately take account of building wake effects (updates in the BPIP algorithmic through the use of Prime Ver. 04274).

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4.3 General design of extraction volumes for treatment at Panda Waste Dry fermentation and RDF facility.

4.3.1 Proposed Dry Fermentation and RDF Facility treatment volumes

Table 4.1 illustrates the proposed extraction volume for the proposed facility buildings and from specified processes. In terms of treatment, the proposed DF facility building will be divided into five distinct extraction zones. This methodology is used as it provides greatest control over the application of effective extraction within the facility building.

For the RDF building, process air will be collected and ducted directly to the three canister RTO for treatment. The make up air for the thermal dryer and RTO combustion fan will be directly ducted from the stage 1 section of the mechanical separation process. The overall mass balance in this instance is neutral (i.e. the volume of air that is taken from the stage 1 mechanical separation process is ducted directly to the make up air for the thermal dryer and RTO. This in turn is utilised within the process and ducted to the high efficiency cyclones and three canister RTO for treatment).

For the Dry fermentation processes, the design has enclosed those processes considered most odourous and capable of causing significant odour emissions. This will ensure meeting the requirements of legislative limits of odourous compounds within the workspace. Double containment is provided on high-risk odour sources (i.e. in vessel composting tunnels). Lower risk odour sources (in terms of odour threshold concentration and emissions) such as the waste reception hall and finished compost screenings and storage hall will have individual localised extraction. The building can be assumed to be near 100% leak free as the design allows for the installation of a high integrity building fabric. This will also be the case for the RDF building fabric.

As can be observed for the DF facility, 2 AC/hr negative extraction will be provided within the main processing building and processes. The overall design has taken account of the risk of odour sources within the process through double containment and treatment design.

All odours from the in vessel composting process (where most the odour is generated) will receive two stages of treatment to ensure compliance with the strict odour emission rate and ground level concentration requirements. All odourous air from the in vessel composting tunnels will be first passed through an acid scrubber for the removal of basic ammonia and amines (see *Section 4.7.2* for design notes). Other alkaline-based odourants will also be removed. This ammonia and amine free odourous air stream will then be mixed with general ventilation air and passed through a biofiltration system whereby the majority of odourous compounds will be oxidised and removed. This biofiltration system will be operated at an empty bed retention time of approx. 50 seconds. The outlet air from the biofilter will then be directed to the exhaust stack. The total treatment volume will be approx. 104,000 m^3/hr with a total odour threshold concentration of less than 700 Ou_E/m^3. This specified odour threshold concentration is achievable due to the biofilter media proposed biofilter inlet plenum design allows for equal air distribution and the nutrient and contaminant control mechanism proposed (i.e. operated in biotrickling mode). Biotrickling mode of operation is only achievable, as a direct result of the biofilter medium proposed which is inorganic, does not break down (i.e. inert), free draining and has engineered equal particle size range distribution. Biotrickling filtration is not achievable in a wood chip based medium. In addition, the inorganic medium will minimise the development of anaerobic zones, and has low residual odour (unlike woodchip). The overall changeout frequency of this media is approximately every 10 to 15 yrs while a wood chip based medium will require changeout every 2 to 4 years. The use of innovative medium and the utilisation of spent activated carbon will ensure compliance with the limits.

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Table 4.1. Treatment volume characteristics from proposed DF and RDF facility buildings and processes.

Extraction volume characteristics from proposed facility buildings / processes			
Collection zones	**Void Volume (m^3)**	**Required extraction rate (AC/hr)**	**Total treatment volume per zone (Am^3/hr)**
Dry fermentation building Stack 1			
Waste reception hall and mixing zone	12,320	2	24,640
Ranking, screening, mixing zone	27,032	2	54,064
In-vessel composting tunnels (half full)	4,257	3[1]	13,000
Pasteurisation tunnels (dump air + 1 AC/hr at half full)	1060	4000 m^3/hr dump + 1 AC/hr	5,060
Finished composting screening and storage hall (Intake directed from this building to the main building)	-	2	See Ranking, screening and mixing zone volume
Total extraction volume (m^3/hr)	**-**	**-**	**96,764**
Design treatment capacity	**-**	**-**	**104,000**
Spare capacity	**-**	**-**	**7,263**
RDF facility building stack			
Three canister RTO system	**-**	**-**	**35,523**
Design treatment capacity	**-**	**-**	**40,824**
Spare capacity	**-**	**-**	**5,300**

Notes: [1] denotes that 3AC/hr air dump volume will be performed upon the in vessel composting tunnels. 3 AC/hr recirculation volume will be performed in each of the composting tunnels. Each tunnel will be approx. half filled with composting material. This provides the 3 AC/hr treatment volume thereby maintaining these high odour load processes under negative pressure.

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4.4 Pollutant emission rate guarantees, stack characteristics and proposed location for the Dry Fermentation and Refuse Derived Fuel processes

The specific emission point characteristics to include location, stack height, stack tip efflux velocity, temperature, proposed ground level (AOD), and proposed finish level height (AOD) are presented in *Table 4.2* for observation. This data formed the basis for emission point characteristics and source characteristics used within the dispersion model.

Table 4.2. Emission exhaust point characteristics used within Aermod Prime (USEPA 07026) dispersion model for contaminant dispersion modelling.

Emission point characteristics	Proposed RDF emission point - RTO	Proposed Dry fermentation Emission point - BTF
X coordinate ING (m)	297481.8	297551.50
Y coordinate ING (m)	269139.9	269250.70
Proposed ground level AOD (m)	56	61.50
Proposed finish level AOD (m)	76	71.50
Stack height from ground level (m)	20	15
Stack tip diameter (m)	0.85	1.40
Efflux velocity in stack tip (m/s)	20	18.76
Temperature (K)	398	293

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In conjunction with the total volumetric extraction flow rates presented in *Table 4.1*, the overall odour emission rates were calculated in *Section 4.4.1*. Screening dispersion modelling was used to ascertain the maximum allowable odour threshold concentration for the emission point. *The overall odour emission rates presented are based on library data for such systems and therefore achievable in this context*.

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4.4.1 Proposed Dry Fermentation and Refuse Derived Fuel facility odour emission rate

Table 4.3 illustrates the odour emission rate for the proposed Dry fermentation and RDF facility exhaust points. As can be observed the overall design treatment volume proposed for the DF facility is up to 28.88 m^3/s and 11.34 m^3/s for the RDF facility. The overall design exhaust odour threshold concentration will be 700 Ou_E/m^3 for the DF facility and 1,000 Ou/m^3 for the RDF facility, which will result in an overall odour emission rate from the two emission points of 31,556 Ou_E/s.

This emission data and source characteristics were used in conjunction with dispersion modelling to assess compliance with the odour impact criterion contained in *Section 5*. The results of the dispersion modelling assessment are presented in *Section 6.1.*

Table 4.3. Guaranteed odour emission data from emission points within the proposed Dry fermentation and Refuse derived fuel Facility processes

Guaranteed odour emission data from emission points within the proposed Dry fermentation and RDF Facility			
Odour source identity	**Volumetric airflow rate (Am^3/s)**	**Guaranteed Odour threshold conc. (Ou_E/m^3)**	**Total odour emission rate (Ou_E/s)**
Proposed Dry fermentation process OCU	28.88	700	20,216
Proposed Refuse Derived Fuel process OCU	11.34	1,000	11,340
Total odour emission rate (Ou_E/s)	**-**	**-**	**31,556**

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4.4.2 Overview of input data

Data presented in *Section 4.4 and 4.4.1* was used to form the basis of the dispersion modelling scenarios in order to determine the ground level impact of the facility emission point. This allows for the transparent transfer of information in order to allow verification of overall design. Since all processes will be indoors with good building fabric (near 100% efficiency for the Facility buildings), rapid roller doors, air curtains where necessary, certain processes doubly contained (i.e. high odour load processes such as the in vessel tunnels) and focused negative ventilation, no fugitive odour emission will occur. In addition, the design of the odour control systems will ensure treatment can continue during routine maintenance. The overall management and control system is designed with odour mitigation as one of the primary elements of the waste treatment and dry fermentation composting process (i.e. holistic approach for design through to CEMS and spot check monitoring during operation).

4.5 End of pipe treatment technologies for the proposed Dry fermentation and Refuse Derived Fuel Facility designs.

This section discusses and evaluates the main technologies that will be used to treat odourous air emanating from processes within the facility. There are many different technologies available for the treatment of odours within such processes, each with varying degrees of effectiveness. By selecting the appropriate combination of technologies and implementing them in the most suitable environment within the facility, the full effectiveness of the technology can be realised. Just as important is the life cycle operational costs for maintaining such odour control effectiveness. The cost of ownership of an odour control technology can be affected significantly through its implementation and where/how it is implemented (i.e. installing carbon

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filtration technology on high VOC concentration odourous airstreams will incur significant operation costs and also lead to increased frequency of shutdown for carbon replacement, the installation of chemical scrubbers utilising oxidising solutions such as Hypo chloride will lead to excessive waste water production that cannot be used in the composting process because of free chlorine). A thorough review of lifetime costs contributes considerably to making sound decisions on overall cost effectiveness of abatement options.

4.5.1 Hierarchy of odour controls

The preferred hierarchy of odour control measures comprises:

- Prevention
- Containment
- Collection and treatment (DEFRA, 2004).

Operational and financial restrictions mean this hierarchy cannot be applied rigidly to every application and a cost-benefit analysis will determine the most appropriate measures for any given situation. The following control options are proposed: The following strategy should be adapted where possible:

Good housekeeping: Inappropriate housekeeping practices can lead to significant emissions of odours from processes that should be relatively odour free. The maintenance of quality and documented management systems for preventative odour release will be implemented as good housekeeping. A closed doors policy will be implemented through out the Dry fermentation and RDF Facility. In addition, scheduled shutdown of plant and equipment will be controlled to minimise odour release. Organic matter debris will be prevented from building up on surfaces and equipment will be organised to allow for easy cleaning of organic matter build-up. Liquid ponding will be prevented while drains/galleys will be designed to prevent blockage and retention of liquid leading to odours. All yard space will be kept clean. Emergency spill cleanup procedure will be available and the cleaning of odourous equipment outdoors will be prevented. Meteorological conditions will be coordinated when any unscheduled odour emission procedure occurs to provide maximum potential odour dispersion before commencement of procedure.

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Process control: Will sometimes be the next most cost effective control depending on process flows and process characteristics.

Process modification: Changing process procedures, waste handling procedures, retention time of waste on the floor, Compost handling procedures, etc.

Containment and negative extraction: Odours from waste handling, dry fermentation and RDF cannot often be controlled by total containment and it is more common use with negative extraction to odour control units. This will prevent the release of fugitive odours from the contained process. Enclosing highly odourous processes such as first stage and second stage composting ensures no significant contamination of building headspace and enables better control of odours. In addition, the negative extraction of odours from around the mechanical separation process will also aid in the efficient capture of odours in the RDF process. Generally, the odorous air will be extracted and treated using end-of-pipe odour abatement system. Also dispersion is usually incorporated into the end of pipe technology to improve dispersion and reduce the risk of odour detection.

4.6 End-of-pipe odour abatement systems to be utilised in the proposed Dry fermentation and Refuse Derived Fuel Facility design

This section describes in detail the overall operation of the proposed odour management, minimization and mitigation techniques to be implemented into the design upgrade of the proposed Dry fermentation and RDF Facility to ensure odours do not result in odour impairment beyond the facility boundary.

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4.6.1 Dry fermentation Facility design

The following key infrastructure will be incorporated into the overall design of the facility design in terms of odour management and control. These include:

1. Installation of a high integrity building fabric providing near 100% leak free integrity. In this proposed design, no leakage will occur from the building skin as the building fabric will prevent any odour leakage and protect the building skin from corrosive gases.

2. Installation of high speed rigid rapid roller doors and high efficiency air curtains will provide added protection from odour release through the access doors of the facility.

3. Installation of fresh air intake louvers on each end of the building. These louvers will be designed to allow fresh air into the building on a head loss of 20 to 40 Pa, thereby ensuring that the building is always maintained under negative pressure. In addition, these self closing louvers will close when the facility doors are opened for access to the facility resulting in air been drawn through the facility doors and hence prevent the release of odours through the open door. The air curtains will automatically start operation when the door opens. Air curtains have been shown to be 90% effective in reducing odour leakage through open doorways. Coupled with negative air extraction, we are confident this design will prevent odours will leaking from the building doorways when opened.

4. The building ventilation system will be zoned into distinct extraction zones which are:
   - General ventilation air from the waste reception hall
   - General ventilation from the ranking, mixing and screening hall
   - General ventilation air from the finished compost screening and loading hall
   - Focused extraction from the enclosed in vessel composting tunnels

   This will enable the focused extraction of odours for treatment. High-risk odour air streams are separated from low load odour sources for treatment minimises the risk of untreated/partially treated odours passing through the exhaust point.

5. Enclosure of high-risk odour processes through double containment of emission sources includes:
   - In vessel composting tunnels,
   - Access corridor to the in vessel composting tunnels and dry fermentation facility.

     Ensuring that high strength odourous do not result in contamination of the building headspace and thereby further reduces the risk of odour release.

6. High risk high odour load air streams will receive two stages of treatment to ensure sufficient odour removal. In vessel composting tunnel airstreams will be directed to a acid scrubber for the removal of Ammonia and Amines which could cause issues with the biofiltration system by poisoning the media the medium proposed in this design can be flushed since it has excellent structural integrity, free draining and will not compact). All blow down liquor can be incorporated back into the compost process to improve the overall nitrogen content of the composting material (i.e. acid scrubbing will produce liquid fertilizer Ammonium sulphate). This minimises the amount of wastewater produced by the site and is in keeping with the principle of efficient operation. The high odour load air stream will then be passed through the biofiltration system for second stage treatment. This system will be operated on a 50 second empty bed retention time and provide sufficient treatment of the airstream. This air stream will also be mixed with general building ventilation air to ensure consistent odour load and to minimise cyclic loads on the biofiltration system.
7. Installation of SCADA system control and monitoring to ensure successful operation. In addition, differential pressure sensors will be installed upon the building envelope to ensure monitoring of effective negative pressure on the building at all times.

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8. Development of an overall odour management plan and preventative maintenance strategy based on the methodologies contained within this document.

Odour Monitoring Ireland has world expertise in the arrangement and the design operation of such biofiltration systems.

The odour abatement techniques proposed in this document have been designed to minimise maintenance, commissioning, start-up and shutdown activities. The cost effectiveness of the chosen technology will be influenced by the following parameters:

Capital costs: site work, modifications to existing buildings, ventilation systems, ductwork, chemical storage and dosing systems, installation, control interfaces, engineering, commissioning and performance monitoring.

Operation and maintenance costs: chemicals, media replacement, electrical running costs, maintenance, component replacement, and maintenance materials.

Other factors: life expectancy, performance, reliability, ease of operation, and effects on WWTP operations.

All such factors have been taken account of within the design of the Odour control equipment for the facility.

4.6.2 RDF Facility design

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The following key infrastructure will be incorporated into the overall design of the facility design in terms of odour management and control. These include:

1. Installation of a high integrity building fabric providing near 100% leak free integrity. In this proposed design, no leakage will occur from the building skin as the building fabric will prevent any odour leakage.

2. Installation of high speed rigid rapid roller doors and high efficiency air curtains where necessary will provide added protection from odour release through the access doors of the facility.

3. The building ventilation system will be zoned into one extraction zones which is:
    - General ventilation air from in and around the first stage mechanical separation process.
4. The thermal drying process will be maintained under slight negative pressure and all process air generated will be ducted to high efficiency cyclones and a three canister RTO for dedusting and deodorisation.
5. Installation of SCADA system control and monitoring to ensure successful operation of the odour control system.
6. Development of an overall odour management plan and preventative maintenance strategy based on the methodologies contained within this document.

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4.7 Odour control system design specifications

4.7.1 Design calculations for the Dry fermentation odour control system

4.7.1.1 Acid scrubber

The following minimum design performance and specification will be attainable on the acid scrubbing plant to be fitted into the odour control unit for the treatment of odours from the in vessel composting tunnels (*see Table 4.4*).

Table 4.4. Acid scrubber process characteristics for Ammonia and Amines Stripping of in vessel composting tunnel air.

Inputs	Values	Results	Values
Air Flow rate	13,000 Am³/h	$(NH4)_2SO_4$ in Blow down	3.10%
Inlet NH_3 Concentration	400 ppmv (304 mg/Nm³)	NH_4HSO_4 in Blow down	2.20%
Liquid Recirculation Rate	56 m³/h	H_2SO_4 in Blow down	0.10%
Blow down Rate	0.20 m³/h	Total Ammonia in Blow down	9,564 mg/L (as N)
Liquid Temperature	55 °C	TDS in Blow down	5.40%
pH in Sump	2.0	HTU	171 mm
Make-up H_2SO_4 Conc.	77%	Inlet Static Pressure	0.0 mbar
Packing Height	1400 mm	Expected NTU	***8.66***
Packing Width	1400 mm	Calculated NTU	***8.66***
Packing Height	2000 mm	Outlet NH_3 Concentration	**0.10ppmv (0.10 mg/Nm³)**
Safety Factor	1.35	Removal Efficiency	**99.90%**
Packing Volume	3.9 m³[1]	Pressure Gradient	1.50 mbar/m
Packing Type	Q-PAC	Packing Pressure Drop	3.0 mbar
Liquid Hold up	3.20%	Theoretical Fan Power	1.90 kW
Liquid Residence Time	11 sec	H_2SO_4 Consumption	16.40 kg/h (9.63 L/h)

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4.7.1.2 Biofiltration system (biotrickling mode)

The following minimum design performance and specification will be attainable on the biofiltration system to be fitted into the odour control unit for the treatment of odours from the dry fermentation and composting plant (*see Table 4.5*). The design parameters for the biofiltration system is included in *Table 4.5* in order to enable independent auditing of the overall design.

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Table 4.5. Biofiltration system process characteristics.

Biotrickling filter characteristics - Biotrickling filter bed 1 to 4				
Design characteristics	**Area (m^2)**	**Bed height (m)**	**Bed volume (m^3)**	**Typical requirements**
Bed dimensions	480	3.0	1,440	-
Media type	LECA Filterlite 10 to 20 mm particle size+ Exhausted activated general purpose carbon 4 mm pellet size.[1]	-	-	-
Void volume (following settlement)		83% pore space providing excellent structure for biomass attachment. The media is designed to be free draining to minimise the presence of anaerobic zones which would be common in wood chip based beds due to high moisture content	-	-
Design Treatment volume	28.88 m^3/s	104,000 m^3/hr	-	-
Empty bed residences time (sec)	-	-	50	**Usually greater than 36 seconds (100 m^3/m^3[media]/hr**
True Retention time (sec)	-	-	41.50	Dependent of media used - 83% void volume for this media.
Surface loading rate (m^3[air]/m^2[media]/hr)	-	-	216	-
Volumetric airflow rate (m^3[air]/m^3[media]/hr	**-**	**-**	**72**	**Usually less than 100**

Reference: Devinny, J.S., Deshusses, M.A., & Webster, T.S., (1999). Biofiltration for air pollution control. CRH Press.
Sheridan, B.A., Curran, T.P., Deshusses, M.A., Dodd, V.A., Biofiltration of air: current operational and technological advances. In review. Reviews in Environmental Technology.

Notes: [1] denotes that spent activated carbon from existing carbon filtration systems treating odourous air from waste transfer stations will be utilised at a 5 to 10% mix throughout the biofiltration system. This will be used for two primary reasons:

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A) The spent activated carbon will be rich in odourous compounds typical of the waste reception and compost screening halls. This will significantly speed up the acclimatisation period of the biofiltration system to treating such odours (i.e. typically within 24 hours).

B) In addition, the activated carbon will minimise any cyclic load effects upon the biofiltration system. By incorporating activated carbon high odour loads, which would typically be generated throughout the day, will be sorbed by the activated carbon. At night-times when operations are low, the microbial consortium within the biofiltration system bed will feed on the excess available compounds within the activated carbon (thereby cleaning it from the next morning high loading). This will ensure that sustained biomass is available within the biofilter bed when loads are high. Without this technique, it is common to encounter cyclic load effects on the outlet due to diffusion limiting effects as a result of insufficient biomass during cyclic high loads as biomass will die and grow depending on load but as a result of lag time in growth, cyclic peaks pass through the biofilter bed untreated. The activated carbon keeps the feedstock concentrations sustained within the bed so that when load is low, the microbial consortium strip the feedstock from the carbon thereby keeping biomass concentrations high within the bed medium for periods of high loads. This has been used successfully within biofiltration systems in the past but not extensively used due to the cost of activated carbon. In this case, the tenderer has a supply of activated carbon from waste transfer station odour control units. The Dublin office of the Irish EPA has facilitated the used of this methodology on another waste licensed composting site.

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4.7.2 Design calculations for the RDF odour control system

The odour control system for the RDF facility is currently in final design and as such no design information is available for review. As part of the SEW process with the EPA, a such information will be provided in confidence.

4.7.3 Contingency arrangement for removal of biofilter media

In terms of contingency for removal of the biofiltration system bed medium, the following elements have been incorporated into the design:

- The bed medium chosen will last a minimum of 10 to 15 years. The actual bed medium itself will not breakdown.
- The bed medium can be blown into the biofilter and sucked out of the biofilter using conventional blowers,
- The biofilter plenum floor provides sufficient structural integrity to allow the operation of a bobcat and mini digger if required.
- The biofilter end walls have been positioned so as to allow bed medium to be directly dumped to the lower floor allowing for quick removal and handling to occur indoors.
- The biofiltration system has been designed so as to deliver air into specific quadrants (4 off). This allows for the operation of the odour control system at reduced capacity when bed changeout is in operation.

In terms of removal, it is anticipated that the bed will be sucked out of position over a period of 2 days using three blowers. When removed the overall bed can be refilled easily within one day using three blowing systems and wheel machinery. Reduced treatment capacity is provided within the design and the utilising of an high building integrity and management techniques will ensure no release of odours from the facility.

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As part of the contingency arrangement, the temporary addition of CLO_2 to the first stage acid scrubber will ensure that the odours released from the biofilter treatment of odours from the in-vessel composting vessels will meet the specifications. Bypass temporary ductwork will facilitate the bypassing of either system to ensure standby capacity.

The wetting of the biofiltration medium will occur during the blowing process. When filling has been completed, the sprinkling system will be reinstalled (easily removable and connectable) and continuous recirculation of liquid and nutrients through out the bed will ensure equal and sufficient moistening of the bed medium. The overall seeding process will occur through recirculation of laboratory concentrated biomass delivered through the sprinkling system specifically grown on the air stream to be treated thereby ensuring minimisation of acclimatisation period and reduced full treatment lag times of approximately 24 hour. During the fill phase suspended activate sludge (SAS) from the local wastewater treatment plant will also be applied to the bed medium. This third generation biofiltration system facilitates optimal design in terms of inlet air distribution, bed medium, process control and standby treatment capabilities.

4.8 Brief overview of control philosophy of proposed SCADA system for Odour Control systems to be located in Panda Waste Dry Fermentation and RDF Facility.

The SCADA system for the odour control unit will be based on Invensys InTouch software, which is an open and extensible HMI with cutting-edge graphical capabilities providing incredible power and flexibility for application design.

InTouch software offers connectivity to the broadest range of automation devices in the industry. In terms of the I/O server and drivers the Woodhead Direct-Link™ SW1000 communication drivers will be used which provides data acquisition between Windows based

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applications (i.e. InTouch software) and industrial devices connected to Ethernet TCP/IP and Serial networks. The Data Access server will be the Woodhead DAServer .

The I/O server will communicate with Advantech ADAM 4000/5000 modules. The ADAM-4000/5000 series modules use the RS-485 communication protocol, the industry's most widely used bi-directional, balanced transmission line standard. RS485 lets the ADAM-4000 series modules transmit and receive data at high rates over long distances (i.e. up to 4 kilometres).

A SCADA system will be installed upon both the odour control system upgrade to be installed on the proposed Facility odour control system. The SCADA system will be installed on a PC located within both the Facility control room building and main offices.

The SCADA system will be primarily used for the control, acquisition and trending of data collected from each odour control system.

The use of the SCADA system will allow the following generic control and monitoring of the odour control system. This includes:

- Extract flow rates will be automatically controlled through the on screen tag but in addition these can also be set manually via the inverter drives.
- Logging of process data to include static pressure, flow, temperature, fan speed, Power consumed, pH, liquid flow, static pressures and hours of operation.
- This will allow for historical graphing and trending of overall equipment operation both continuously and historically. All data collected will be dumped to Excel type (*.CSV) files for secure storage.

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4.8.1 Dry fermentation and RDF Odour control systems monitoring and control

It is proposed to install the following static pressure sensors within the odour control system to be located in the Facility. These include:

- Differential pressure sensor across the building envelope in order to ascertain effective level of negative pressure applied to the building.
- Static pressure sensor on outlet duct work from in vessel composting tunnels. This will allow for automatic adjustment of the biofilter and Acid scrubber fans to ensure negative pressure upon the extraction line at all times. This will ensure minimization of odour leakage from composting tunnels.
- Static pressure measurement between outlet of Acid scrubber and inlet to biofilter. In conjunction with the static pressure reading before the acid scrubber, this will allow for the display of differential pressure head loss across the acid scrubber. This will be used to estimate wash down self-clean cycle time upon the acid scrubber.
- Temperature and Static pressure measurements throughout the RTO system including inlet air plenum, each ceramic canister and within the combustion chamber.
- Static pressure monitoring across each high efficiency cyclone to ensure optimal operation capacity.
- Static pressure measurement upon the ductwork run extracting odourous air from the in vessel tunnels and general building ventilation air for each process.
- Static pressure sensors upon the inlet to all biofilters quadrants (between fan and biofilter). This will allow for the measurement of pressure head loss across the biofilter medium continuously and will be used as an alert mechanism for particulate build-up and wash down sequence. The control of biomass and particulate can be achieved through the use of the plenum floor and bed flushing.
- Static pressure sensor in the headspace of the biofilter. This will be used to control the bifurcated fan extraction capacity to ensure a slight negative pressure in the headspace of the biofilters. It will also aid equal air distribution within the bed medium through equalization of pressure in the headspace of the bed. The VSD controlled

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bifurcated fans will automatically increase or decrease in speed depending on headspace static pressure. In addition, in conjunction with static pressure readings on the inlet of the biofilter bed mediums, overall differential pressure across the bed medium can be displayed.

In addition the following additional sensors will be included within the design. These include:

- Liquid pressure sensor across the multistage gauze strainer system on biofiltration irrigation line. This will be used to alarm when the gauze strainer requires cleaning and also to display any significant changes in liquid backpressure as a result of nozzle blockage.
- Continuous pH monitoring of recirculation liquid in the acid scrubber. This will be used to control the dosing of H_2SO_4 to ensure effective and efficient scrubbing of Ammonia and amines from the highly contaminated primary and secondary composting tunnels.
- Continuous monitoring of liquid recirculation flow rate to ensure liquid delivery within the acid scrubber and also to control the speed of the recirculation pump. This is a more energy efficient method of controlling pump speed as opposed to using a control valve. Using a gate or globe type control valve results in wastage of energy to pump at full speed against a semi-closed valve.
- Continuous monitoring of acid storage tank high, high and low, low levels to ensure acid availability for scrubbing at all times. This will be linked into an alarm whereby early warning of acid depletion will be alarmed. In addition, the acid storage tank bund will also be monitored for tank failure.
- Continuous monitoring of water storage tank high, high and low, low levels to ensure water availability for biofiltration system.
- Continuous monitoring of gas consumption rate on the thermal dryer and RTO system.
- Continuous monitoring of RTO burner operation.

All monitoring equipment will have established design values and alarm tags incorporated into the SCADA to ensure optimal control and troubleshooting of the odour control system (i.e. established and balanced set points from initial commissioning). All alarms will be recorded and logged and if any odour complaints are recorded, then the specific operation of the odour control system at the time of the complaint can be verified through the review of historical data.

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The following general control mechanisms will be utilised for the control of the BTF odour control system. These include:

- The exhaust airflow rates from the composting tunnels to be varied dependent on process stage.
- The overall flowrate of gases fed to the acid scrubber and biofilter to be varied in conjunction with the flow being fed from the composting tunnels.
- The makeup cooling air from the composting building to be fed post acid scrubber via mechanically actuated damper.
- The exhaust rate from biofilter to be varied in response to the static pressure measured above the biofilter bed.
- The extraction rate from the general composting building to be varied in line with operation of the equipment within the composting building (excluding the operation of the composting tunnels). The ability for the system to go into night/weekend setback automatically but with the proviso of manual override in the event of changed working practices.
- The irrigation system will be set to operate on an automatic period, however the SCADA system is capable of allowing irrigation periods to be varied in response to flow and humidity parameters if required.
- For the operation of the ammonia scrubber both scrubber liquor flowrate and pH of the scrubbing liquor will be monitored and will be both, automatically and manually variable.
- Provision for control of ventilation airflow rate dependent on effective negative pressure application upon the composting building.

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The PC's running the SCADA software will be password protected to prevent unauthorized alterations to the operation of the odour control systems.

As with other parameters manual override of the systems will be built into the programming including trending, alarm set points and historical data recording.

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4.9 Minimum maintenance schedule for Dry fermentation Facility odour minimisation and control systems.

Table 4.6 illustrate the require preventative maintenance schedule checking that is required to ensure the continuous efficient operation of the proposed odour control systems to be located within the proposed DF Facility. This is detailed due to the sensitive nature of biological treatment systems. The three canister RTO system is not readily upset (as long as static pressure and temperature is maintained within limit constraints) and therefore it is not included in this discussion.

As can be observed, daily, weekly, monthly, six monthly and yearly checking and maintenance should be performed on the key mechanical elements of the BTF odour control system. The operation and maintenance manual for the odour control system should be consulted before performing any physical works, which requires the removal, changing or alteration of any key component within the odour minimisation and control system.

This schedule allows for the identification of key failure mechanisms for the odour control system and also allows for the implementation of a preventative maintenance schedule. Spare parts for each critical component should be stored to ensure speedy replacement if fault occurs. In addition to this mechanical preventative maintenance schedule, the results generated from the preventative checking performed as part of the Odour Management Plan (*see Section 3.1*) for the odour control systems will also be consulted and considered.

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Table 4.6. Maintenance schedule for ***proposed Dry fermentation Facility*** odour control system.

Equipment	Daily	Weekly	Monthly	Six Monthly	Annually	Estimated life span	Risk of failure
Centrifugal fans	Check for excessive noise/vibration	Check and verify total airflow rate using pitot in stack. Cross verify with VSD recorded values and fan curve.	Check lubrication of bearings	Inspect impellor for signs of excessive vibration, corrosion or solids build up.	Replace bearings if necessary and rebalance in accordance with manufacturers specifications	10 yrs	Low
Bifurcated Fans	Check for excessive noise/vibration	-	Check lubrication of bearings	Inspect impellor for signs of excessive vibration, corrosion or solids build up.	Replace plastic impellors if significant abrasion has occurred. Replace bearings if necessary	10 yrs for motors, 5 yrs for impellors	Low
Scrubber recirculation Pumps	Check for leaks	Check for excessive noise/vibration	-	-	Replace seals if required	5 yrs	Low
Scrubber dosing Pumps	Check for leaks	Check for excessive noise/vibration	Check pump connections for damage/ weeping	Clean and check operation of non return valve in head of pump	Replace diaphragm and pump head if required	5 yrs	Low
Scrubber flow meter	Check for leaks	Verify electronic reading output against inline float metre for approximate flow rate.	-	-	Remove from service and clean electrodes	1 to 3 yrs	Medium
pH Monitor	-	Clean any scale of surface of pH electrode using detergent.	Calibrate using pH buffer solution 4 and 7.	Replace Electrode	-	1/2 to 1 yr	Medium
Ductwork Extract Grilles	-	-	Clean and check for blockage/damage	-	Check and rebalance VCD on each extract grills as necessary.	10 to 15 yrs	Low
Building membrane integrity	Check building fabric for tears and damage	Check static pressure sensor on building fabric with handheld sensor and verify readings	-	-	Perform annual building integrity test using smoke generation machine	60 yrs	Low/Medium

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Table 4.6 continued. Maintenance schedule for ***proposed Dry fermentation Facility*** odour control system.

Equipment	Daily	Weekly	Monthly	Six Monthly	Annually	Estimated life span	Risk of failure
Irrigation Pumps	Check for leaks	Check for excessive noise/vibration	-	-	Replace seals if required	5 yrs	Medium
Nutrient Pump	Check for leaks	Check for excessive noise/vibration	Check pump connections for damage/ weeping	Clean and check operation of non return valve in head of pump	Replace diaphragm and pump head if required	1 to 3 yrs	High
Spray Nozzles	-	Check for Blockages clean and replace if necessary	-	-	Replace spray nozzles if necessary.	1 to 2 yrs	High
Static pressure sensors	Check piping connection for blockages and for condensing moisture, clean as necessary	Verify SCADA reading with onsite handheld sensor and calibrate as necessary		-	Replace static pressure sensors if necessary	1 to 2 yrs	High
Variable speed drives	-	Perform self diagnostic	-	Change fresh air inlet panel enclosure filters.	-	10 yrs	Low
Depth sensors	check sensor ends for solids build-up and clean as necessary	Verify readings from depth sensor with visual depth float metre	-	-	-	5 to 10 yrs	Low
Biofiltration multistage gauze filter	-	Check pressure sensor connection. Isolate sprinkling system and clean gauze filters with detergent.	-	-	-	3 to 7 yrs	High
Inlet and Outlet drain from Biofiltration system	Check for blockage and clean as necessary	-	-	-	-	10 yrs	High
Biofiltration inlet plenum	-	Check biofiltration side walls for excessive airflow through visual inspection	Check bed medium for settlement. Excessive settlement may be a result of plenum failure	-	-	15 to 20 yrs	Low

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Table 4.6 continued. Maintenance schedule for ***proposed Dry fermentation Facility*** odour control system.

Equipment	Daily	Weekly	Monthly	Six Monthly	Annually	Estimated life span	Risk of failure
Biofiltration medium	Review SCADA differential pressure and CEMS readings to ensure within specification	Check bed medium for abrasion and dry spots, check sprinkling system for failure.	Check bed medium for settlement, top up filter bed if necessary, check base level of filter bed for excessive biomass growth, pH adjustment to be used if excessive biomass growth observed.	Perform quarterly olfactometry testing of exhaust air stream from biofilter to ensure within specification	Review SCADA collated data and independent testing result to establish any trends	10 to 15 yrs	Low
Anti vibration mounts	-	Check visually for failure and corrosion	-	-	-	2 to 5 yrs	Low
Acid storage tank	Check bund for acid presence or crystal, check tank for visual leaks	-	-	-	-	20 yrs	Low
Biofilter water recirculation storage tank	Check tank for leaks and integrity.	-	Check tank internals for excess sedimentation and desludge as necessary	-	-	20 yrs	Low
Air curtains on Waste reception hall and finished compost screening hall	Walk through door to assess flow pressure subjectively	-	Remove reusable SS mesh filters and clean using either power washer and/or brush. Check fan bearings and internal blower seating	-	Replace bearings and balance internal blower seating	10 yrs	Low
Rapid roller doors	Clean LED and radar safety sensors with clean cloth. Check control panel for error codes	Check gaskets, door rail, saw tooth belts and springs for wear and tear.	-	-	Perform service under contract with supplier and replace consumable parts (dependent on use)	10 to 15 yrs	Medium

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4.10 Continuous monitoring techniques for odour precursors to be employed by Panda Waste

In order to ensure efficient odour management, specific continuous monitoring techniques will be employed within the design of the proposed facility. These include:

1. SCADA monitoring of process parameters is provided within this odour management system design proposal. These include the following key transducers to allow for continuous monitoring of the system process characteristics.
    - Static pressure monitoring throughout the odour control systems to allow for the continuous report of satisfactory system dynamics. The static pressure sensors will allow for the measurement of applied vacuum pressure upon the extraction ductwork, differential head loss across each piece of plant, and allow for the focused identification of blockages within the Facility systems flow.
    - Continuous indication of total airflow rate from the dust filtration system to the odour control system so as to ensure sufficient monitoring treatment volume.
    - Alarm tagging of the facility process parameters to alert the facility managers of any issues with extraction capacity.
    - Continuous recirculation liquid flow rate monitoring on the acid scrubbing system to ensure liquid recirculation within the scrubbing vessel.
    - Continuous pH monitoring and control of the acid scrubbing system. In addition, continuous monitoring of pH on the recirculation liquid for the biofiltration system will be performed. Nutrient dosing system activity will be monitored including sprinkling usage frequency.
    - Continuous monitoring of effective negative extraction upon the Dry fermentation Facility building to ensure building integrity and no escape of odours.
    - Continuous monitoring of odour control systems operation hours, fan speed and alarm tagging of for preventative maintenance. This list is non-exhaustive and general SCADA philosophy can be observed in *Section 4.8*.

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4.11 General process verification techniques to be used during build and operate stages for Panda Waste Dry Fermentation and RDF Facility operations.

The following assessment and monitoring procedures will be utilised for process verification during the build, commissioning and operation stages of the proposed facilities in order to ensure effective odour minimisation, containment and treatment of odours occur at the facility.

4.11.1 Containment assessment techniques

The following techniques will be used during the build stage of the project to ensure that containment systems are sufficiently designed to contain odours at the facilities. All subcontractors will be requested to perform the following works in conjunction with an independent assessment team before sign off on installed works. These include:

- Building integrity testing of the facility including individual zones of the building utilising pressurisation and smoke generation testing. A small fan will pressurise the various building zones skin while a smoke generation machine will generate a 0.20 μm particle size smoke to a 1-metre visibility distance. Sufficient building integrity will be assessed through the absence of the escape of large volumes of smoke from the building. In addition the proposed building will be sealed at the eves, apex and weak zones in the building fabric utilising expanding foam on the inner side of the building. This will include all major joining to the building fabric to include, doorways, etc. During the build stage of the building, the inner side of the complete building will be fitted with an high integrity fabric, which will prevent any leakage from this building. Individual zones within the building will also be integrity tested to ensure no major sources of odour, which could result in building headspace air contamination.

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- All rapid roller doors will be flashed sufficiently to prevent the release of odours. The door-mounting rail will be flashed directly to the inner wall of the building while the door mounting rails will be gasketed to prevent any release of odours during process upset. The integrity of this seal will be accessed during the building integrity test.
- Any zones of identified leakage from the facility building will result in the performing of additional works to ensure integrity.

The assessment of all containment techniques will be implemented into the overall contract to ensure works are carried out properly and operate without difficulties.

4.11.2 Ventilation and extraction system assessment techniques

The following techniques will be used to ensure the installed equipment is sufficient and compliant with requirements. All subcontractors will be requested to perform the following works in conjunction with an independent assessment team before sign off on installed works. These include:

- The odour ventilation system will be assessed for all parameters including materials of construction, design, duct airflow velocities, system pressures, etc.
- The ventilation system will be designed to ensure sufficient extraction throughout the system with head loss in mind.
- The ventilation system ductwork will be designed to ensure condensate does not cause blockage in any section of the extraction system. Access ports will also be installed to allow maintenance staff to access volume control dampers and for ease of cleaning. Self-drains will be directly ducted to an enclosed sump within the composting process.
- The ventilation system for the facility will be designed on high sweep velocities within the duct work to ensure no particulate settlement within the ductwork (i.e. self cleaning).
- The ventilation extraction grills on all process ductwork within the facility will be designed with low face velocities in mind to minimise the entrainment of dust within the ductwork. In addition, the ductwork will be located away from dust generating operations.
- Static pressure sensors will be installed at strategic points in the system to allow for predictive maintenance. All static sensors will be SCADA linked with tag alarm levels included. All alarm levels will be established during the commissioning aspects of the project. Continuous volumetric airflow monitoring is not an attractive option in composting extraction systems due to the build up of residues upon pitot/sensor heads resulting in erroneous results.
- Entry points into processes will be designed in such a manner to minimise the collection of dust and prevent blocking on duct extraction points. Access ports will be installed in order to allow for easy of cleaning in such an event. Low face velocities across extraction grills will minimise dust entrainment.
- Ductwork will be flanged in sections to allow for easy of maintenance and to allow for sectional removal/replacement as necessary.
- All extraction system design will be confirmed and assessed in accordance with presented design, pressure monitoring and airflow rate monitoring.

Such assessment and control techniques are used through out Ireland on odour control installations. The regulator is welcome to visit such installation

4.11.3 Odour control system assessment techniques

The following techniques will be used to ensure the installed odour control equipment is sufficient and within requirements. All subcontractors will be requested to perform the following works in conjunction with an independent assessment team before sign off on installed works. These include:

- Assessment of odour emission rate from odour control unit in accordance with EN13725:2003.

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- Assessment of volumetric treatment capacity in accordance with EN13284-1:2002.
- Assessment of speciated volatile organic compound emission rate in accordance with EN13649:2002-Stationary source emissions-Determination of the mass concentration of individual gaseous organic compounds-Activated carbon and solvent desorption method, EN12619:1999-Stationary source emissions-Determination of the mass concentration of total gaseous organic carbon at low concentrations in flue gases-Continuous flame ionisation detector method and TA Luft 2002 for speciated VOC's (*Class 1,* range for this process, where applicable).
- Assessment of static pressures throughout the system for SCADA alarm tagging,
- Assessment of tiered SCADA control system for odour control systems to be located upon the facility.
- All odour control exhaust points will be fitted with fitted odour sniffing ports on the exhaust stack for subjective assessment during daily routine quality assurance. All operators will receive training on the German institute of Engineers intensity scale and in-house odour sensitivity testing will be performed using a traditional infield assessment technique. The Irish EPA (*who permits such sites*) uses such an intensity assessment technique on Waste and IPPC licensed facilities.

Emission limit values as specified in *Section 4.4* will ensure compliance with the requirements. In addition, the overall site Odour Management Plan will form part of the preventative maintenance schedule for both facilities.

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5. Results of odour dispersion modelling for Panda Waste Dry Fermentation and RDF Facility operation.

AERMOD Prime (USEPA ver. 07026) and Aermap (USEPA ver. 06341) was used to determine the overall odour impact of:

- The Dry Fermentation and RDF Facility design,

Impacts from individual stacks processes and combined are assessed in accordance with the following requirements. These include

5.1 Establishment of odour impact criterion for dry fermentation and composting facility odours

Odours from Dry fermentation and RDF operations arise mainly from the volatilisation of odourous gases from:

- The uncontrolled anaerobic biodegradation of proteins and carbohydrates to produce unstable intermediates in the waste inlet stream,
- Directly from the accepted materials and bad material handling/management practices, Incorrect processing of waste and composting material,
- Positive wind pressure on buildings, open doors and temperature increases will increase positive pressure within biological treatment facilities and may cause the fugitive release of odour from such facilities. Incorporating efficient air extraction systems maintaining negative ventilation and appropriate treatment of extracted air within an odour control system will reduce/eliminate odour impact.
- Poor process design and consideration.
- Inefficient odour control/abatement equipment, operation and design including loose fitting covers, inefficient extraction and odour control unit failure.

Some of the compounds emitted are characterised by their high odour intensity and low odour detection threshold (*see Section 2.4*). A sample of a report carried out in the Netherlands, United Kingdom and USA ranking generic and environmental odours according to the like or dislike by a group of people professionally involved in odour management is illustrated in *Table 5.1* (EPA, 2001, Environment Agency, 2002). Although not scientifically based, it is interesting to observe the results of such studies.

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Table 5.1. Ranking of environmental odours according to like and dislike (i.e. similar odour hedonic tone).

Generic odours	*Hedonic score*[1] **Dravnieks, 1994**	**Ranking**[2]	**Ranking**[2]	**Ranking**[2]	**Environmental odours**	**Ranking**[2]	**Ranking**[2]	**Ranking**[2]
Descriptor	**USA**	**UK median**	**UK mean**	**NL mean**	**Descriptor**	**NL mean**	**UK mean**	**UK Median**
Roses	3.08	4	4.4	3.4	**Bread Factory**	**1.7**	**2.5**	**1**
Coffee	2.33	3	4.5	4.6	Coffee Roaster	4.6	3.9	2
Cinnamon	2.54	4	4.9	6	Chocolate Factory	5.1	4.6	3
Mowed lawn	2.14	4	4.9	6.4	Beer Brewery	8.1	7.7	6
Orange	2.86	4	5.2	5.8	Fragrance & Flavour Factory	9.8	8.5	8
Hay	1.31	7	6.9	7.5	Charcoal Production	9.4	9.2	8
Soap	0.96	8	7.8	7.3	**Green Fraction composting**	**14**	**10.3**	**9**
Brandy		9	8.8	7.8	Fish smoking	9.8	10.5	9
Raisins	1.56	8	8.8	7.9	Frozen Chips production	9.6	11	10
Beer	0.14	9	9.5	9.3	Sugar Factory	9.8	11.3	11
Cork	0.19	10	10	10.5	Car Paint Shop	9.8	11.7	12
Peanut Butter	1.99	10	10.4	11.1	**Livestock odours**	**12.8**	**12.6**	**12**
Vinegar	-1.26	14	13.3	14.8	Asphalt	11.2	12.7	13
Wet Wool	-2.28	14	14	14.1	**Livestock Feed Factory**	**13.2**	**14.2**	**15**
Paint	-0.75	15	14	14.4	**Oil Refinery**	**13.2**	**14.3**	**14**
Sauerkraut	**-0.6**	**15**	**14.6**	**12.8**	Car Park Bldg	8.3	14.4	15
Cleaning Agent	**-1.69**	**15**	**14.7**	**12.1**	**Wastewater Treatment**	**12.9**	**16.1**	**17**
Sweat	-2.53	18	16.6	17.2	Fat & Grease Processing	15.7	17.3	18
Sour Milk	-2.91	19	18	17.5	Creamery/milk products		17.7	10
Cat's Pee	-3.64	19	18.8	19.4	Pet Food Manufacture		17.7	19
Sewer odour	**-3.68**	-	-	-	Brickworks (burning rubber)		17.8	18
-	-	-	-	-	**Slaughter House**	**17**	**18.3**	**19**
-	-	-	-	-	**Landfill**	**14.1**	**18.5**	**20**

Notes: *Source: Draft Odour H4-Part 1, Integrated Pollution Prevention and Control (IPPC). (2004). Environment Agency, Bristol, UK.*
[1] denotes the higher the positive "value", the more pleasant the odour descriptor and similarly below, the greater the negative value, the more unpleasant the odour descriptor
[2] denotes ranking in order of dislike ability.

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As can be observed from *Table 5.1*, and using the Dutch based ranking system, Green waste composting have a mean raking of 14.0 in terms of dislike. Other odours with similar mean dislike ranking include Landfill, Oil Refinery, Livestock Feed Factory, Livestock odour (i.e. intensive pig/poultry production). Green fraction composting and landfill odours are similar in their dislike ability and therefore it is rational to suggest that a similar odour impact criterion may be used based on these facts. Selection of odour impact criterion can be illustrated through the mean ranking system (i.e. 1.50 Ou_E m^{-3} for Abattoir/slaughterhouse odours with a mean ranking of 17 (very dislikeable) to 1.50 to 3.0 Ou_E m^{-3} for green fraction composting and landfill odour with a mean ranking of 14 (more likeable).

5.2 Commonly used odour annoyance criteria utilised in dispersion models

An odour impact criterion defines the odour threshold concentration limit value above baseline in ambient air, which will result in an odour stimulus capable of causing an odour complaint. There are a number of interlinked factor, which causes a nearby receptor (i.e. resident) to complain. These include:

- Odour threshold concentration, odour intensity and hedonic tone-defined measurable parameters at odour source,
- Frequency of odour-how frequently the odour is present at the receptor location,
- Duration of odour-how long the odour persists at the receptor location,
- Physiological-previous experiences encountered by receptor, etc.

By assessing these combined interlinked factors, the ability for a facility to cause odour complaint can be determined. As odour is not measurable in ambient air due to issues in sampling techniques, limit of detections for olfactometers and the inability to monitor continuously, therefore dispersion models become useful tools in odour impact assessments and odour risk analysis. Dispersion modelling also allows for the assessment of proposed changes in processes within the composting facility without actually having to wait for the processes to be changed (i.e. predictive analysis).

When utilising dispersion models for impact assessment, specific impact criterion (odour concentrations) need to be established at receptors. For odour assessment in general terms, this is called an odour impact criterion, which defines the maximum allowable ground level concentration (GLC) of odour at a receptor location for a particular exposure period (i.e. ≤ 1.50 Ou_E m^{-3} at the 98th percentile of hourly averages). Commonly used odour annoyance criteria in Ireland, UK, Netherlands and other world wide countries are illustrated in *Table 5.2*. The odour concentration, % odour exposure at this odour concentration, the dislike ability, the dispersion model and industry it applies are presented (*see Table 5.2*).

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Table 5.2. Odour annoyance criterion used for environmental odours.

Country	Odour conc. limit ($Ou_E\ m^3$)	Percentile value (%)	Average time (minutes)	Industry type	Dispersion model	Type area it applies	Dislike ability (*see Table 5.1*)	Application of criterion
Ireland	≤6.0[1]	98th	60	Intensive pig production	Complex 1	Limit value for existing pig production units	12.80	For all pig production units in Ireland
Ireland	≤3.0[1]	98th	60	Intensive pig production	Complex 1	Limit value for existing pig production units	12.80	For all pig production units in Ireland
Ireland	≤1.50[2]	98th	60	Slaughter house	Complex 1/ISC ST3	Limit value for new slaughter house facilities	17.0	Limit value for new slaughter house facilities
Ireland	≤1.50[3]	98th	60	Balbriggan WWTP	ISC Prime/ISC ST3	Limit value at sensitive receptor locations	12.90	Limit value for existing facility at sensitive receptor locations.
UK	≤1.50[4]	98th	60	WWTP	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	12.90	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
Ireland	≤3.0[3]	98th	60	Enniscorthy WWTP	ISC Prime/ISC ST3	Limit value at sensitive receptor locations	12.90	Limit value for existing facility at sensitive receptor locations.
UK	≤5.0[4]	98th	60	WWTP-Newbiggin by the Sea Planning	ADMS	Used as a limit value prevent odour impact associated with WWTP	12.90	Planning application-Newbiggin by the Sea
UK	≤1.50[4]	98th	60	Livestock feed factory	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	13.20	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
UK	≤1.50[4]	98th	60	Oil refinery	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	13.20	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
UK	≤3.0[5]	98th	60	Landfill activities	Complex 1	Odour exposure criterion developed through laboratory based odour intensity studies and complaint correlation	14.10	Longhurst et al 1998 for Landfill planning application
NL	≤3.50[6]	98th	60	WWTP	Complex 1	Limit value to prevent odour nuisance existing plant	12.90	Industry sector specific air quality criterion for odours in Netherlands
NL	≤1.50[6]	98th	60	WWTP	Complex 1	Limit value to prevent odour nuisance new plant	12.90	Industry sector specific air quality criterion for odours in Netherlands

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Notes: [1] denotes reference BAT Note development for intensive agriculture sector.

[2] denotes EPA, (2004). BAT Notes for the Slaughterhouse sector, EPA, Johnston Castle, Wexford.

[3] denotes Odour limit values used during EIA application for WWTP's.

[4] denotes Environment Agency, (2002). Technical Guidance Notes IPPC H4-IPPC, Horizontal Guidance for Odour, Part 1-Regulation and Permitting. Environment Agency, Bristol, UK.

[5] denotes Magette, W., Curran, T., Provolo, G., Dodd, V., Grace, P., and Sheridan, B., (2002). BAT Note for the Pig and Poultry Sector. EPA, Johnston Castle, Wexford.

[6] denotes EPA, 2001. Odour Impacts and Odour emissions control for Intensive Agriculture. R&D Report Series no. 14. EPA, Johnston Castle, Wexford

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Table 5.2. illustrates the range of odour impact criterion used in Ireland, UK, Netherlands, and other worldwide communities. The impact criterion accepted in Ireland and UK is based on research performed in Netherlands over the mid 80's and early 90's. In the late 90's the UK Environment Agency performed some research on validating those standards developed in Netherlands through studies performed in the UK. The main aims of these studies were for the developing of guidance notes on odour for licensing procedures under the EPA Act 1992. Over the last decade, these impact criterions have been providing protection to the community at large in the vicinity of such facilities. There is a general trend in odour impact criterion and dislike ability presented in *Table 5.1*. As can be observed in *Table 5.1 and 5.2*, the more offensive the odour is perceived, the lower the acceptable ambient odour concentration above baseline. Odours such as bakery odours are considered less offensive than pig production facilities and this is observed through the relative dislike ability and also the odour impact criterion established to limit nuisance. Green fraction composting odours have similar dislike ability to Waste water treatment and Landfill odour and therefore it would be rational to suggest a similar odour impact criterion. Other factors that require consideration include the location of the facility, the surrounding sensitive receptors, and amount of odour mitigation to be implemented into the overall design. For example in Ireland, pig production facilities are generally located in rural environments, whereby sensitive receptors in the vicinity of the facility are working in similar livestock operations and therefore do not consider the perceived odour as offensive as say a person not familiar with the odour. This composting facility on the other hand is located close to the sensitive receptors. This results in the installation of odour management and mitigation technologies to control and abate the odour emission. By abating the sources of offensive odours within the facility, the facility has a markedly lower potential risk of causing complaint. Taking into account these factors for the existing and proposed Dry Fermentation and RDF facility, it is proposed that:

- All sensitive locations should be located outside the 1.50 Ou_E m^{-3} at the 98^{th} percentile of hourly averages over a meteorological year.
- All sensitive locations should be located outside the 3.0 Ou_E m^{-3} at the 99.5^{th} percentile of hourly averages over a meteorological year.

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These proposed odour impact criterion is sufficiently conservative to provide protection to the community at large taking into account latest suggested odour impact criterion by environmental agencies in Ireland, UK and Netherlands. In the case of Panda Waste Dry Fermentation and Composting facility, all odour sources capable of generating offensive odours will be enclosed inside the main building, sealed and negatively ventilated to an odour control system. All odour sources will be enclosed, sealed and abated with an odour treatment unit. The 99.5^{th} percentile of hourly averages is used to complement the 98^{th} percentile of hourly averages to take account of predicted downwind odour concentrations during short time worst-case meteorological conditions thereby providing added protection to the public at large.

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5.3 Odour dispersion modelling results for Scenarios 1 and 2.

AERMOD Prime (USEPA ver. 07026) was used to determine the overall odour impact of the proposed Panda Waste Dry Fermentation and RDF Facility design.

Impacts from emission points are assessed in accordance with the impact criterion contained in *Section 5.1 and 5.2*.

Two distinct scenarios were assessed:

The output data was analysed to calculate the following:

Ref Scenario 1:

- Predicted odour emission contribution of overall proposed dry fermentation and RDF facility design operation to surrounding population (*see Tables 4.2 and 4.3*), to odour plume dispersal at the 98^{th} percentile for a ground level concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.2*).

Ref: Scenario 2:

- Predicted odour emission contribution of overall proposed dry fermentation and RDF facility design operation to surrounding population (*see Tables 4.2 and 4.3*), to odour plume dispersal at the 99.5^{th} percentile for a ground level concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.3*).

All dispersion-modelling computations give the odour concentration at each 50-meter x y Cartesian grid receptor location that is predicted to be exceeded for 2% (175 hours) and 0.50% (44 hours) of hourly sequential meteorological data over seven years.

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This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while either the facility is in operation. It will also allow the operators of the facility to assess the effectiveness of their suggested odour abatement/minimisation strategies. The intensity of the odour from the two or more sources of the facility operation within the Recycling facility will depend on the strength of the initial odour threshold concentration from the sources and the distance downwind at which the prediction and/or measurement is being made. Where the odour emission plumes from a number of sources combine downwind, then the predicted odour concentrations may be higher than that resulting from an individual emission source. It is important to note that various odour sources have different odour characters. This is important when assessing those odour sources to minimise and/or abate. Although an odour source may have a high odour emission rate, the corresponding odour intensity (strength) may be low and therefore is easily diluted.

5.4 Meteorological data

Dublin airport meteorological station Year 2000 to 2006 inclusive was used for input to Aermod Prime. This allowed for the determination of overall odour impact from the proposed facility design on the surrounding population over the 7 years. The analysis of 7 years of meteorological data is preferred over a single year as it provides more statistical significant estimates of predicted ground level concentrations. In addition, it is recommended in many regulatory documents (UK and Irish EPA) that at least 3 to 5 years be assessed continuously. In some cases, some dispersion-modelling consultants will examine each individual year and then present the data from the worst-case year. This is not the correct methodology, as all years should be assessed together so that the worst-case ground level concentrations over the 7 years are predicted.

The wind rose plot and statistical aspects of the meteorological file are contained in *Section 9*.

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6. Discussion of results from dispersion modelling study

This section provides discussion on the results obtained during the study.

6.1 Predicted odour impact assessment of proposed Panda Waste Dry Fermentation and Composting Facility (ref: Scenario 1 and 2)

The plotted odour concentrations of ≤ 1.50 Ou_E m^{-3} for the 98th and ≤ 3.0 Ou_E m^{-3} for the 99.5th percentile for the proposed Panda Waste Dry Fermentation and RDF Facility operation is illustrated in *Figure 8.2 and Figure 8.3,* respectively.

As can be observed in *Figure 8.2*, it is predicted that odour plume spread is in a westerly direction of approximately 20 metres from the boundary of the facility with no sensitive receptors impacted by the plume. All resident locations in the vicinity of the proposed facility operations will perceive an odour concentration less than 1.50 Ou_E/m^3 at the 98th percentile of hourly averages for 7 years of hourly sequential meteorological data. In accordance with odour impact criterion in *Sections 5.1 and 5.2*, and in keeping with currently recommended odour impact criterion in this country, no long-term odour impacts will be generated by receptors in the vicinity of the proposed facility operations.

Figure 8.3 illustrates that residential receptors located in the vicinity of the facility will experience an odour threshold concentration of less than 3.0 Ou_E/m^3 at the 99.5th percentile of hourly averages for 7 years of hourly sequential meteorological data. In accordance with odour impact criterion in *Sections 5.1 and 5.2* and in keeping with currently recommended odour impact criterion in this country, no short-term odour impacts will be generated by receptors in the vicinity of the proposed facility operations.

It is therefore concluded that following the implementation of key odour minimisation, mitigation and management techniques, that all residential and business receptors in the vicinity of the proposed facility will not experience nuisance odours with all receptors perceiving an odour concentration less than 1.50 and 3.0 Ou_E/m^3 for the 98th and 99.5th percentile of hourly averages for 7 years of hourly sequential meteorological data.

The implementation of an odour management system and plan for the operating site will ensure that this is maintained throughout the life of the facility.

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7. General conclusions

The following general conclusions were drawn from the study:

1. This document provides the structure and methodologies for the development of an overall odour management, minimisation and mitigation procedure for the relevant operating entities at the Panda Waste Dry fermentation and Refuse derived fuel facility.

2. The overall proposed odour mitigation techniques are based on sound engineering principles and proven design. All such technologies are in operation for the management of odours at many facilities throughout the world (references included with documentation). The overall incorporation of robust preventative maintenance procedures, containment measures, focused extraction, zoned ventilation, SCADA control, monitoring, trending and data-logging and multiple stages of treatment will ensure that odours will not cause impact on the surrounding area and that the odour control systems (biotrickling filter and Regenerative thermal oxidiser) will operate at optimal capacity.

3. The Dry fermentation and RDF facility design will ensure that all ground level concentration of odours at the nearest sensitive receptors will be less than 1.50 and 3.0 Ou_E/m^3 at the 98^{th} and 99.5^{th} percentile of hourly averages for seven years of hourly sequential meteorological data in the vicinity of the facility. The implementation of odour management, minimisation and mitigation techniques and technologies outlined in the overall facilities operation will achieve the specified odour impact criterion to prevent nuisance odours at nearest residential and business neighbours (*see Figures 8.2 and 8.3*).

4. This overall document provides a strategy and engineering design for the implementation of odour minimisation, mitigation and control of odour emissions from the facility operations and provides the backbone development of an odour management and preventative maintenance plan for the processes. The guaranteed emission rates of odours from the overall facility operations will provide compliance with the odour impact criterion contained in *Section 5* of this document.

5. The implementation of key odour minimisation, mitigation and management techniques, that all residential and business receptors in the vicinity of the proposed facility will not experience nuisance odours with all receptors perceiving an odour concentration less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages for 7 years of hourly sequential meteorological data. The implementation of an odour management system and plan for the operating site will ensure that this is maintained throughout the life of the facility.

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8. Odour contour plots from dispersion modelling assessment using AERMOD Prime dispersion modelling software and 7 years of meteorological data for Panda Waste Dry Fermentation and RDF facility operation - Location layout map

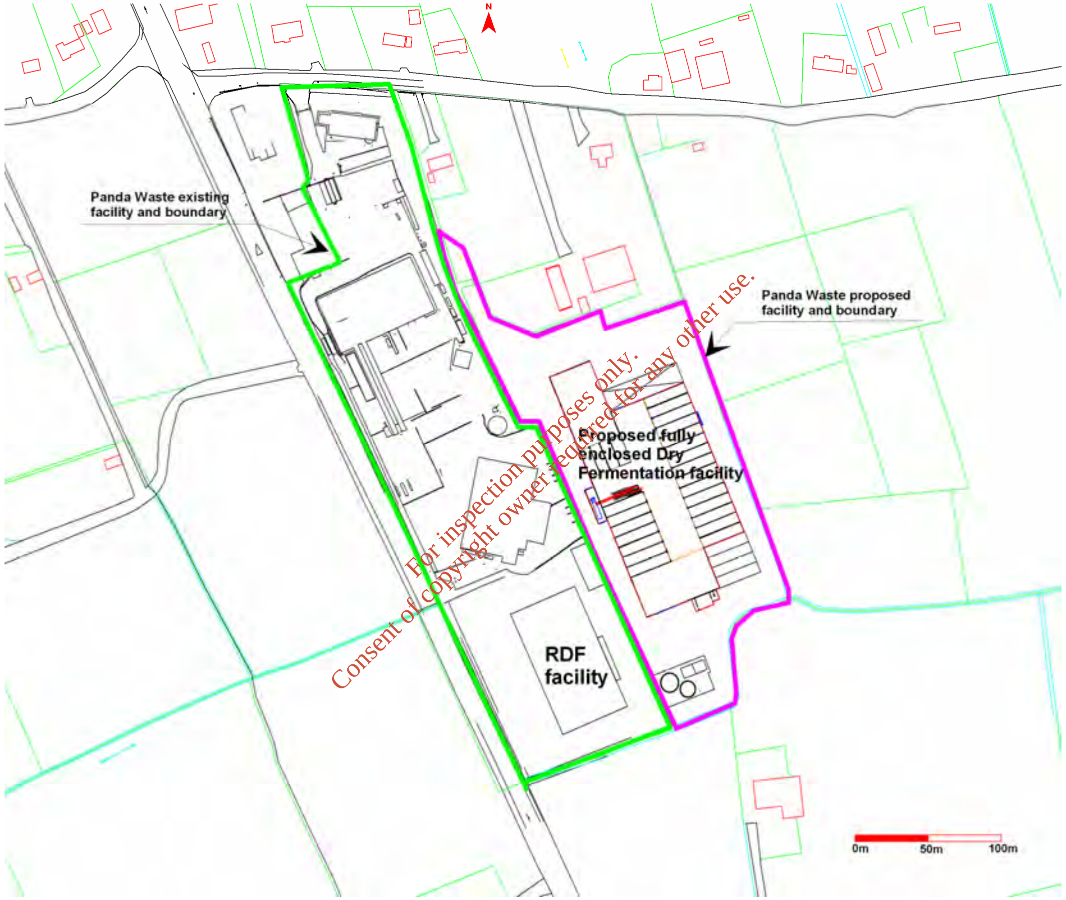

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Figure 8.1. Aerial diagram of proposed Panda Waste Dry Fermentation and RDF Facility design and proposed boundary ( )

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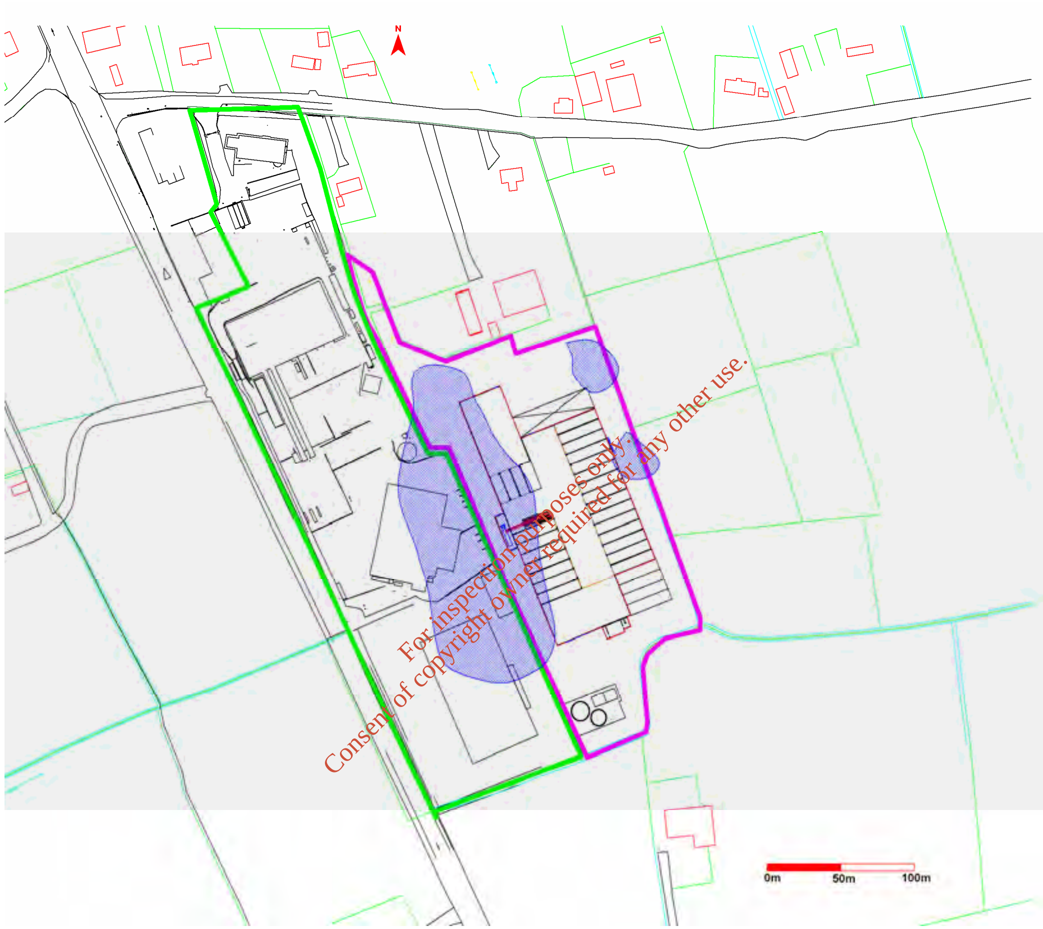

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Figure 8.2. Predicted odour emission contribution of proposed overall Panda Waste Dry Fermentation and RDF Facility operation to odour plume dispersal for the 98th percentile for an odour concentration of $\leq 1.50\ Ou_E\ m^{-3}$ (——) for 7 years of hourly sequential meteorological data from Dublin Airport (2000 to 2006 inclusive).

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Figure 8.3. Predicted odour emission contribution of proposed overall Panda Waste Dry Fermentation and RDF Facility operation to odour plume dispersal for the 99.5th percentile for an odour concentration of $\leq$ 3.0 Ou_E m^{-3} (▬) for 7 years of hourly sequential meteorological data from Dublin Airport (2000 to 2006 inclusive).

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9. Meteorological data examined and used in the dispersion modelling exercise

Table 9.1. Tabular illustration of Dublin Airport meteorological files for Years 2000 to 2006 inclusive (7 years).

5 year Meteorological file for Dublin Airport 2000 to 2006 inclusive							
Dir \ Speed	**<= 1.54 m/s**	**<= 3.09 m/s**	**<= 5.14 m/s**	**<= 8.23 m/s**	**<= 10.80 m/s**	**> 10.80 m/s**	**Total**
0.0	0.64	0.48	0.93	0.45	0.06	0.00	**2.56**
22.5	0.14	0.48	1.06	0.54	0.16	0.00	**2.38**
45.0	0.11	0.32	1.31	0.74	0.22	0.01	**2.71**
67.5	0.08	0.24	1.56	0.90	0.37	0.03	**3.17**
90.0	0.13	0.41	2.18	0.92	0.30	0.07	**3.99**
112.5	0.16	0.66	2.54	0.76	0.16	0.04	**4.30**
135.0	0.21	0.76	4.18	2.81	0.79	0.15	**8.90**
157.5	0.21	0.72	2.53	1.71	0.60	0.09	**5.86**
180.0	0.20	0.45	1.33	0.77	0.33	0.05	**3.12**
202.5	0.17	0.40	2.25	2.20	1.02	0.25	**6.30**
225.0	0.17	0.60	4.21	4.55	2.31	0.67	**12.51**
247.5	0.18	0.59	4.76	5.24	2.91	0.96	**14.63**
270.0	0.18	0.62	4.96	4.26	2.15	0.70	**12.86**
292.5	0.17	0.67	4.10	2.22	0.72	0.15	**8.03**
315.0	0.24	0.50	2.73	1.31	0.27	0.04	**5.10**
337.5	0.22	0.34	1.48	0.77	0.14	0.04	**2.98**
Total	**3.19**	**8.25**	**42.10**	**30.15**	**12.47**	**3.25**	**99.42**
Calms	**-**	**-**	**-**	**-**	**-**	**-**	**0.50**
Missing	**-**	**-**	**-**	**-**	**-**	**-**	**0.08**
Total	**-**	**-**	**-**	**-**	**-**	**-**	**100.00**

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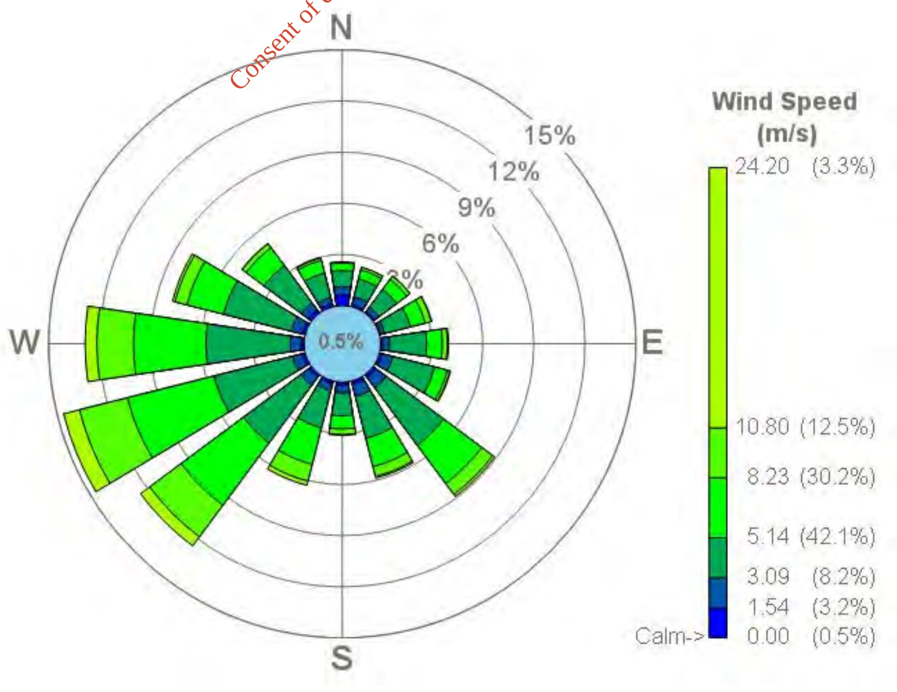

Figure 9.1. Windrose illustration of meteorological files Dublin Airport 2000 to 2006 inclusive.

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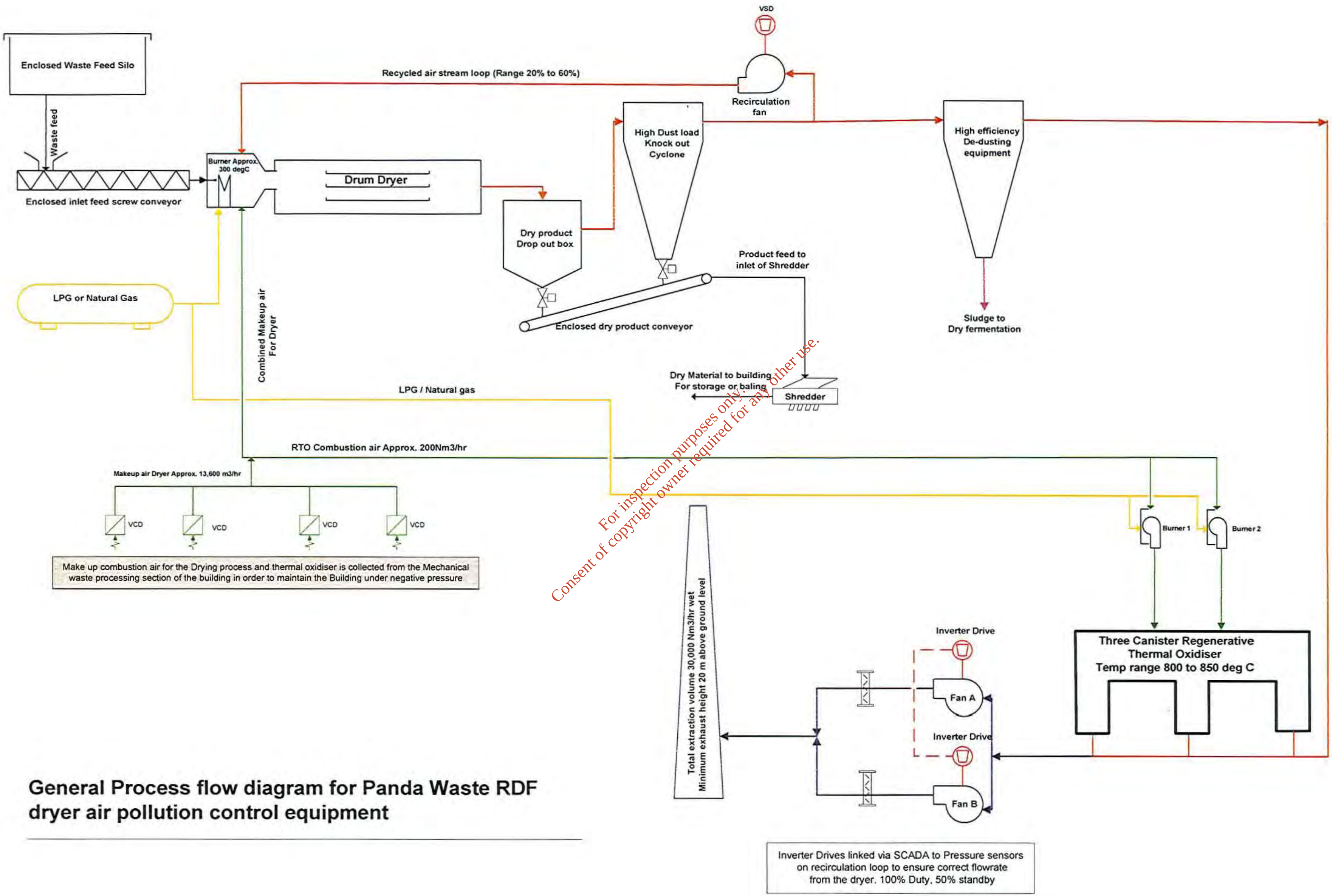

General Process flow diagram for Panda Waste RDF dryer air pollution control equipment

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APPENDIX 4

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Annual Environmental Report

01st January 2008 – 31st December 2008

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1.0 Introduction

Panda were granted their second EPA Waste Licence W0140-2 on the 1st April 2005. This precedes the old Licence 140-1. Under this licence Panda will be able to process 165,000 tonnes per annum and operate two in vessel composting units, a new C&D waste recovery building and a civic amenity facility as well as the operations allowed under the old Licence 140-1. Appendix A illustrates the current site layout.

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1.1 Company details

Licence No:	W0140-2
Name:	Nurendale Limited t/a Panda
Address:	Rathdrinagh Beauparc Co. Meath
Telephone Number:	1850 65 65 65
Fax Number:	046 9024189
Website:	www.panda.ie

1.2 Management Structure

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Eamon Waters is the Managing Director of Panda and Brian McCabe is the General Manager. David Naughton is the Environmental Manager. There are 140 employees either working directly or indirectly at the facility. Appendix B illustrates the organisational structure of the facility.

1.3 Financial Provision

A statement from our accountants is provided in Appendix C. At the present time the annual turnover and company assets are sufficient to offset environmental liabilities incurred during the course of operations and in the event that the company is closed.

1.4 Environmental Policy

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In carrying out our function, Panda acknowledge that our activities impact upon the environment both through routine internal operations and the actions of our staff.
It is Panda's policy to protect the environment during all activities, both on and off-site.

This is achieved by:

- Strategic preparation and implementation of operating procedures (including an emergency response procedure).
- Utilizing BAT (Best Available Technology).
- Actively promoting environmental awareness amongst staff and clients through appropriate training and communication programs.
- Reduce energy use through effective education and awareness and the installation of energy efficient technology where appropriate.
- Implementing a policy of continuous improvement, by means of targeted objectives. All objectives and targets are monitored and up-dated accordingly.

Panda are committed to complying with all relevant environmental regulations and aim to supply a safe competitive and sustainable service with specific regards to the surrounding environment.

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1.5 Activities

Under the waste licence W0140-2, Panda conducts the following activities:

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts, 1996 to 2003

Class 11.

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Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 12.

Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 13.

Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts, 1996 to 2003

Class 2.

Recycling or reclamation of organic substances, which are not used as solvents (including composting and other biological transformation processes).

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Class 3.

Recycling or reclamation of metals and metal compounds.

Class 4.

Recycling or reclamation of other inorganic materials.

Class 11.

Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.

Class 13.

Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.

The company provides a waste collection service for the domestic, commercial and industrial sectors throughout Ireland and was awarded the "Large Operator of the Year award 2007" and "Runner up" in 2008 from Repak. The facility operates 8am-6.30pm

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(Monday-Friday) & 9am-2pm (Saturdays). The facility is licensed to accept non-hazardous wastes only and to operate a civic amenity facility.

1.6 Waste Activities carried out at the Facility

Panda operate two different sheds for processing the different waste streams. The bottom shed (2) in the yard is used to segregate the C&D waste entering the site using a shredder, trommel, wind blower, magnet, ballistic separator and a picking line to recover ferrous and non ferrous metals, rubble, timber and inorganic fines. The residuals are sent to landfill. Shovels are used to load the shredder, and a grab is used to pick out large pieces of steel etc and load the waste sent to Landfill.

In the top shed (1) all domestic, commercial and industrial collections of mixed municipal waste and dry recyclables are tipped in their respective sections. Cardboard and plastic is recovered which is already segregated at source, whilst the mixed municipal waste is sent to Landfill or mechanically treated waste is treated in the in-vessel composting system. A shredder, magnet and trommel used for separating the organic fraction. Shovels are used to load the articulated trailers going to landfill and load the in-vessel composting system.

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Panda invested in a rock crusher to further process the C&D rubble to suitable size material for use as builders fill.

Panda invested in a flip-flop unit to further process the C&D trommelled fines. This system removes stones, wood, metal and residual material from the fines. This material is then sent as landfill cover. Panda are actively researching methods to further clean the stone and separating the wood from the residual material.

Panda process wood on-site using a shredder and a grab to load the material. The shredded timber is then sent to various outlets for different uses such as the manufacturing of chipboard.

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The dual weighbridge was fully completed and operational in October 2006. The second weighbridge was retained as back up for the dual weighbridge.

1.7 Water Usage:

Water is extracted from 2 wells on site and stored in a water storage tank. Water for office and amenities use is taken from public supply and is metered by the council. All other water use on site is taken from the water storage tank.

Water usage on site consists of:

- In-house road sweeper.
- Dust suppression sprayers at doorways into shed one and on the eastern boundary fence between the back-up weighbridge and the retail outlet to the north.
- 2 atomiser units in shed one.
- Dust suppression sprayers in shed 2.
- Dust suppression sprayers at C&D fines extraction point from trammel.
- Hoses on site for dust suppression.
- Sprinkler system on biofilter and in-vessel compost tunnels.
- Truck wash.

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2.0 Summary Information

2.1 Waste Received

The waste received at the facility for 2008 was 203,443.85 tonnes. From the pie chart (Fig 1) it is evident that waste from a Waste Transfer Station is the largest source of Panda's waste collection.

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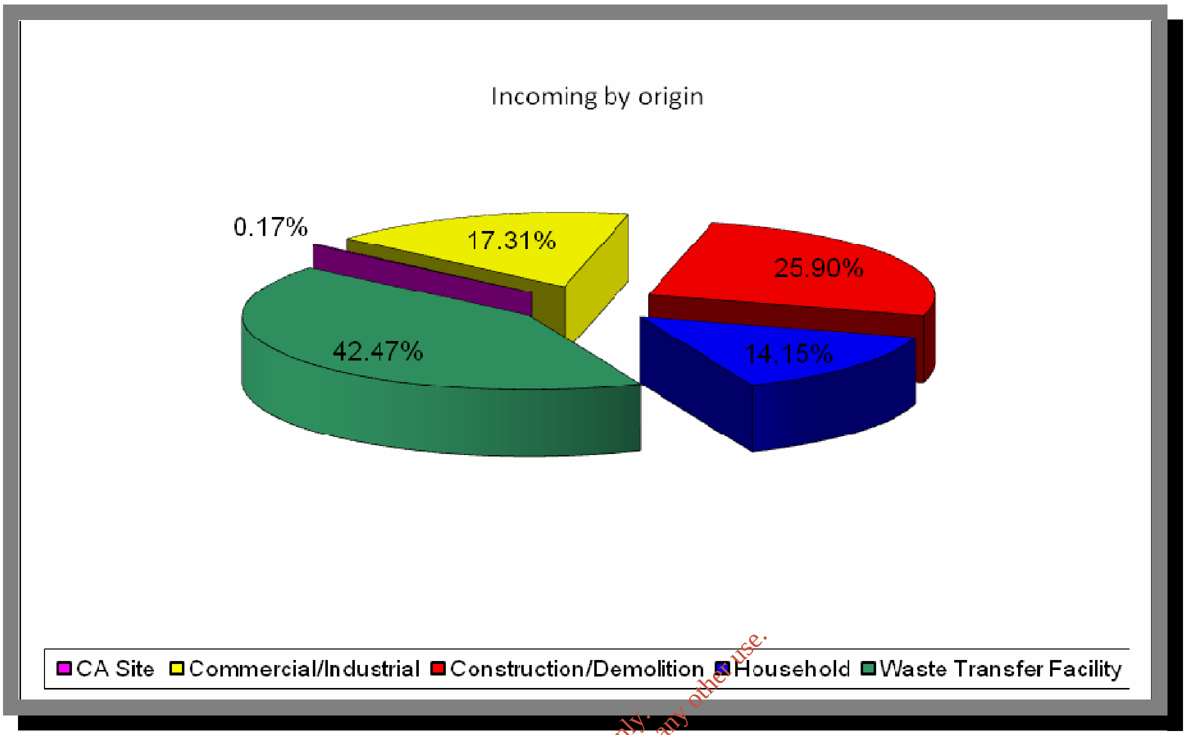

Fig. 1: Waste Collected by Panda Waste by Customer profile

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2.2 Waste Transferred Off-Site for Disposal or Recovery

See Appendix D for the breakdown of the different destinations used for the waste accepted at the facility and of waste removed off site by EWC Code. The installation of the in-vessel composting tunnels reduces the weight of the organic material by 30% therefore decreasing the weight of the organic material sent to landfill as is required under the Landfill Directive.

2.3 Waste Recovery Reports

To contribute to the Landfill Directive Panda have invested in a shredder, trommel, magnet and an in-vessel composting system. All municipal waste will be put through the shredder and trommel and the organic fraction of the waste will then be put through the dynamic in–vessel composting system. The material taken from the tunnels is then sent as sub-cover to landfill.

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Other materials recovered from these processes are ferrous metals collected by the magnet. The residuals are sent to landfill. Panda are actively researching the RDF market for the residuals.

To reduce the amount of recyclable material sent to landfill, Panda have received planning permission to build a third shed for the purposes of recovering dry recyclables. This would make shed (1) only available to municipal waste. Plastic, paper, cardboard, aluminium cans, steel cans would be baled in this third shed and sent for further processing. This will enable Panda to increase its efforts in encouraging customers to recycle either in the kerbside collection or commercial collections of materials such as paper, cardboard and plastic. The sales team will drive this process by educating the customer base of the materials that can be recovered.

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Panda invested in a C&D shed in 2005. A shredder, trommel, magnet, wind shifter and a picking line were purchased so as to divert as much C&D waste away from landfill as possible to reach the "Changing Our Ways 1998" target of diverting 85% away from Landfill by 2013. To date the processing of C&D Waste has been extremely successful. Panda are using the rubble segregated at the facility as a raw material in the use of landfill road construction and as back fill on construction works. The timber that is segregated in the shed is then shredded and reused.

Table 1 and Fig 2 details the recovery rates of waste leaving Panda's facility.

Table 1. Outgoing destination and recovery rate.

Destination	Tonnes	%
Recovered	151,774.40	75.17
Disposed	50,144.72	24.83
Trade Effluent	1,905.23	0.93

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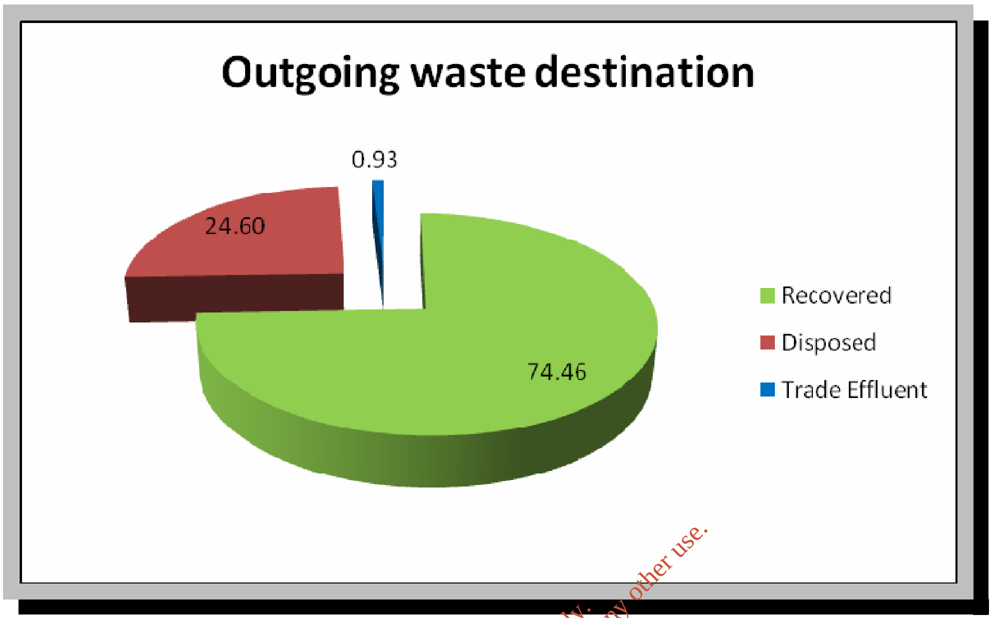
Fig 2. Outgoing destination recovery rate.



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2.4 Summary report on emissions and interpretation of environmental monitoring

Under Schedule C of the licence W0140-2 Panda monitor emissions from surface water and interceptor SW-1, compost, trade effluent from the composting process, noise and ambient air monitoring. The following sub-headings detail the results from independent laboratories of the different parameters and the emission limit values ELV's set by the EPA and any incident that may have occurred during the year.

2.4.1 Surface Water

Surface Water passes through a silt trap and oil interceptor prior to being discharged into holding tanks, which run beside the southern boundary of the facility. The surface water monitoring point was relocated to co-ordinates X/E 297456.080 Y/N 269143.030 as the stream running along the southern boundary was piped as notified to the agency.

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Panda propose to install a wetland system for surface water drainage as set out in the Environmental Targets and Objectives and received planning permission for its construction. A review of our waste licence was submitted to the Agency.

2.4.2 Dust Emissions

As per schedule B4 for dust deposition limits, there are three sampling locations as shown on drawing No. 2.2.1 of Licence Application Register No. 140-2. There is a fourth sampling site, D4, as required by Condition 6.13.3, as may be amended under Condition 6.16.

As per condition 6.13.1, all waste for disposal, stored overnight at the facility was placed in suitably covered and enclosed containers within the waste transfer buildings and were removed within 48 hours or 72 hours on a bank holiday weekend. In dry weather, the site roads and any other areas used by vehicles were sprayed with water. A dust suppression unit was installed in Shed (2) to ensure dust emissions from the bottom shed are kept to a minimum. Figs 3-6 illustrate dust recordings for 2008.

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Fig 3: Dust emission results for DS1

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Fig 4: Dust emission results for DS2

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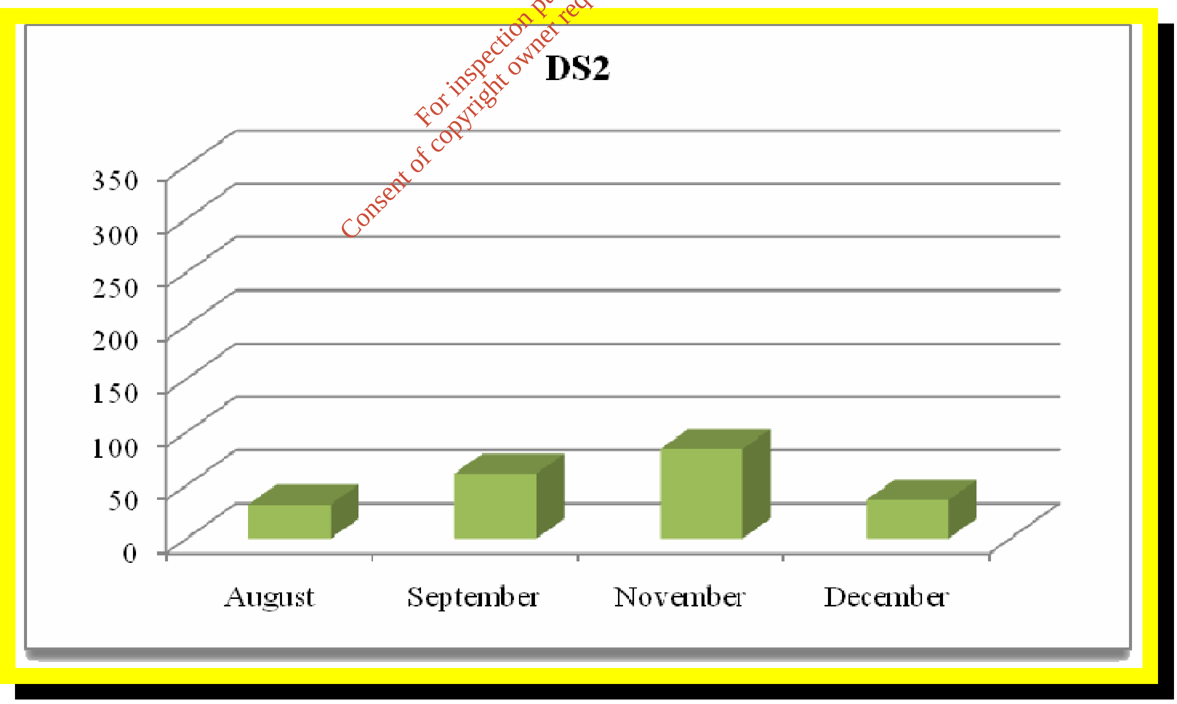

Fig 5: Dust emission results for DS3

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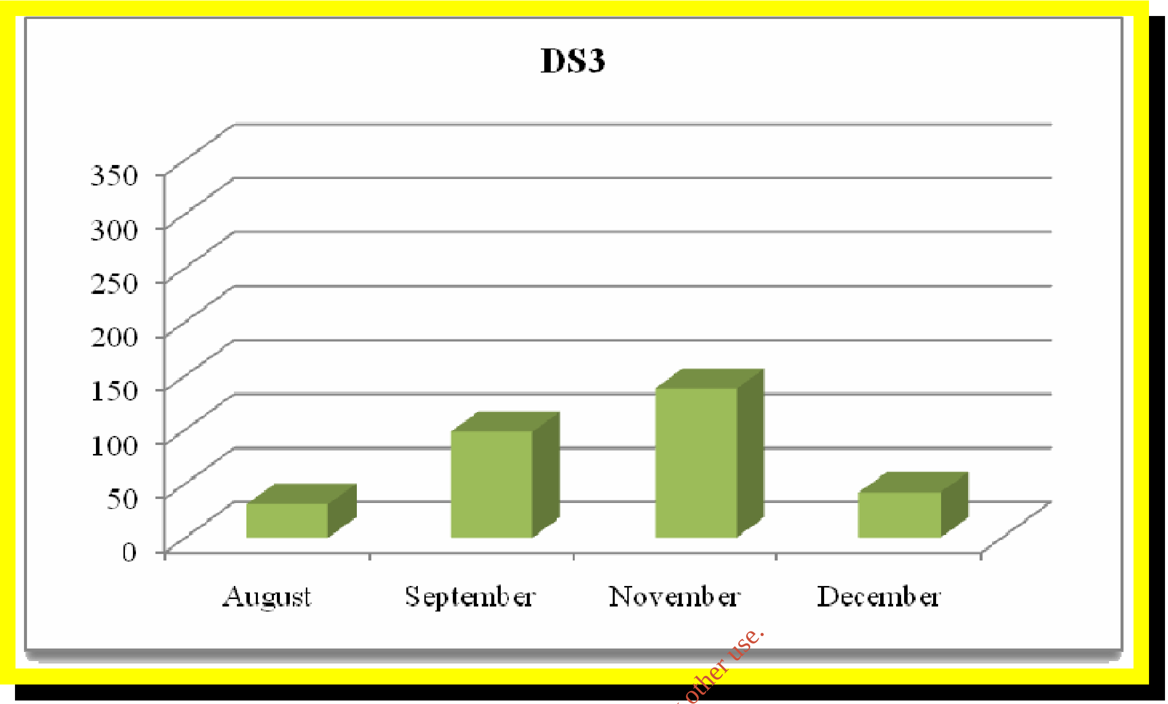
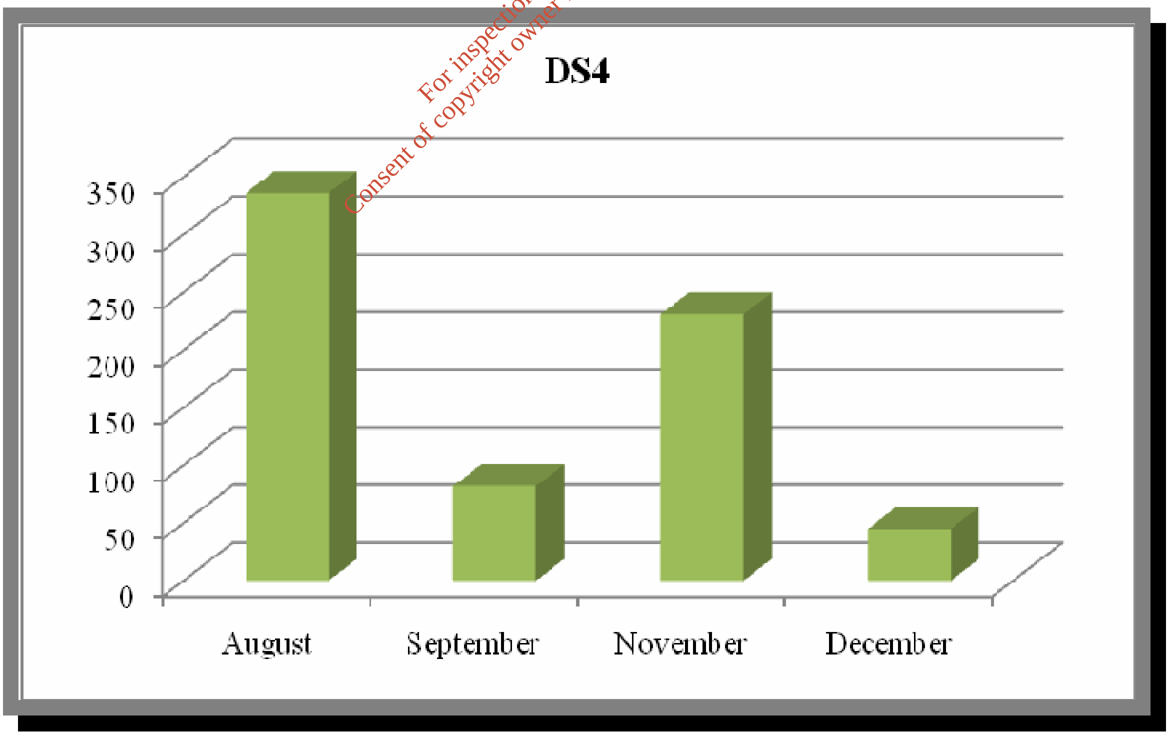


Fig 6: Dust emission results for DS4



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As per Schedule B.4, the dust deposition limit for the site is 350 mg m^{-2} d^{-1}. In 2008, dust deposition limits were not exceeded.

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2.4.3 Noise Emissions

Noise emissions are monitored according to Schedule B.3 and the emission limit values (ELV) set out in Schedule C5 of the licence. An independent competent person was used to conduct the noise sampling throughout the year. A summary of the recorded noise levels for this reporting period is provided in Tables 2-5.

Table 2: Recorded Noise Levels dB(A) on 19th March 2008– Intervals 30 minutes

Location	Time	Leq	L10	L90	Comments
N1	16.4	50.8	51.2	47.9	N2 road traffic and traffic entering Panda site – non Panda noise source
N2	16.45	50.2	51.3	48	N2 & slip road traffic. Panda waste inaudible at background of 48 dBA
N3	16.5	53.2	54.6	47.8	Slip road and N2 traffic
N4	17.2	61.2	62.3	59.2	Portable motor outside transfer house and trucks
N2 (B)	17.3	52.8	53.9	50.7	Operation inaudible, road traffic dominant from N2 and slip road
N3 (B)+	17.35	52.3	53.2	50.1	N2 road traffic and emission from Panda waste just inaudible at background level of 50.1 dBA

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Table 3: Recorded Noise Levels dB(A) on 17th May 2008– Intervals 30 minutes

Location	Time	Leq	L10	L90	Comments
N1	10.4	51.3	52	48.1	N2 road traffic and traffic entering Panda site – non Panda noise source
N2	10.5	49.6	50.2	47	N2 & slip road traffic. Panda waste inaudible at background of 47 dBA
N3	11.15	54.4	55.4	48.3	Slip road and N2 traffic
N4	11.25	60.5	61.8	58.7	Portable motor outside transfer house and trucks
N2 (B)	11.55	53.2	54.7	51.3	Operation inaudible, road traffic dominant from N2 and slip road
N3 (B)+	12.1	51.8	52.5	49.2	N2 road traffic and emission from Panda waste just inaudible at background level of 49.2 dBA

Table 4: Recorded Noise Levels dB(A) on 25th September 2008– Intervals 30 minutes

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Location	Time	Leq	L10	L90	Comments
N1	16.4	51.1	51.9	47.8	N2 road traffic and traffic entering Panda site – non Panda noise source
N2	16.55	49.6	50.7	47.4	N2 & slip road traffic. Panda waste inaudible at background of 47.4 dBA
N3	17.2	53.6	54.8	48.5	Slip road and N2 traffic
N4	17.3	61.6	62.5	59.8	Portable motor outside transfer house and trucks
N2 (B)	17.45	52.4	53.2	50.5	Operation inaudible, road traffic dominant from N2 and slip road
N3 (B)+	17.55	51.8	53.7	50.8	N2 road traffic and emission from Panda waste just inaudible at background level of 50.8 dBA

Table 5: Recorded Noise Levels dB(A) on 12th December 2008– Intervals 30 minutes

Location	Time	Leq	L10	L90	Comments
N1	15.3	56.3	58.4	49.8	N2 road traffic and traffic entering Panda site – non Panda noise source
N2	15.4	55.6	57.8	50.1	N2 & slip road traffic. Panda waste in-barely audible at background of 50.1 dBA
N3	16.3	56.1	57.2	50.8	Panda Waste and N2 traffic
N4	16.35	63	64.8	60.1	Portable motor outside transfer house and trucks
N2 (B)	16.45	56.8	58.6	50.7	Operation inaudible, road traffic dominant from N2 and slip road
N3 (B)+	16.55	55.1	56.2	50.4	N2 road traffic and emission from Panda waste just audible at background level of 50.4 dBA

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As can be seen from the tables above there was no incidents from the monitoring conducted.

2.4.4 Trade Effluent

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As part of the monitoring programme Panda must test the trade effluent sent off site for disposal. Table 6 shows the results for the trade effluent tested for 2008.

Table 6: Results for Trade effluent sent off site for disposal

Parameter	**Units**	**Result** 12/09/08	**Result** 16/12/08	**Result** 18/12/08	**Result** 22/12/08
Ammonia	mg/L as N	972.12	100.96	37.02	99.18
BOD	mg/L	4500	1150	1475	5700
Cadmium	ug/L	<0.09	0.2	<0.09	1.3
Calcium	mg/L	104.4	293.4	255	2706
Chloride	mg/L	417.3	194.4	20.98	1298.41
Cobalt	ug/L	8.7	3.9	4.1	35.4
COD	mg/L	4860	2275	2540	14550
Copper	ug/L	28	37.4	37	127.2
Iron (Total)	ug/L	2730	8546	10160	40660
Lead	ug/L	29.7	17.1	18.2	272.4
Magnesium	mg/L	13.24	29.12	32.85	289.2
Manganese	ug/L	124.3	1015	1098	6308
Mineral Oil	ug/L	784.21	69.26	285.86	196.99
Nickel	ug/L	78.7	36.8	35.7	410.8
pH	pH units	8.4	6.7	6.7	6.4
Solids (Total Suspended)	mg/L	437	171	183	1795
Sulphate	mg/L as SO_4	<1.39	39397.55	<1.39	72.49
Tin	ug/L	13.9	<2.8	<2.8	19.9

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2.4.5 Compost Analysis

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As part of the monitoring programme Panda must test Compost. Table 7 shows the results for the Compost tested for 2008.

Table 7 Results for Trade effluent sent off site for disposal

Test Parameter	Units	Result 12/09/2008	Result 18/12/2008
Moisture Content	%	51.16	43.36
Organic Matter	%	60.9	79.22
Iron (solid)	ug/Kg		3233060
Arsenic (solid)	ug/Kg	1089	
Boron (solid)	ug/Kg	11400	
Cadmium (solid)	ug/Kg	142	973.43
Calcium	mg/Kg		28108
Chloride	mg/Kg	2632.41	2764.75
Chromium	ug/Kg	15400	
Cobalt	ug/Kg		<1
Copper	ug/Kg	27480	54015
Faecal Coliforms	No/100ml	520	0
Foreign matter	%	33.97	25.52
Lead (solid)	ug/Kg	117500	115392
Magnesium (solid)	mg/Kg		1938
Manganese (solids)	ug/Kg		149473
Mercury	ug/Kg	13	
Nickel (solid)	ug/Kg	31890	17855
Selenium (solid)	ug/Kg	248	
Sulphate (solid)	mg/Kg as SO4	4338.96	3101.1
Tin (solid)	ug/Kg		18358
Total Coliforms	No/100ml	610	170
VOC (solid)	ug/Kg	2192.192	<1
Zinc	ug/Kg	105000	
Semi VOC (Solid)	mg/Kg		<1

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2.4.6 Biofilter Monitoring

Panda commissioned a consultant to conduct ambient air monitoring on site to test for Bacteria, Hydrogen Sulphide and *Aspergillus fumigatus*. The bed media of the biofilter and the air handling system were also tested as required under Condition C.1 of the licence.

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Round 1 Monitoring Results.

Table 8. Airflow rate, temperature and differential pressure measurement results from the biofiltration system.

Measurement Location	Air Velocity (m s^{-1})	Volumetric airflow rate (m^3 s^{-1})	Differential Pressure (Pa)	Temperature (Kelvin)
Duct 1	4.6	0.58	1428	303
Duct 2	6.9	0.87	1526	306
Total	-	**1.45**	-	-

Table 9. Inlet and outlet speciated VOC, Ammonia, Hydrogen sulphide and Mercaptans analysis.

Compound Identity	Inlet conc. (µg m^{-3})	Outlet conc. (µg m^{-3})	Notes
Mercaptans	228	78	66% RE of Mercaptans grouped in concentration
Ammonia	9,107	379	96% RE
Total VOC's	48,200	8,100	83% removal overall
Hydrogen sulphide	128	14	89% removal

Table 10. Ambient bioaerosol concentrations at monitoring locations DS1 and DS3.

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Sample location	Total Mesophilic bacteria (CFU/m^3)	Aspergillus fumigatus (CFU/m^3)
Sample location DS1 (Triplicate sampling)	211	64
Sample location DS3 (Triplicate sampling)	288	92

Table 11. Total viable bacteria count on biofilter bed medium.

Sample Id.	Bed Depth (metres)	Result (TVC/kg)
TVC1PWB0608	0.2	$1.80*10^3$ cfu/kg
TVC2PWC0608	0.6	$8.40*10^5$ cfu/kg

Table 12. pH and % Moisture Content.

Parameter	June 2008
Moisture Content (%)	31
pH	5.1

Round 2 Monitoring Results.

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Table 13. Airflow rate, temperature and differential pressure measurement results from the biofiltration system.

Measurement Location	Air Velocity ($m\ s^{-1}$)	Volumetric airflow rate ($m^3\ s^{-1}$)	Differential Pressure (Pa)	Temperature (Kelvin)
Duct 1	9.9	1.24	890	300
Duct 2	11.4	1.43	920	301
Total	-	**2.67**	-	-

Table 14. Inlet and outlet speciated VOC, Ammonia, Hydrogen sulphide and Mercaptans analysis.

Compound Identity	Inlet conc. ($\mu g\ m^{-3}$)	Outlet conc. ($\mu g\ m^{-3}$)	Notes
Mercaptans	312	112	64% RE of Mercaptans grouped in concentration
Ammonia	28,833	1,517	95% RE
Total VOC's	15,289	4,238	72% removal overall
Hydrogen sulphide	89	<4.5	95% removal

Table 15. pH and % Moisture Content.

Parameter	November 2008
Moisture Content (%)	42
pH	6.2

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2.4.7 Bund Integrity

The Bund Integrity Test was carried out in July 2006. It was determined that the capacity of the road diesel bund is adequate per the licence requirement. The capacity of the inadequately sized bund has now been increased and re-testing of the bund is scheduled for mid 2009.

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2.4.8 Summary of resource and energy consumption

A summary of the resource and energy consumption by Panda between Jan-Dec 2008 is provided in Table 8.

2.4.8.1 Electricity

Fig 7. Shows the electrical energy consumption for the period January 2008 – December 2008. It is clear to see that the energy consumption is higher in the winter months than the summer months.

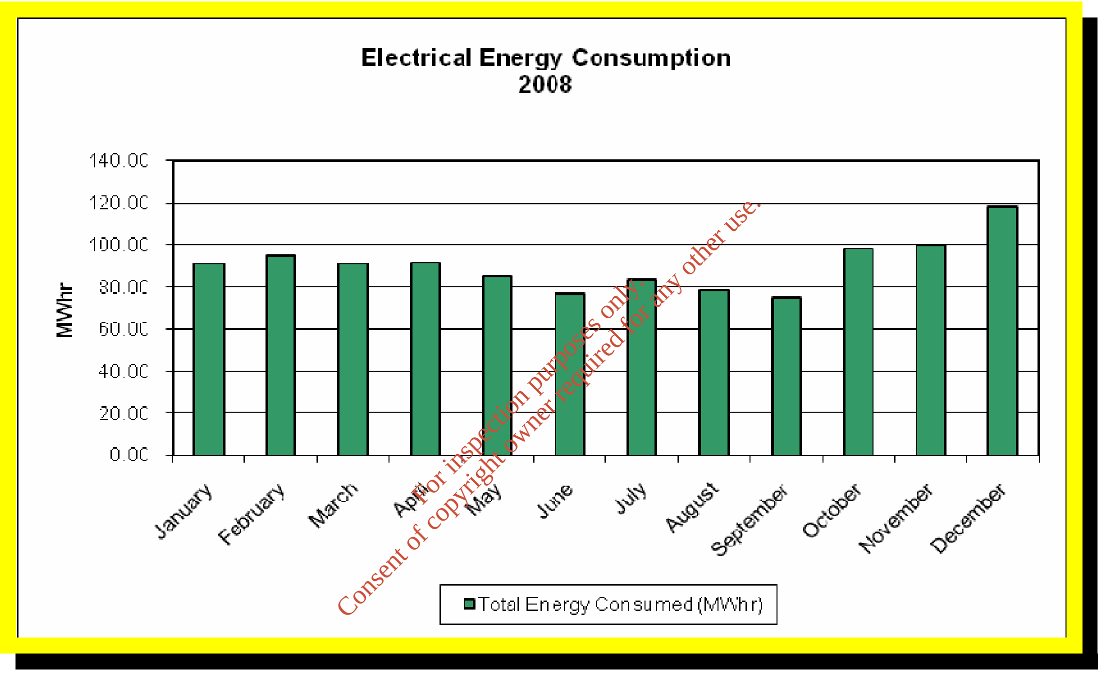

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Fig 7. Bar chart of electrical energy consumption for the year 2008

2.4.8.2 Fuel

Figs 8 and 9 illustrate bar charts of the fuel power consumption for 2008. It can be seen that the road fleet fuel energy consumption rises in the second half of the year.

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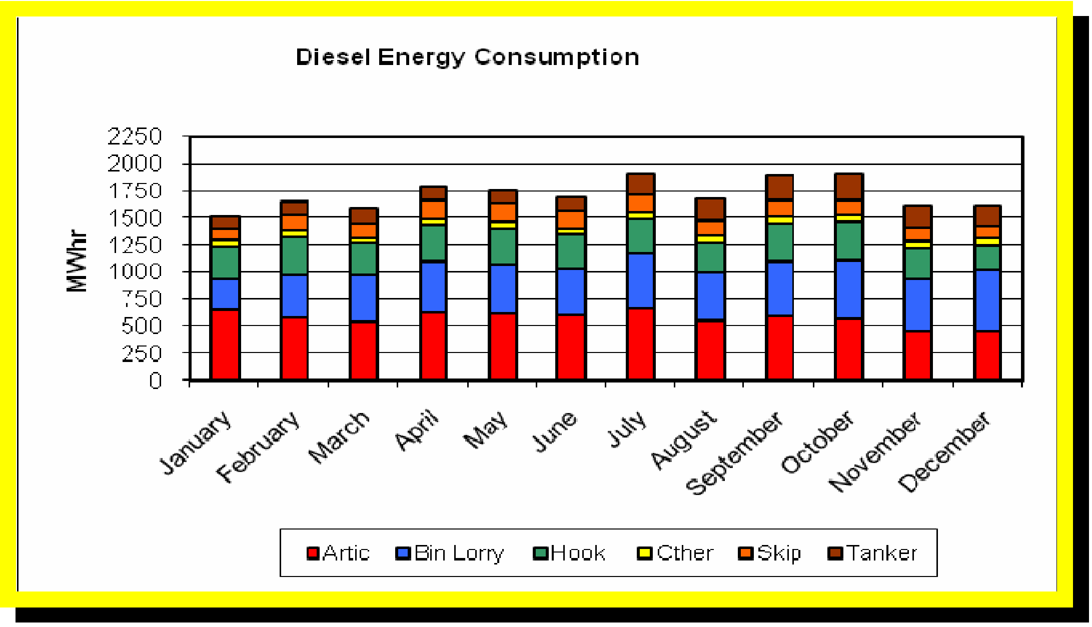

Fig 8. Bar Chart of Fuel Energy Consumption 2008.

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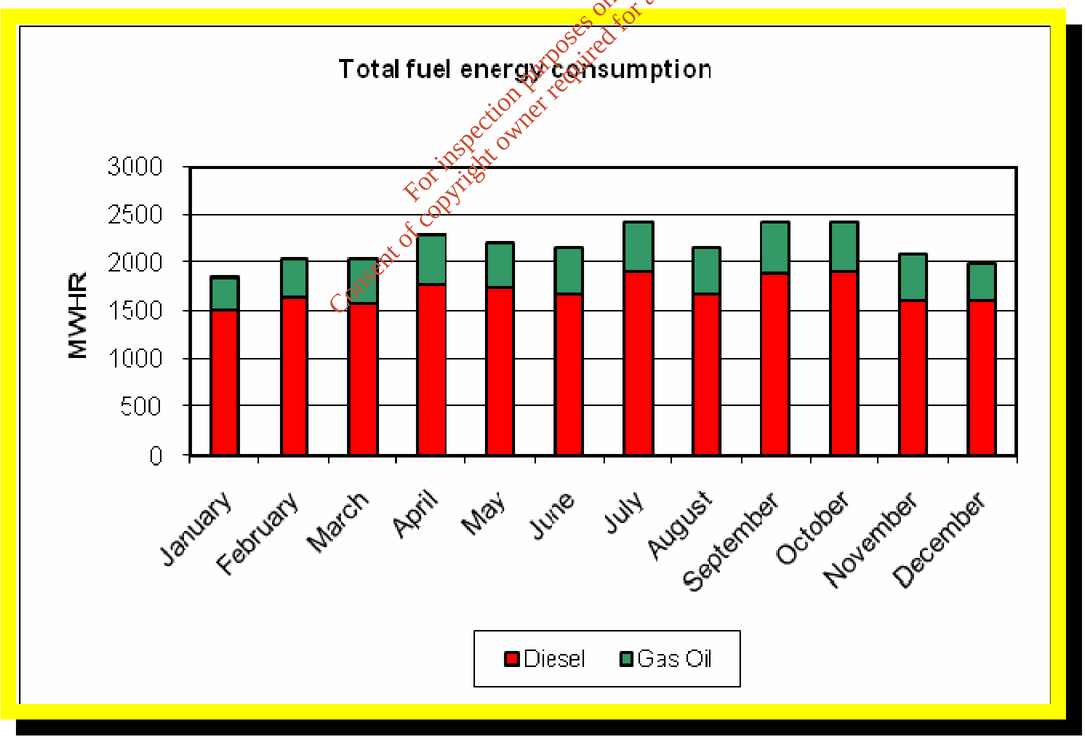

Fig 9. Bar Chart of Fuel Energy Consumption for 2008.

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2.4.8.3 Summary

The table and Fig. below shows a summary of the energy consumption, and tonnes of carbon dioxide produced.

	Consumption (MWhr)	%	tCO2
Electricity	1086.44	4.00	76.49
Diesel	20626.95	75.87	5156.74
Gas Oil	5475.26	20.14	1368.81
Total	**27188.64**		**6602.04**

Table 16. Summary of Energy Consumption 2008.

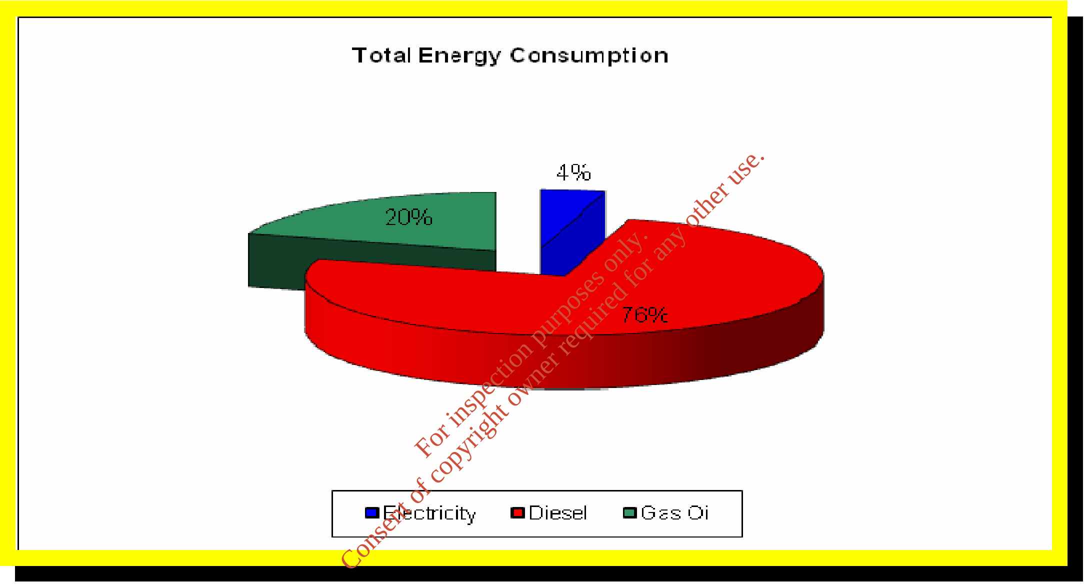

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Fig 10. Total Energy Consumption.

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2.5 Site infrastructure

Panda acquired land at the southern and Eastern boundary of the site so as to complete the surface water run off drainage on site and to add building three at the southern end of the facility.

2.5.1 In-place

The current site infrastructure is outlined below (List 1). Table 17 details the waste processing equipment used on site, together with the associated duty capacities

List 1: Current site infrastructure

1. Office block
2. Truck wash
3. 2 x Weighbridge and associated office.
4. 1 x Waste processing building (2800 m^2)
5. 1 x Waste processing building (2600 m^2)
6. 2 x Dust suppression system
7. 2 x In-vessel Composting Tunnels
8. Ancillary ESB building
9. Canteen & toilets and associated waste water treatment system.
10. Water reservoir (350 m^3) capacity
11. Fencing around the site
12. Tyre Bay

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Table 17: Waste processing equipment

Description	Duty Capacity
Shed 1	
1 x M&J 2000 Shredder	50 Tonnes per hour
1 x Trommel	50 Tonnes per hour
1 x Magnet	20 Tonnes per hour
2 x Composting Tunnels	60 Tonnes per day
Shed 2	
1 x M&J 4000 Shredder	100 Tonnes per hour
1 x Trommel	100 Tonnes per hour
1 x Magnet	20 Tonnes per hour
1 x Nihot	50 tonnes per hour
1 x Ballistic Separator	15 Tonnes per hour
Outside	
1 x Flip Flop	70 tonnes per hour
2 x Magnet	20 Tonnes per hour
1 x Wind Shifter	20 Tonnes per hour
1 x Rubble Crusher	50 Tonnes per day
1 x Flip Flop (Not in use)	50 tonnes per hour
1 x Single Drum Separator	40 tonnes per hour
1 x Baler (Not in use)	20 Tonnes per hour
Mobile	
3 x Volvo L120	1 x Kobelco Track
1 x Teleporter	2 x Hoists
1 x Volvo L60	2 x Forklift
1 x Fuchs Grab	1 x Shunter
1 x JCB Grab	1 x Scarab Roadsweeper
1 x Doppstadt Shredder	30 tonnes per hour

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There is sufficient back up if the shredder; a loading shovel or an excavator breaks down. The stone crusher is only used intermittently and therefore back up is not required. In the

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event that there is a major problem with the trommel or composting tunnels (i.e. if it can't be fixed within 48 hrs), unprocessed waste will be transferred to other approved waste processing facilities.

2.5.2 Planned Infra-structure

Proposed infrastructure is outlined in List 2. It is anticipated that the majority of the proposed infrastructure will be in-place by late 2009 or early 2010, with the bring centre being built at a later date.

List 2: Proposed infrastructure:

1. Wetland for surface water run off
2. Waste processing Shed 3, 4,320 m2.

2.6 Progress Report on Proposals Developed to Minimise Water Demand & Trade Effluent Discharge

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To minimise the water demand on site Panda are investigating collecting the rainwater from the roof and using this in the road sweeper to clean the yard. This would constitute a significant reduction in usage on site as the road sweeper is running ten hours per day.

2.7 PRTR Emission.

Panda's PRTR emission return is provided in Appendix E.

3.0 Environmental objectives and targets – 2009

Objective: Improve Surface Water Quality on site

Target: To recycle surface water run off and improve the quality of the discharge

PWS are proposing two large- scale development/ infrastructural projects for the current year. Both involve the development of the new land purchased in 2005. The first project is to construct the wetland to complete the surface drainage works on site as specified in an audit carried out by the Agency in September 2005. The wetland will also eliminate

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any heavy metals entering the stream. The installation of this technology should improve the surface water samples coming from the main yard.

Responsibilities: The project manager for this will be David Naughton who will be advised by specialists in the area of wetland systems. The Environmental Dept will measure the success of the project by sampling the parameters as set in Condition C.2.2

Objective: Build a third shed for Recyclable/compostable Materials

Target: To divert material from Landfill and increase the recycling rate of the Facility

Panda received planning permission in 2007 to construct a third shed on the purchased land at the southern part of the site. The shed will be used to recycle material such as paper, cardboard, aluminium, steel and plastic and to further process compost in material suitable for land reclamation. With the third shed it is hoped to recover more packaging waste and therefore achieve PWS targets on recycling packaging waste and therefore comply with government and EU targets. It would be hoped to have the shed in working order by the end of the year, however it will depend on the licence review process and the approval of the Agency. The architects and engineers will work closely with the Managing Director on this project.

Responsibilities: Eamon Waters will manage the construction issues along with the engineers contracted for the project. Eamon Waters, David Naughton and David Jervis will research the different technologies available to recycle the different waste streams. David Naughton will keep the EPA up to date with the developments.

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Objective: Upgrade the waste process activities in shed 2

Target: To re-arrange the equipment in shed 2 to include the wood shredder. This will mean that waste processing associated with shredder will be relocated to inside shed 2. By re-arranging the process and moving the shredder inside, Panda will be in compliance with condition 8.8 of our waste licence. The expected completion date will be towards the end of 2009.

Responsibilities: Mr David Jervis (Operations Manager) will be responsible for the re-organisation of the equipment. David Naughton (Environmental Manager) will aid David Jervis in supervising the project to ensure that all works will be carried out in accordance

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with PWS's waste licence and in accordance with the appropriate National and European legislation and protocols.

Objective: Reduce energy demand in the yard.

Target: To reduce the lighting in the yard when the site is not operational, therefore reducing energy consumption in the yard.

Responsibilities: The Environmental Manager in conjunction with the Electrical Consultant will ensure completion of the changeover with an anticipated completion date of mid April.

3.1 Completion of Environmental Targets & Objectives 2008

Panda will endeavour to complete the targets not already completed in 2008. The targets not met in 2008 were due to the delay in reviewing Panda the licence application lodged in May 2007, therefore delaying the construction of this large scale construction project. These targets should be completed by the end of the year (2009).

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3.2 Summary of reported incidents and complaints

3.2.1. Reported Incidents Summary

31st March 2008

There were non-compliances noted following an audit conducted by the Agency on 27th February 2008 (Audit report reference no. W0140-02/nc13ap.doc). A full non - compliance schedule was sent to the Agency on the 31st March 2008.

5th November 2008

A spill of Mixed Municipal Waste occurred between the facility and Knockharley Landfill heading North on the N2. Panda staff immediately cleaned up the spill. Upon completion of the investigation, it was found that the driver had not followed procedures in that he did not cover the load before leaving the facility. This was evident after reviewing CCTV footage. A report of the incident was sent to the Agency on the 5th November 2008.

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3.2.2 Complaints:

11th January 2008

The Agency informed Panda that there was an odour emanating from the facility that morning and on the 10th January 2008. The complaint was made by Ms Helen Kierans of Boyne Waste.

Actions taken: When Panda were informed of the complaint, David Naughton immediately conducted an investigation, wind direction recorded that day on the "Daily Odour & Biofilter Assessment" was noted and also the "Daily Inspections of Boundaries & Site" sheets were reviewed. The wind direction on the dates in question was verified with Met Eireann. The wind direction on those days in question was blowing in the opposite direction to that of Ms. Helen Kierans.

7th February 2008

The Agency informed Panda that there was an odour emanating from the facility all day on the 6th February 2008 and was particularly strong at 17.00. The complaint was made by Ms Helen Kierans of Boyne Waste.

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Actions Taken: Panda investigated the compliant. Panda refuted the complaint that there was an odour emanating from the facility all day. The odour at the site at 17.00 was found to be malodorous load of waste that entered the facility. This was tipped immediately in the MMW building where it was covered with c30cm woodchip as the landfill was closed. This load was sent to the landfill the following morning once the landfill reopened.

27th May 2008

The Agency notified Panda that they had received a complaint from Mr Gerry Lynch of dust coming from the facility on the 21st April 2008, 2nd May 2008 and the 25th May 2008. Mr. Lynch also complained of noise coming from the facility early in the morning. Mr. Lynch also complained of a foul odour emanating from the facility.

Actions Taken: Panda investigated the compliant and responded by refuting the compliant. Numerous reasons were given as to why the compliant was refuted as per letter to the Agency and Mr Lynch dated the 28th May 2008 reference No PWS-EPA-09-08.

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4th June 2008

The Agency notified Panda that they had received a complaint from Ms Helen Kierans of Boyne Waste regarding an odour emanating from the facility on the 3rd June 2008 at 17.15

Actions Taken: Panda investigated the complaint. The "Daily Inspections of Boundaries & Site" and the "Daily Odour & Biofilter Assessment" were inspected. It was noted that there was no odour recorded. All staff in Panda are instructed to report an odour issues to the Environmental Department. On this occasion no such report was made. Logistical staff was interviewed, to ascertain if there were the possibility of any malodorous loads entering the facility, no such instance occurred.

1st July 2008

The Agency notified Panda that they had received a complaint from Ms. Helen Kierans of Boyne Waste regarding a bad odour that day since 14.00 and Ms. Kierans also stated that the odour was very bad the previous day.

Actions Taken: Panda conducted an investigation into the cause for this complaint. After reviewing all monitoring records and from speaking with staff, no there was no evidence of odour emanating from the facility. The Agency recommended that the Environmental Manager visit the complainant's residence, which he did do. The complainant stated that she was concerned for the health of her kids. The Environmental Manager left his mobile number with the complainant and requested that Ms. Kierans contact the facility or the Environmental Manager in future as per the "See something, Say something" document published by the Agency in relation of how to make an environmental complaint.

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24th October 2008

The Agency notified Panda that they had received a complaint (name held with the inspector) regarding odours and litter from trucks en-route to our facility.

Actions Taken: The Operations Manager and weighbridge staff conducted the initial investigations for the week in question. CCTV footage was reviewed along with the checks on the nuisance monitoring sheets. As no vehicle registration was given and no evidence of such negligence was uncovered in the investigation, the contents of the complaint could not be verified. Upon return of the Environmental Manager from annual

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leave, the investigation was reviewed and the came outcome was reached. This complaint from the Agency was circulated to all drivers.

3.3 Review of nuisance controls

3.3.1 Odour

There are two rotary atomiser-fogging units at either end of building one, used to sort the mixed municipal waste. These spray odour suppression liquid. A sprinkling system is on each doorway into shed 1 and between the back-up weighbridge and commercial premise on the western boundary of the facility. This sprinkling system is connected to the odour suppression liquid.

The yard foreman is responsible for controlling the odour-suppressing units. This involves controlling the concentration of odour suppressant in order to provide adequate odour control. There is a power washer available to wash odorous bins. All drivers are responsible for washing their own compactors or skips. Each day, the environmental officer conducts an inspection of the site. A daily odour assessment of the biofilter is carried out and a record of this is filed in the environmental office.

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3.3.2 Noise

There were four noise survey's done 2008. Noise levels from operations at Panda were inaudible as background noise from the N2 and the slip road to the north of the facility was the dominant source of noise. In general, the noise emissions were in the main steady, with no tonal or impulsive noise from the works audible at any of the nearest locations.

3.3.3. Dust

A water tanker is available for controlling dust outside the waste transfer station. Dust analysis was carried out four times this year. Dust inside building one is dampened using the rotary atomiser fogging units. A dust suppression system was installed in shed (2) in 2005 and along the western boundary between the back-up weighbridge and the commercial premise in 2008.

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3.3.4. Vermin

A file on vermin control is maintained in the environmental office. A sub-contractor is used to control any vermin on site.

3.3.5. Flies

Good housekeeping practices are used to prevent fly infestations. The yard is kept clean using a road sweeper 10 hours a day and all waste for disposal is removed from the facility within 48 hours, or 72 hours in the case of a bank holiday weekends.

3.3.6. Birds

In order to avoid having birds as a nuisance, litter control is practised at all times and no waste is stored outside.

3.3.7. Litter

A designated member of staff carries out litter inspections of the facility three times a day.

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4.0 Development of Procedures on Site

The Emergency Response Procedure (ERP) has been implemented to reflect the changes of the company and update useful contact telephone numbers. Both Health and Safety and the Environment are covered under the ERP.

There was a revision of the odour-monitoring sheet to include a map of the facility to make it easier to position possible nuisances on the facility. General weather conditions and wind direction are obtained through Met Eireann on a daily basis.

Recycling certificates are issued to customers, on request, so that they can determine their recycling on a monthly basis. There is one for C&D Recycling and one for Packaging Waste.

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5.0 Pollution Emission Register

After consulting the PERL list Panda are not using any substance that is listed at present.

6.0 Report on Programme for Public Information

Panda have commissioned a web designer to update the company's website. One of the features is a page dedicated to the environment where facility licences and permits including (W0140-2), the waste collection permits, Environmental Policy and Health and Safety Statement can be downloaded. There will also be a calendar available for the kerbside collections. Over the Christmas period 2008 Panda put advertisements in all the local newspapers to inform customers of the schedule of bin collections over the Christmas Period. Panda also issued all domestic customers with a Christmas calendar showing collection days over that period. If there were any change to a domestic run or route, this would also be advertised in the local media.

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Advertisements are taken out regularly in the local newspapers informing customers of the services that Panda offer. There is also a large advertisement in the golden pages, which is available to the general public. Regular tours of the site are given to schools and to anybody whom requests one.

During the reporting period there were no requests from members of the public to inspect any Environmental Records.

The information in the Annual Environmental Report is true and accurate representation of the activities conducted by Panda in 2008

Signed: ________________   Date: ______________

David Naughton

Environmental Manager

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Appendix A

Site Layout

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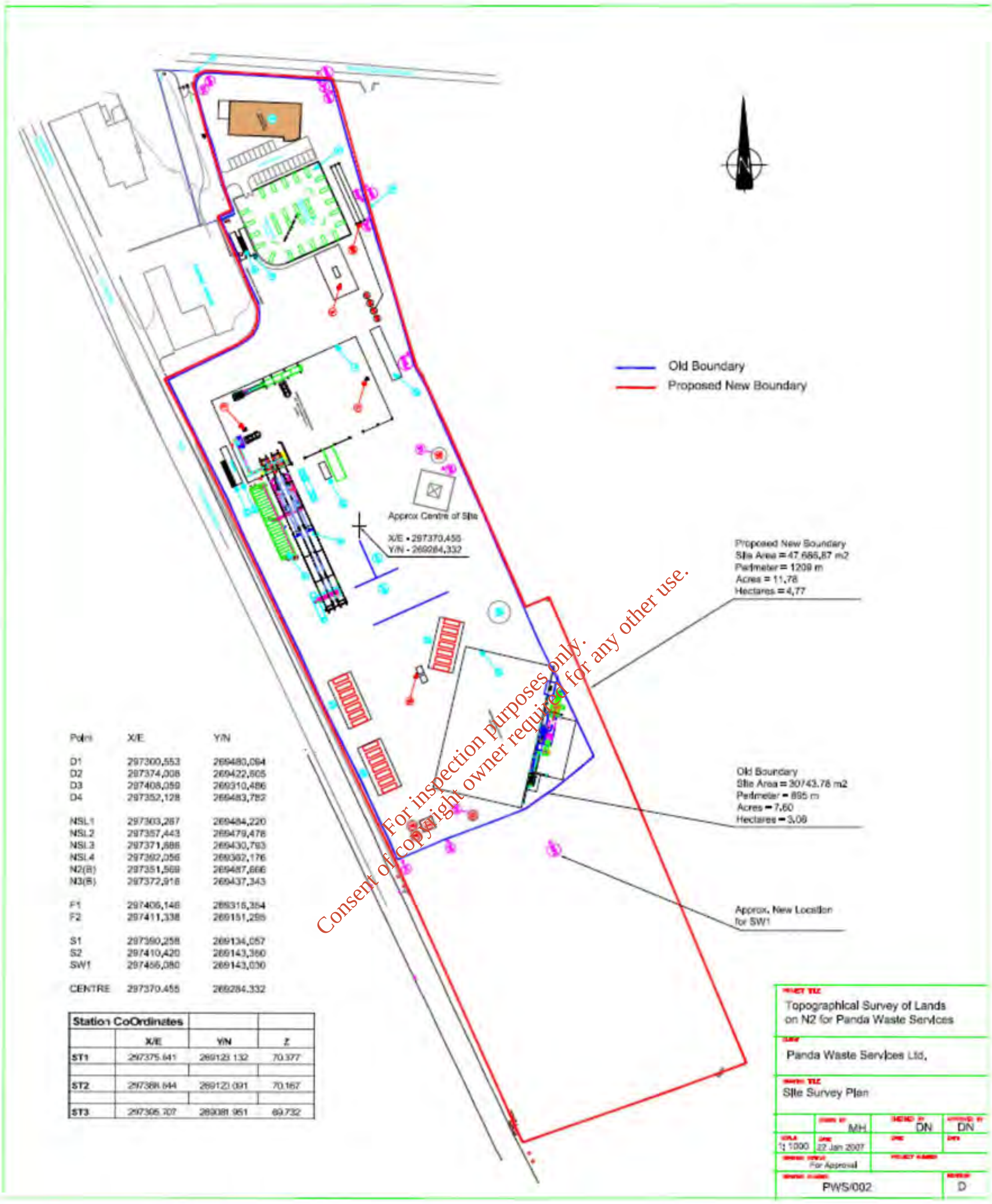

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Appendix B

Organisational Structure

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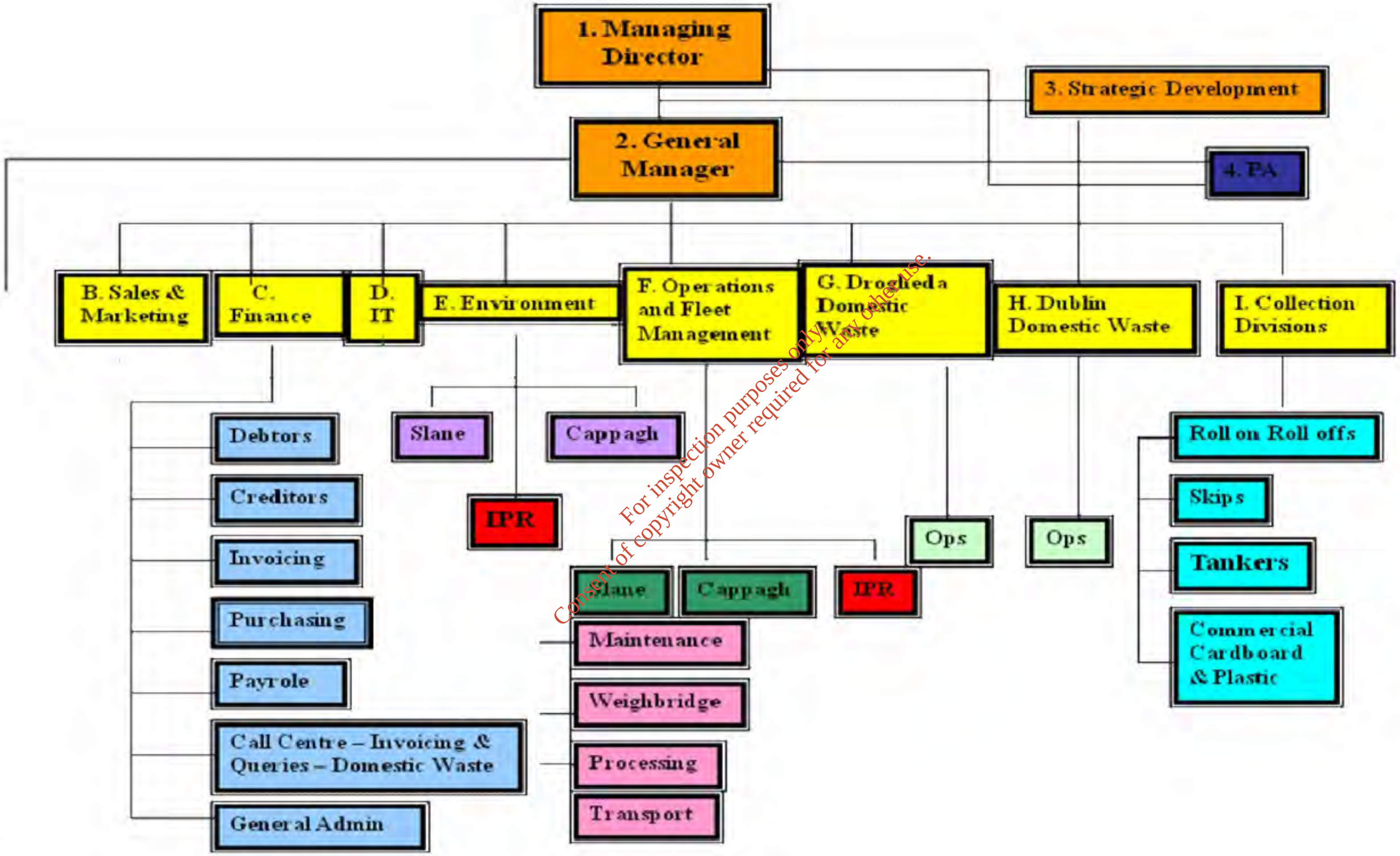

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Appendix C

Financial Statement

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Fagan Lynch Donnellan
Chartered Accountants & Registered Auditors

Our Ref: VL/LL

23rd March 2009

Environmental Protection Agency,
McCumiskey House,
Richview,
Clonskeagh Road,
Dublin 14.

Re: Nurendale Ltd – T/A Panda Waste.

Dear Sir,

We act as Auditors and Taxation Agents for the above and have acted in this capacity in excess of 10 years.

We wish to confirm as follows:

1. Statutory Accounts have been filed for all years up to 31.12.2007 with Companies Office.

   Accounts and Tax Returns have also been filed with Inspector of Taxes for all years to 31st December 2007.

2. The company trades profitably and is on a very sound financial footing.

Further information is available on request.

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Yours faithfully,

FAGAN LYNCH DONNELLAN

Newbridge House, Athlumney, Navan, Co. Meath
Tel: (046) 9023021 Fax: (046) 9029341 e-mail: info@fld.ie

John Fagan FCA Vincent Lynch FCA Mark McCartney FCCA

Authorised by the Institute of Chartered Accountants in Ireland to carry out Investment Business

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Appendix D

Destinations

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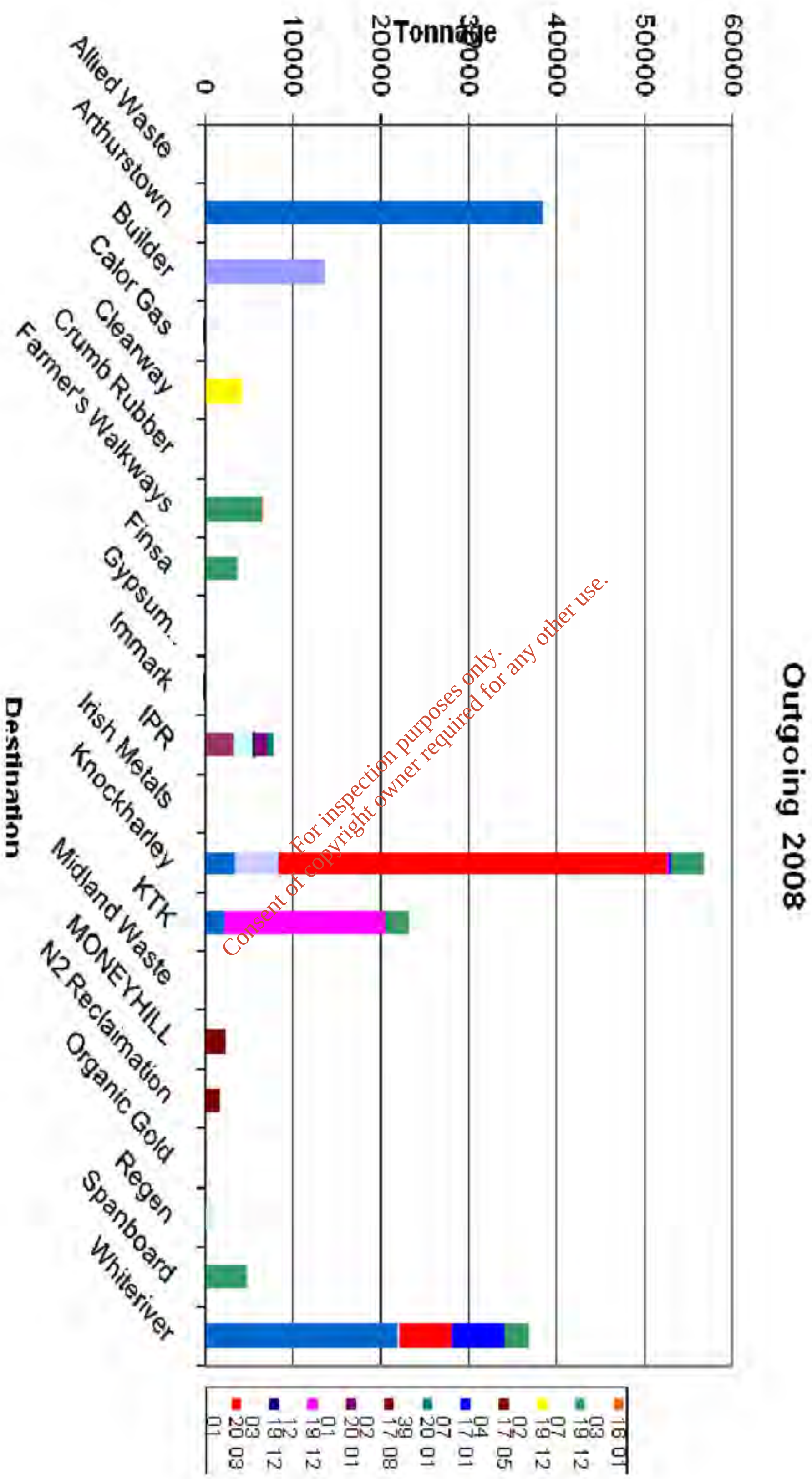

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Destination	Builders Fill	Cardboard	Dry Recyclable Material	Electrical Goods	Gas cylinders	Mechanically Separated Waste	Mechanically Treated Waste	Mixed Dry Recyclables	Mixed Municipal waste	Non Ferrous Metal
	17 01 07	15 01 01	20 03 01	20 01 36	16 01 06	19 12 12	19 12 12	20 03 01	20 03 01	19 12 03
Allied Waste										
Arthurstown						38549.69				
Builder	13747.84									
Calor Gas					1.78					
Clearway										54.78
Crumb Rubber										
Farmer's Walkways										
Finsa										
Gypsum Recycling Ireland										
Immark				2.3						
IPR		3274.07	2401.92					5.64		
Irish Metals										4.18
Knockharley						3423.22	4877.48		44403.26	
KTK						2163.22				
Midland Waste										
MONEYHILL										
N2 Reclaimation										
Organic Gold										
Regen			1136.58							
Spanboard										
Whiteriver						21789.88	398.48		5741.46	
Grand Total	13747.84	3274.07	3538.5	2.3	1.78	65926.01	5275.96	5.64	50144.72	58.96

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Destination	Off-specification Compost	Paper	Plaster Board	Plastic	Rubble	Soil & stones	Steel out	Timber -out	Tyres	Grand Total
	19 12 12	20 01 01	17 08 02	20 01 39	17 01 07	17 05 04	19 12 02	19 12 07	16 01 03	
Allied Waste								18.48		18.48
Arthurstown										38549.69
Builder										13747.84
Calor Gas										1.78
Clearway							4263.34			4318.12
Crumb Rubber									47.18	47.18
Farmer's Walkways								6582.4	7.28	6589.68
Finsa								3750.08		3750.08
Gypsum Recycling Ireland			88.66							88.66
Immark										2.3
IPR		1478.96		551.72						7712.31
Irish Metals										4.18
Knockharley	25.5				262.86			3869.1		56861.42
KTK	18306.6							2686.66		23156.48
Midland Waste								199.5		199.5
MONEYHILL						2394.9				2394.9
N2 Reclaimation						1657.28				1657.28
Organic Gold								121.3		121.3
Regen										1136.58
Spanboard								4666.8		4666.8
Whiteriver	177.34				5970.52			2801.98		36879.66
Grand Total	18509.44	1478.96	88.66	551.72	6233.38	4052.18	4263.34	24696.3	54.46	201919.12

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Appendix E

PRTR Emissions

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| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | Filename : AER PRTR Emission.xls | Return Year : 2008 |

25/03/2009 09:40

AER Returns Worksheet

Version 1.1.03

REFERENCE YEAR	2008

1. FACILITY IDENTIFICATION

Parent Company Name	Nurendale Ltd trading as Panda Waste Services Ltd.,
Facility Name	Nurendale Limited trading as Panda Waste Services Limited
PRTR Identification Number	W0140
Licence Number	W0140-02

Waste or IPPC Classes of Activity

No.	class_name
4.4	Recycling or reclamation of other inorganic materials.
4.11	Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.
4.13	Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.
3.11	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.12	Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.13	Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.
4.2	Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).
4.3	Recycling or reclamation of metals and metal compounds.

Address 1	Rathdrinagh
Address 2	Beauparc
Address 3	Navan
Address 4	County Meath
Country	Ireland
Coordinates of Location	566700.000
River Basin District	IEEA
NACE Code	3832
Main Economic Activity	Recovery of sorted materials
AER Returns Contact Name	David Naughton
AER Returns Contact Email Address	david.naughton@panda.ie
AER Returns Contact Position	Environmental Manager
AER Returns Contact Telephone Number	1850 65 65 65
AER Returns Contact Mobile Phone Number	
AER Returns Contact Fax Number	046 9024189
Production Volume	0.0
Production Volume Units	
Number of Installations	0
Number of Operating Hours in Year	0
Number of Employees	0
User Feedback/Comments	
Web Address	www.panda.ie

2. PRTR CLASS ACTIVITIES

Activity Number	Activity Name
5c	Installations for the disposal of non-hazardous waste

3. SOLVENTS REGULATIONS (S.I. No. 543 of 2002)

Is it applicable?	No
Have you been granted an exemption ?	No
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	
Is the reduction scheme compliance route being used ?	

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4.1 RELEASES TO AIR

| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | Filename : AER PRTR Emission.xls | Return Year : 2008 | 25/03/2009 09:40

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR

POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
06	Ammonia (NH3)	M	alt	GCMS/Ion chromatography	73.0	73.0	0.0	0.0
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR

POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (As required in your Licence)

RELEASES TO AIR

POLLUTANT		METHOD			QUANTITY				
			Method Used						
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
220	Mercaptans	M	alt	GCMS/Ion chromatography	6.6	0.0	6.6	0.0	0.0
237	Volatile organic compounds (as TOC)	M	alt	GCMS/Ion chromatography	369.16	0.0	369.16	0.0	0.0
215	Hydrogen sulphide	M	alt	Jerome Analyser	0.34	0.0	0.34	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Additional Data Requested from Landfill operators

For the purposes of the National Inventory on Greenhouse Gases, landfill operators are requested to provide summary data on landfill gas (Methane) flared or utilised on their facilities to accompany the figures for total methane generated. Operators should only report their Net methane (CH4) emission to the environment under T(total) KG/yr for Section A: Sector specific PRTR pollutants above. Please complete the table below:

Landfill: Nurendale Limited trading as Panda Waste Services Limited

Please enter summary data on the quantities of methane flared and / or utilised

			Method Used			
	T (Total) kg/Year	M/C/E	Method Code	Designation or Description	Facility Total Capacity m3 per hour	
Total estimated methane generation (as per site model)	0.0				N/A	
Methane flared	0.0				0.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	0.0				N/A	

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4.2 RELEASES TO WATERS

| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | Filename : AER PRTR Emission.xls | Return Year : 2008 | 25/03/2009 09:46

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

Data on ambient monitoring of storm/surface water or groundwater, conducted as part of your licence requirements, should NOT be submitted under AER / PRTR Reporting as this on

RELEASES TO WATERS

POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO WATERS

POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO WATERS

POLLUTANT					QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

4.3 RELEASES TO WASTEWATER OR SEWER

| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | File 25/03/2009 09:46

SECTION A : PRTR POLLUTANTS

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER

POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
06	Ammonia (NH3)	M	Alt	Colorimetry	576.9	576.9	0.0	0.0
18	Cadmium and compounds (as Cd)	M	Alt	ICPMS	0.0007	0.0007	0.0	0.0
79	Chlorides (as Cl)	M	Alt	Colorimetry	919.79	919.79	0.0	0.0
20	Copper and compounds (as Cu)	M	Alt	ICPMS	0.11	0.11	0.0	0.0
23	Lead and compounds (as Pb)	M	Alt	ICPMS	0.16	0.16	0.0	0.0
22	Nickel and compounds (as Ni)	M	Alt	ICPMS	0.267	0.267	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER

POLLUTANT		METHOD			QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
303	BOD	M	Alt	Electrometry	6108.55	6108.55	0.0	0.0
305	Calcium	M	Alt	ICPMS	1599.82	1599.82	0.0	0.0
356	Cobalt	M	Alt	ICPMS	0.025	0.025	0.0	0.0
306	COD	M	Alt	Colorimetry	11538.55	11538.55	0.0	0.0
357	Iron	M	Alt	ICPMS	29.58	29.58	0.0	0.0
320	Magnesium	M	Alt	ICPMS	173.57	173.57	0.0	0.0
321	Manganese (as Mn)	M	Alt	ICPMS	4.07	4.07	0.0	0.0
324	Mineral oils	C	SCC	GC-FID	0.636	0.636	0.0	0.0
343	Sulphate	M	Alt	Colorimetry	18799.57	18799.57	0.0	0.0
240	Suspended Solids	M	Alt	Filtration/Drying @ 104C	1231.73	1231.73	0.0	0.0
358	Tin	M	Alt	ICPMS	0.016	0.016	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

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4.4 RELEASES TO LAND

| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | Filename : AER PRTR Emission.xls | Return Year :   25/03/2009 09:46

SECTION A : PRTR POLLUTANTS

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

5. ONSITE TREATMENT & OFFSITE TRANSFERS OF WASTE

| PRTR# : W0140 | Facility Name : Nurendale Limited trading as Panda Waste Services Limited | Filename : AER PRTR Emission.xls | Return Year : 2008 | 25/03/2009 09:46

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Transfer Destination	European Waste Code	Hazardous	Quantity T/Year	Description of Waste	Waste Treatment Operation	Method Used: M/C/E	Method Used: Method Used	Location of Treatment	Name and Licence / Permit No. of Recoverer / Disposer / Broker	Address of Recoverer / Disposer / Broker	Name and Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)	Licence / Permit No. of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
Within the Country	17 01 07	No	13747.84	Mixture of concrete, bricks, tiles and ceramics	R13	M	Weighed	Offsite in Ireland	Builders	Various		
Within the Country	15 01 01	No	3274.07	Paper and Cardboard	R13	M	Weighed	Offsite in Ireland	Irish Packaging recycling Wpr 021/2	Ballymount Rd, Walkinstown, D12		
Within the Country	20 03 01	No	2407.56	Mixed Dry Recyclables	R13	M	Weighed	Offsite in Ireland	Irish Packaging recycling Wpr 021/2	Ballymount Rd, Walkinstown, D12		
To Other Countries	20 03 01	No	1136.58	Mixed Dry Recyclables	R13	M	Weighed	Abroad	Regen, NI 44110	Newry, Co Down		
Within the Country	20 01 36	No	2.3	Electrical Goods	R13	M	Weighed	Offsite in Ireland	Immark W0185-01	Rathcoole, Co. Dublin		
Within the Country	16 05 05	No	1.78	Gas Cylinders	R13	M	Weighed	Offsite in Ireland	Calor Gas	N/a		
Within the Country	19 12 12	No	38549.69	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	Athurstwon W0004-03	Kill Co. Kildare		
Within the Country	19 12 12	No	3423.22	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
Within the Country	19 12 12	No	2163.22	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	KTK Landfill W0081-03	Kill Co. Kildare		
Within the Country	19 12 12	No	21789.88	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	19 12 12	No	4877.48	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
Within the Country	19 12 12	No	398.48	Mechanically Seperated Waste	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	20 03 01	No	44403.26	Mixed Municipal Waste	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
Within the Country	20 03 01	No	5741.46	Mixed Municipal Waste	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	19 12 03	No	54.78	Non Ferrous Metals	R13	M	Weighed	Offsite in Ireland	Clearway 984 510	Portadown, Co. Armagh		
Within the Country	19 12 03	No	4.18	Non Ferrous Metals	R13	M	Weighed	Offsite in Ireland	irish Metal Refineries WMP 2008/10	Duleek, Co. Meath		
Within the Country	19 12 12	No	25.5	Off Spec Compost	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
Within the Country	19 12 12	No	18306.6	Off Spec Compost	R13	M	Weighed	Offsite in Ireland	KTK Landfill W0081-03	Kill Co. Kildare		
Within the Country	19 12 12	No	177.34	Off Spec Compost	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	20 01 01	No	1479.0	Paper and Cardboard	R13	M	Weighed	Offsite in Ireland	Irish Packaging recycling Wpr 021/2	Ballymount Rd, Walkinstown, D12		
Within the Country	17 08 02	No	88.66	Plasterboard	R13	M	Weighed	Offsite in Ireland	Gypsum Recycling Ireland WMP 238/2006	Rathcoffey, Co. Kildare		
Within the Country	20 01 39	No	551.72	Plastic	R13	M	Weighed	Offsite in Ireland	Irish Packaging recycling Wpr 021/2	Ballymount Rd, Walkinstown, D12		
Within the Country	17 01 07	No	262.86	Rubble	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
Within the Country	17 01 07	No	5970.5	Rubble	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	17 05 04	No	2394.9	Soil and Stones	R13	M	Weighed	Offsite in Ireland	Moneyhill WMP 2005/43	Garristown, Co. Meath		
Within the Country	17 05 04	No	1657.28	Soil and Stones	R13	M	Weighed	Offsite in Ireland	N2 Reclamation WMP 2004/53	Dawn View, Johnstown, Slane, Co. Meath		
Within the Country	19 12 02	No	4263.3	Steel	R13	M	Weighed	Offsite in Ireland	Clearway 984 510	Portadown, Co. Armagh		
Within the Country	19 12 07	No	18.48	Timber	R13	M	Weighed	Offsite in Ireland	Allied Waste Wp-150-2006	Clonmellon, Navan, Co. Meath		
Within the Country	19 12 07	No	6582.4	Timber	R13	M	Weighed	Offsite in Ireland	Farmers	Various		
Within the Country	19 12 07	No	3750.08	Timber	R13	M	Weighed	Offsite in Ireland	Finsa Farm Products P0022-02	Scarriff, Co. Clare		
Within the Country	19 12 07	No	3869.1	Timber	R13	M	Weighed	Offsite in Ireland	Knockharley W0146-02	Navan, Co. Meath		
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Within the Country	19 12 07	No	121.3	Timber	R13	M	Weighed	Offsite in Ireland	Organic Gold WMP 2002/26	Wilkinstown, Co. Meath		
Within the Country	19 12 07	No	4666.8	Timber	R13	M	Weighed	Offsite in Ireland	Spanboard Products WMEX 10-01	Coleraine, Northern Ireland		
Within the Country	19 12 07	No	2801.98	Timber	R13	M	Weighed	Offsite in Ireland	Whiteriver Landfill W0060-02	Colon, Co. Louth		
Within the Country	**16 01 03**	**No**	47.18	Tyres	R13	M	Weighed	Offsite in Ireland	Crumb Rubber WP2007/01	Dundalk, Co. Louth		
Within the Country	16 01 03	No	7.28	Tyres	R13	M	Weighed	Offsite in Ireland	Farmers	Various		

* Select a row by double-clicking the Description of Waste then click the delete button

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APPENDIX 5

Wastewater

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Waste Water Management Memo

PREPARED FOR: Panda Waste

PREPARED BY: Andrew Walsh, CBE

COPIES: Michael Watson, O'Callaghan Moran

Eamon Waters, Panda Waste

David Naughton, Panda Waste

Michael O'Gorman, CBE

DATE: August 15th 2009

Introduction:

The Panda Waste bio-waste facility will generate a number of effluents that must be managed in a manner that does not lead to pollution of waters, flooding and does not result in pathogen cross-contamination within the facility. The facility is also configured in accordance with sustainable urban drainage (SUDS) and with a focus on maximum effluent re-use in the facility in order to minimize the hydraulic and BOD load of effluents exported from the site. As the facility does not have a discharge license, the facility is being designed to maximize the re-use of effluents within the process with excess effluents being collected by tanker and delivered to a waste water treatment plant for appropriate treatment. As part of the process design, an effluent mass balance has been prepared. The rainfall data is taken from historical information from Dublin Airport weather and from 1:25 year storm events with a one hour return.

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Effluents:

The effluents generated on site are listed in Table 1 below and are categorized based on flow, pollutant load and pathogen transmission potential.

Table 1: Panda Bio-Waste Effluents

Effluent	Flow	Organic Loading	Pathogen Risk
Fermenter percolate MBT	Low	High	High
Fermenter percolate Bio-waste	Low	High	High
Compost tunnel leachate MBT	Low / Moderate	High	High
Compost tunnel leachate Bio-waste	Low / Moderate	High	High
Building floor wash-down	Moderate	High	High
Biofilter & scrubber effluent	Moderate	Moderate / Low	Low
External pavement storm water	Moderate/High	Low / Moderate	Low
Roof storm water	Moderate/High	Low	Low

MBT: Mechanical Biological Treatment inputs (mixed waste)
Bio-waste: Source separated food and green waste inputs

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The Effluent Stores

The effluent storage capacities are detailed in Table 2.

Table 2. Capacities of effluent management stores at the Panda Waste Facility.

Store	Contents	Net volume
Roof water tank	Roof water from bio-waste building (existing steel tank)	660 m^3
Percolate tank 1	MBT dry fermentation percolate (New concrete tank)	200 m^3
Percolate tank 2	Bio-waste dry fermentation percolate (New concrete tank)	200 m^3
Effluent tank 1	Tunnel leachate & wash down (New steel tank)	320 m^3
Effluent tank 2	Odour abatement effluent tank (New steel tank)	700 m^3

Effluent Mass Balance:

The effluent mass balance for the high strength effluents is detailed in Table 3. It contains information on the low and high flow scenarios for the effluents generated. These flows are influenced by the seasonal presentation of bio-waste at the facility. The mass balance of effluent generation for the odour abatement system is illustrated in table 4. A schematic diagram of the effluent management system for the facility is illustrated in drawing attached (CCS/Job 24/007/Effluent Schematic).

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Table 3. Monthly Effluent Mass Balance for Panda Bio-waste Facility effluent tank No. 1 (m^3/month)

Effluent	Low flow	High Flow
Bio-waste percolate	(5)	(10)
MBT percolate	(50)	(70)
Bio-waste tunnels	15	25
MBT tunnels	15	25
Watering of bio-waste tunnel compost	(7.5)	(10)
Watering of MBT tunnel compost	(7.5)	(10)
Floor wash-down	25	35
Vehicle wash-down	45	55
TOTAL EFFLUENT OFF SITE	*30*	*40*

Table 4. Monthly Effluent Mass Balance for Panda Bio-waste Facility effluent tank No. 2 (m^3/month)

Effluent	Low flow	High Flow
Biofilter effluent	55	65
Scrubber effluent	90	110
TOTAL EFFLUENT OFF SITE	*145*	*175*

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Roof Water Management
The total roof area for the facility is 12,183 m^2. Storm water from the roof will be directed to a pump chamber to be stored within an existing above ground storage tank with a capacity of 660 m^3. This reservoir will be used as a primary source of non-potable water at the site for wash down, odour abatement, dust suppression and sanitary purposes. The tank capacity will allow for twice the storage capacity required for a 1:25 year storm event (26.57mm/hr 60min duration rainfall event = 324 m^3). In addition, given mean monthly winter rainfall in the area, roof water flows are likely to average between 800 and 1,000 m^3 per month. The subsequent grey water re-use within the facility (odour abatement & wash down) will utilize approximately 25-30% of this water thus preserving equivalent amounts of potable water (Table 5).

Table 5. Principal roof water re-uses (m^3/month)

Use	**Low flow**	**High Flow**
Biofilter	70	100
Scrubber	90	110
Floor wash-down	25	35
Vehicle wash-down	45	55
TOTAL	230	300

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Pavement Storm Water Management:
Given the low pollution and pathogen potential of clean storm water from the surrounding paved areas, this water will discharge directly to a soakaway via a Class 1 petrol interceptor located adjacent to the facility (Planning Drawing No. 2009-101-103).

Percolate Management
The percolate tanks are active anaerobic reactors that will be net users of water that will be sourced from the effluent tank No. 1. In the event of excess percolate being produced, this will be pumped to effluent tank No. 1.

Fermenter Percolate Management (MBT)
Seven of the 14 dry fermentation chambers will be utilized for the processing of mixed waste (MBT). Due to the relatively dry nature of this material (approx. 52% moisture) and the target moisture content of 68% during fermentation, there will be a net moisture deficit of between 50-70 m^3/month in the process where the net water generation resulting from hydrolysis being overweighed by the initial water deficit.

Fermenter Percolate Management (Bio-waste)
Seven of the 14 dry fermentation chambers will be utilized for the processing of source separated food and green waste (bio-waste). Given the target moisture content of 68% during fermentation and the typical moisture content of the incoming material (approx. 60%), there will be a deficit in the effluent generation of approximately 5-10 m^3/month.

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Effluent tank No. 1 Management

Internal Floor Wash-Down

The internal floor area of the facility (excluding interior of processing vessels and vehicle wash down areas is 4,200 m^2. Wash down of these floors is expected to generate approximately 25-35 m^3 of effluent per month.

Vehicle Wash-Down

There are two main vehicle wash down areas within the building. Given the expected incoming traffic at the design capacity, the truck wash down is expected to generate approximately 45-55 m^3/month at full design capacity.

Tunnel Leachate Management (MBT)

Post-fermentation, the solid state MBT material is transferred to four aerobic tunnels where a net generation of 15-25 m^3 of leachate will be produced over the duration of the retention, i.e. 28 days. In addition, during the final two weeks of composting, it is expected that the material in the tunnels will run at a moisture deficit and as a result, it is expected that the process will consume 7.5-10m^3/month. This water will be sourced from the odour abatement effluent storage tank to minimize off-site disposal of high strength liquors.

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Tunnel Leachate Management (Bio-waste)

Post-fermentation, the solid state bio-waste is transferred to four aerobic tunnels where a net generation of 15-25 m^3 of leachate will be produced over the duration of the retention, i.e. 28 days. In addition, during the final two weeks of composting, it is expected that the material in the tunnels will run at a moisture deficit and as a result, it is expected that the process will consume 7.5-10m^3/month. This water will be sourced from the odour abatement effluent storage tank to minimize off-site disposal of high strength liquors.

Effluent tank No. 2 (Odour Abatement Effluents)

The odour abatement system consists of a wet acid scrubber in tandem with a biofilter operating in tandem. The biofilter is designed to operate in bio-trickling mode with the recirculation of the effluent. The scrubber effluent will generate up to 90 – 110 m3/month with the bio-trickling filter generating a net 55-65 m^3/month.

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APPENDIX 6

SUDS August 2009

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HYDROGEOLOGICAL RISK ASSESSMENT FOR A PROPOSED DEVELOPMENT BEAUPARC COUNTY MEATH

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Prepared For: -

Panda Waste Service
Rathdrinagh
Beauparc
Co. Meath

Prepared By: -

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

August 2009

email. info@ocallaghanmoran.com Website: www.ocallaghanmoran.com

O'Callaghan Moran & Associates. Registration No. 8272844U

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TABLE OF CONTENTS

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1 INTRODUCTION

O' Callaghan Moran & Associates (OCM) was requested by Panda Waste Services Ltd (Panda) to undertake a hydrogeological assessment at the site of a proposed extension to its Materials Recovery Facility (MRF) at Beauparc, Navan, Co Meath. The objective of the assessment was to establish if the natural ground conditions would allow storm water from paved areas to percolate to ground through a suitably designed drainage system.

1.1 Background

Panda submitted an application for planning permission to Meath County Council in June 2009 for the extension of its existing Materials Recovery Facility comprising the construction of a new building to accommodate additional recycling activities. The application relates to the development of a new building to accommodate a processing system comprising dry fermentation and composting that will treat the existing organic waste stream accepted at the facility and divert it from landfill.

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On the 4th August 2009 the Council requested further information in relation to the application. One of the requests required soakaway design calculations for the proposal to direct rainfall runoff from paved areas (approximately 5,000m^2 area) to a soakaway at the south eastern section of the site.

> ***(ii) For proposed soakaway, applicant shall submit full details and calculations together with soil permeability test rates and depth measurement from bottom of proposed soakaway to winter water table level.***

1.2 Assessment

OCM's assessment comprised a desk study review of the local area geology and hydrogeology database, an area reconnaissance, and a site investigation comprising trial pit excavation and permeability testing.

Rainwater run-off the paved yards will discharge to a soakaway via an oil interceptor. The BRE 365 design for the soakaway has been calculated for a 1:100 year storm event. Rain water run-off from the building roof will be kept separate from yard run-off. The roof water will be directed to an existing above ground water storage tank, which has a capacity of 660m^3.

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2 SITE LOCATION

2.1 Site Location & Surrounds

The facility is located in Rathdrinagh, Beauparc, Navan, County Meath. It is in the townland of Rathdrinagh, at National Grid Reference: E2973 N2689. The site is located on the N2 approximately 4km south of Slane, County Meath. The River Boyne flows in an easterly direction approximately 3km north east of the site.

The facility is bordered to the west by the N2 Dublin to Monaghan Road and to the north by a third class road, the Knockcommon Road. Surrounding activity is predominantly agriculture, however there are some commercial units adjacent the site to the west. There are nine residential dwellings with 0.5km on the Knockcommon Road and thirteen residences within 0.5km along the N2 and a third class road on the western side of the N2, Senchelstown Road.

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2.2 Topography & Surface Water Drainage

The proposed extension area encompasses 3.2 hectares (ha) and adjoins the eastern boundary of the existing MRF. It is part of a larger farm holding and is currently used as pasture.

It slopes from north to south, falling from an elevation of approximately 60.5 m Ordnance Datum (OD), along the northern boundary, to 55.5 mOD along a drain at the southern boundary.

The site is in the catchment of the River Boyne, located approximately 3km to the north east of the site.

2.3 Land Use

The lands are currently used for animal grazing.

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3 GEOLOGY AND HYDROGEOLOGY

Information on the local geology and hydrogeology was obtained from the bedrock geology maps, published by the Geological Survey of Ireland (GSI), the construction logs for two onsite groundwater wells and current site investigations undertaken at the site.

3.1 Bedrock Geology

The bedrock geology is shown on Figure 3.1. The site is underlain by the Balrickard Formation. It is described by the GSI as coarse sandstone, shale. It is bounded to the north and south by the Donore Formation which is shale, sandstone and limestone. To the east is the Walshestown Formation which is described as shale, sandstone and limestone. The Loughshinny Formation (dark micrite & calcarenite, shale), Platin Formation (crinoidal peloidal grainstone-packstone) and the Donore Formation are to the west.

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The groundwater well logs indicate bedrock and water strikes at 10-12m below ground. The type of bedrock is not specified in one of the borehole logs and is described as limestone in the other. From the gravels observed by OCM during the site investigation it is considered likely that the bedrock is a shale as described by the GSI.

3.2 Subsoil (Quaternary) Geology

The trial pitting from the investigations undertaken as part of this assessment indicate a brown clay to approximately 1m which is underlain by a grey/black clay. A trial pit was excavated to 3.1m and bedrock was not encountered. Groundwater was also not encountered in any of the trial pits. The groundwater well information indicates that the subsoils are at least 10-12m deep.

The soil maps prepared by Teagasc indicates that the subsoil type is till derived from Namurian Shales and Sandstones (TNSSs) and the site investigation confirmed this.

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3.3 Aquifer Vulnerability

Vulnerability is defined by the GSI as the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The GSI uses four groundwater vulnerability categories - extreme, high, moderate and low - for mapping purposes and in the assessment of risk to groundwaters.

The subsoils are the single most important natural feature influencing groundwater vulnerability. Groundwater is most at risk where the subsoils are either absent or thin and in areas of karstic limestone, where surface streams sink underground at swallow holes.

The Vulnerability map for Meath indicates that the vulnerability at the site is Low (Ref to Figure 3.2). The site specific information on subsoil thickness confirms that the Vulnerability is Low.

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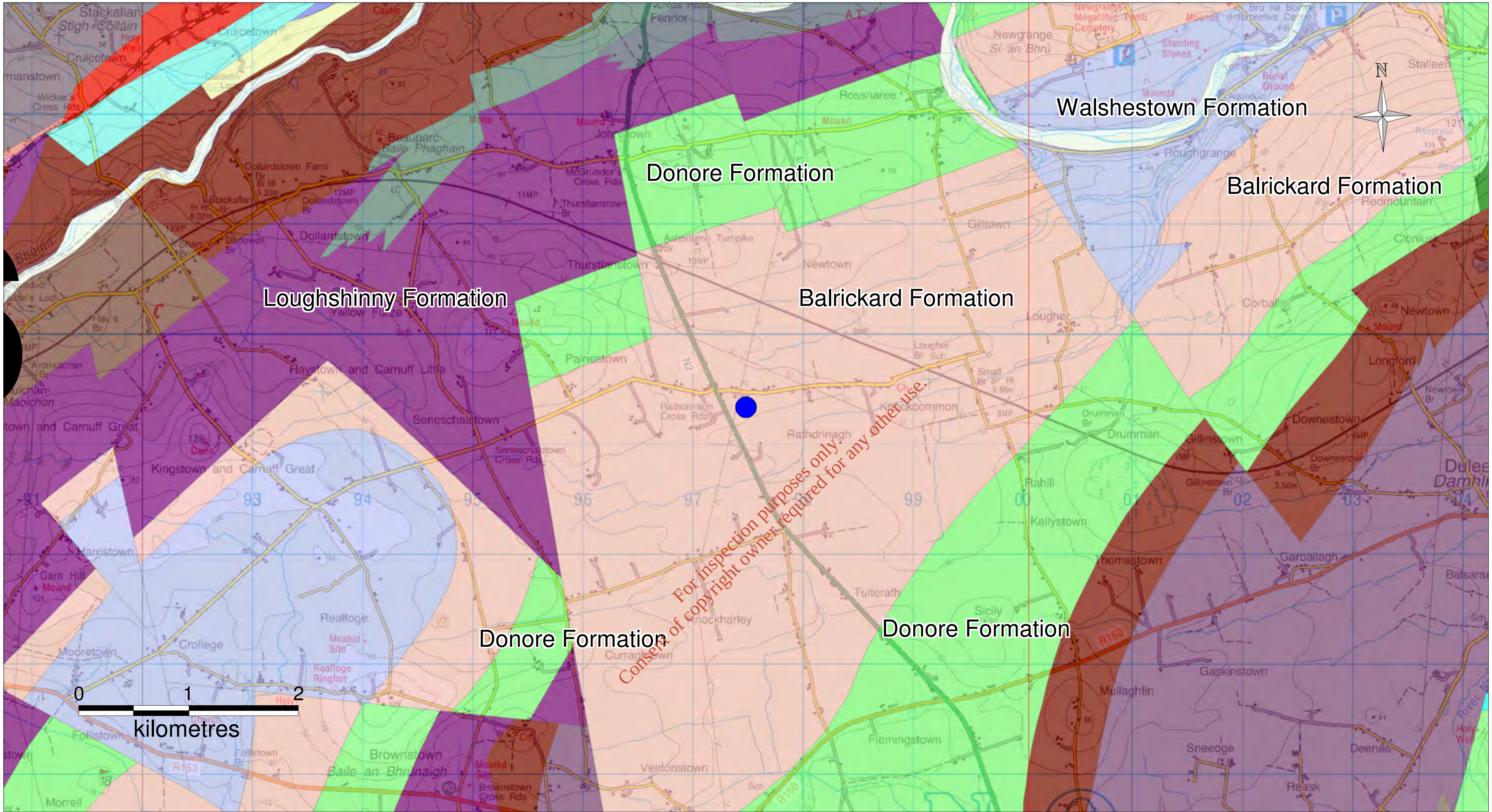

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CLIENT
Panda Waste Services

TITLE
Bedrock Geology

Legend
● Site Location

FIGURE No.
3.1

SCALE
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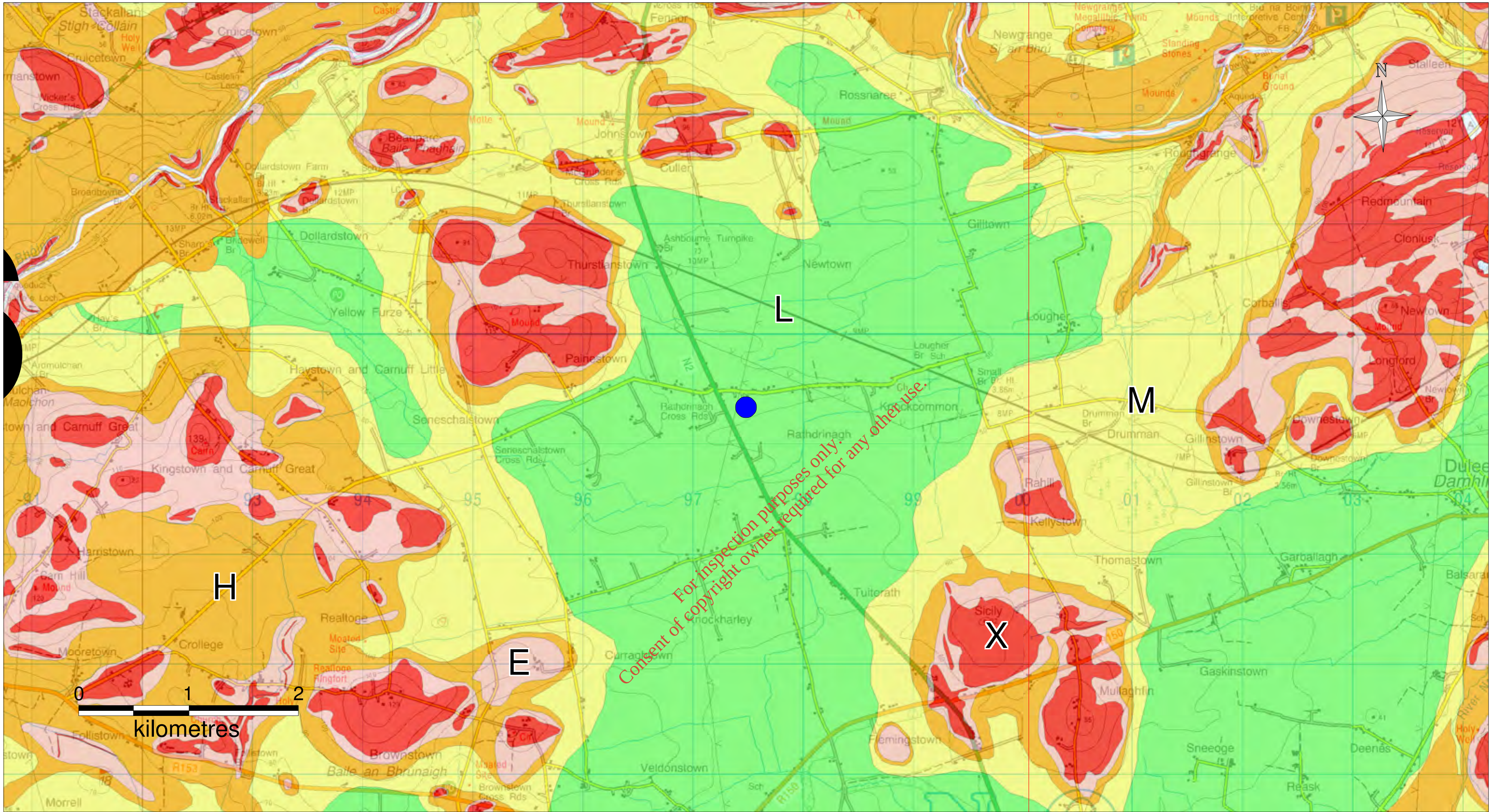

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Aquifer Vulnerability

Legend
● Site Location

FIGURE No.
3.2

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3.4 Aquifer Characteristics

The aquifer map for the Navan area is shown in Figure 3.3. The Balrickard Formation, is classified by the GSI as a bedrock aquifer that is generally unproductive except for local zones**(Pl)**. The Donore and Walshestown Formations are also classified as Pl. The Platin Formation, to the southwest, is considered a locally important Karstified bedrock aquifer (Lk) and the Loughshinny Formation is a bedrock aquifer that is generally moderately productive (Lm).

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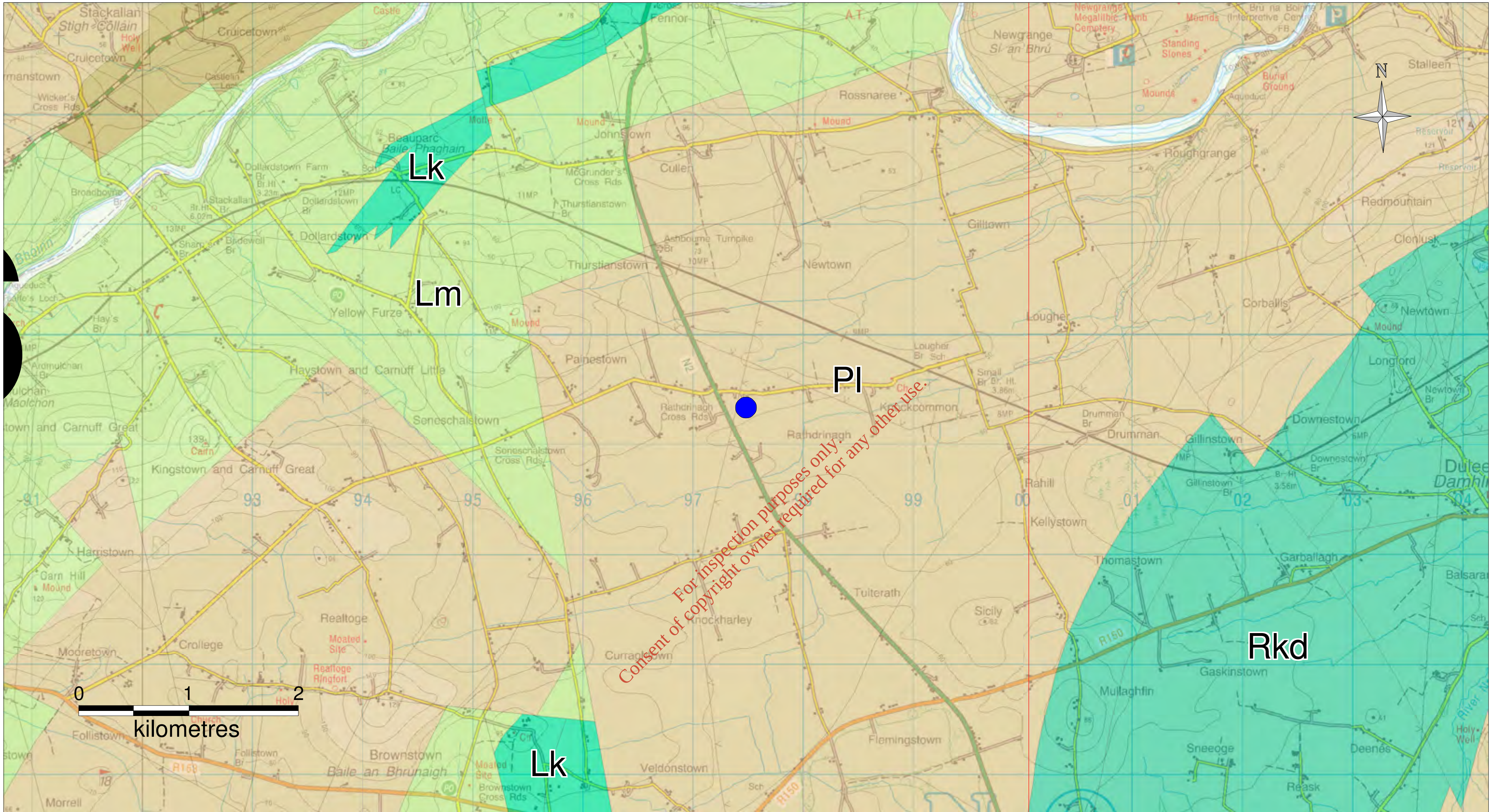

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Panda Waste Services

TITLE

Bedrock Aquifer

Legend

● Site Location

FIGURE No.

3.3

SCALE

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4 SITE INVESTIGATION

OCM undertook the site investigations on the 13th August 2009. OCM inspected the location of the proposed soakaway area on the original design layout. Drainage had been proposed for a green area to be located in the south east portion of the site. OCM excavated four trial pits in the vicinity of the soakaway. The trial pit locations are shown on Figure 4.1. The trial pit logs & Photos are presented in Appendix 1.

4.1 Trial Pits

TP1 and TP-2 were excavated to a depth of 2.1 and 3.2m respectively to assess the nature and thickness of the subsoils and to establish the approximate location of the winter water table. This can be interpreted from observations of mottling of the subsoil layer, which occurs as the subsoil dries out as water table levels drop during the drier summer period. Two additional trial pits (TP-3 and TP-4) were excavated to 1.5m and 0.8m below ground level for the purposes of percolation testing.

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In general the trial pits indicate a dry well draining top soil layer approximately 25 cm thick. The subsoils were consistent in each of the trial pits and comprised brown clay with occasional gravel to 1.1m below ground with lenses of yellow clay at approximately 0.7m below ground level. This was underlain by a stiff grey/black clay with shale gravels. No inflows of water were observed in any of the trial pits. Bedrock was not encountered in any of the trial pits and there was no evidence of the winter water table. It is therefore assumed that the winter water table level is at least greater than 1.5m below ground level.

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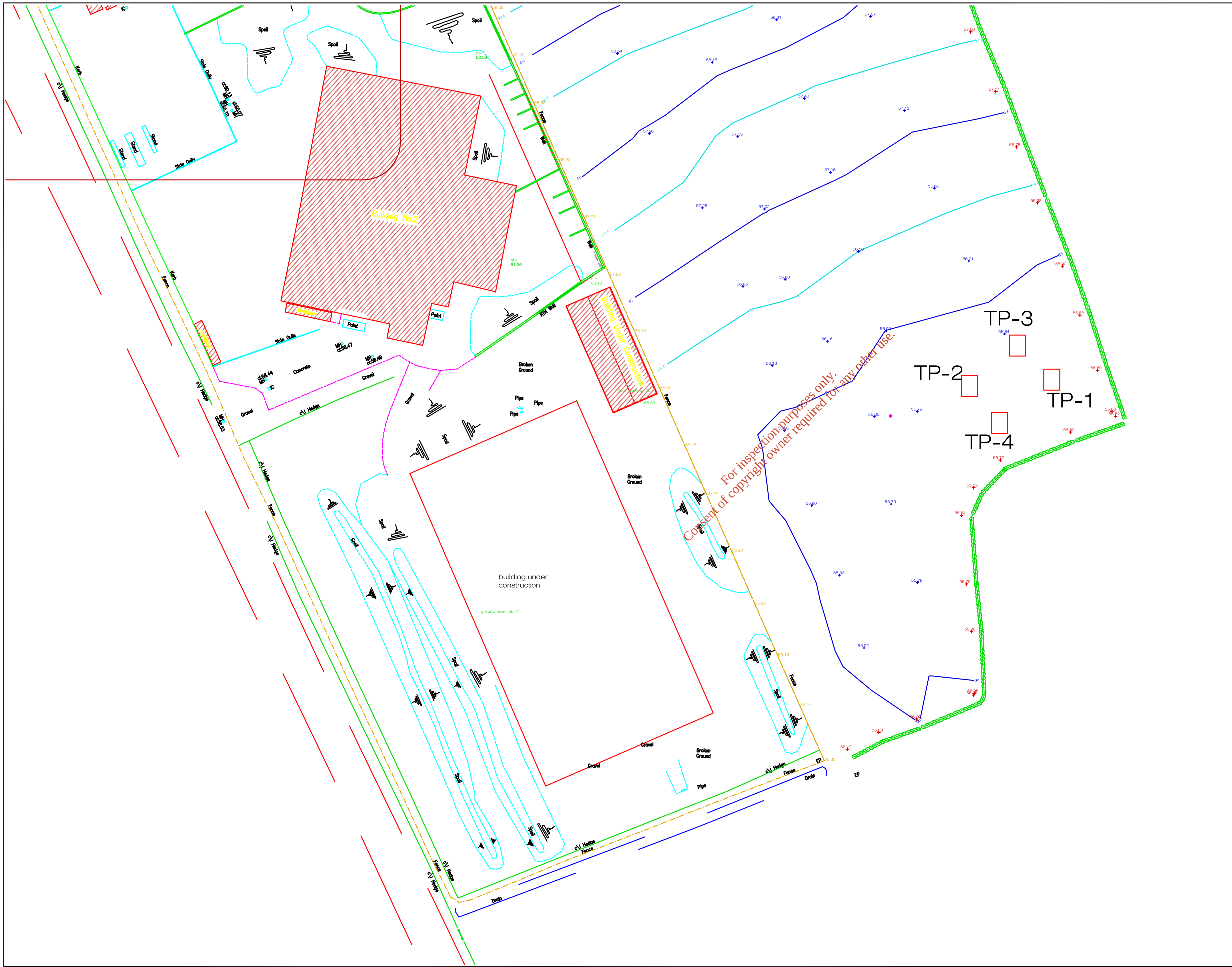

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NOTES

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REV	DATE	DESCRIPTION	DRN	CHKD	APP

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CLIENT

PANDA

TITLE

TRIAL PIT
LOCATIONS
BEAUPARC

SCALE	DRAWING No.	REV.
1:1000 A3	09138-01	A

DOS Filename : DOSFILENAME

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4.2 Percolation Tests

OCM conducted two percolation tests in TP3 and TP4 in accordance with British Research Establishment (BRE 365) Soakaway Design Guidance. The results are presented in Appendix 2.

4.2.1 Results

TP-3 had trial pit dimensions 3m x 1.2m x 1.3m deep. The pit was filled to within 0.2 m of the top of the pit, and the drop in water level was observed. The water level dropped approximately 6cm in TP-3 in one hour. The water level in TP-3 dropped 90 cm in 16 hours. The permeability for this area was calculated at 6.42^{-7} m/s.

TP-4 had trial pit dimensions 1.5m x 0.8m x 0.7m deep. The pit was filled to within 0.05 m of the top of the pit, and the drop in water level was observed. The water level dropped approximately 7.5cm in TP-4 in one hour. The water level in TP-4 dropped 43 cm in 8 hours. The permeability for this area was calculated at 5.93^{-7} m/s.

This permeability indicates that the soils are suitable for percolation of the stormwater from the paved area of the extension.

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5 HYDROGEOLOGICAL RISK ASSESSMENT OF PROPOSED SUSTAINABLE URBAN DRAINAGE SYSTEM (SUDS)

It is likely that the water table level mirrors the topography and falls to the south toward the low point on site where the ground level is approximately 55.05mOD. It is likely that the water table in this area is at least 10 m below ground level. No water strikes were encountered in any of the trial pits excavated at the site.

Anecdotal evidence from the site owner indicates that this portion of the site does not flood in the winter period.

5.1 Groundwater Risk Assessment

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In addition to ensuring the correct design of the soakaway the potential for infiltrating stormwater to impact on surface and/or groundwater must be considered. The standard risk assessment model of "source - pathway - receptor" is used as the framework.

- Source: The source is the stormwater which will enters the soakaway. The "first flush" of stormwater after a dry period can contain pollutants collected from surface e.g. oil from road surfaces and organic matter from gutters and drains. BRE guidance suggests the use of an oil water interceptor as part of the drainage system to mitigate the risk from hydrocarbon sources such as run-off from roads or vehicles. OCM understand that this will be incorporated in the design to mitigate potential impact on the underlying bedrock aquifer.

- Pathway: The pathway is the soakaway system and underlying subsoils. The design has been completed for a storm duration of 60minutes for a 1:100 year return period. There are at least 10m of subsoils beneath the site.

- Receptor: OCM assume that the design would include the discharge of stormwater to ground via a suitably designed percolation system(s). The Aquifer vulnerability is Low in the proposed percolation area. The water table level appears to be at least 10m below ground level in this area.

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- The nearest watercourse is the surface water drain which runs along the southern boundary. Once the stormwater is allowed to percolate through the subsoil having come though an oil interceptor the travel time and dilution in the unsaturated zone should mitigate any risk to the water course. An ecological survey of the site has confirmed that the surface water drain does not support aquatic life and is not of significant ecological value.

5.2 Discharge of Stormwater to Ground.

The indicative size of the soakaway shown on the planning application drawing is approximately $300m^2$. The percolation test results indicate a soakaway size of approximately $130m^2$ will be sufficient to accommodate the surface water flows from the paved areas around the new extension (approximately $5,000m^2$ area). The soakaway layout should be approximately 130m x 1m x 1.5m deep which can be accommodated in the proposed landscaped area to the south east of the site.

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6 CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

OCM considers that a stormwater attenuation system, with a percolation area located in the southeast of the site, can be designed to accommodate the proposed development.

OCM estimate that the water table is located at least >3.1m below ground level in the south of the site. Anecdotal evidence from the site owner indicates that this portion of the site does not flood in the winter period. The available site investigation information on water table levels and soil drainage characteristics supports this observation.

In the proposed percolation area the Aquifer vulnerability is Low. OCM understand that all necessary measures (interceptor) will be incorporated in the design to ensure that the aquifer is not impacted by stormwater discharges.

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The nearest watercourse is the surface water drain which is located at the southern boundary. Once the stormwater has percolated through the subsoil the travel time and dilution in the unsaturated zone should mitigate any risk to the water course.

6.2 Recommendations

OCM recommend that an oil water interceptor system be incorporated into the design to minimise the risk of hydrocarbon run-off from roads and vehicles entering the groundwater system.

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APPENDIX 1

Trial Pits Logs & Photos

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TRIAL PIT LOG

CONTRACT: PANDA

TRIAL PIT NO: TP-1

LOCATION: Beauparc, Co Meath

DATE: 13/08/2009.

METHOD OF EXCAVATION: Track Mounted Excavator

DESCRIPTION	BOREHOLE DEPTH (m)	SYMBOLIC LOG	SAMPLE TYPE	DEPTH (m)/ Reading (ppm)
Topsoil	Metres (m)			
Firm brown Clay with very occasional gravels.	0.5m			
Stiff yellow Clay with occasional gravels	1.0m			
Very stiff grey/black Clay with gravels Angular shale gravels	1.5m			
Trial Pit Termitated	2.0m 2.5m 3.0m			

Comments:
Pit walls stable to completion.
No groundwater encountered.

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TRIAL PIT LOG

CONTRACT: PANDA		**TRIAL PIT NO:** TP-2		
LOCATION: Beauparc, Co Meath	**DATE:** 13/08/2009.			
METHOD OF EXCAVATION: Track Mounted Excavator				
DESCRIPTION	**BOREHOLE DEPTH (m)**	**SYMBOLIC LOG**	**SAMPLE TYPE**	**DEPTH (m)/ Reading (ppm)**
Topsoil	**Metres (m)**			
Firm brown Clay with very occasional gravels.	**0.5m**			
Firm yellow/brown CLAY with occasional gravels				
Stiff grey/black Claywith gravels Angular shale gravels	**1.0m** **1.5m** **2.0m** **2.5m** **3.0m**			
Trial Pit Terminated **Comments:** Pit walls stable to completion. No groundwater encountered.	**3.5m**			

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TRIAL PIT LOG

CONTRACT: PANDA	**TRIAL PIT NO:** TP-3
LOCATION: Beauparc, Co Meath	**DATE:** 13/08/2009.
METHOD OF EXCAVATION: Track Mounted Excavator	

DESCRIPTION	BOREHOLE DEPTH (m)	SYMBOLIC LOG	SAMPLE TYPE	DEPTH (m)/ Reading (ppm)
Topsoil	Metres (m)			
Firm brown Clay with very occasional gravels.	0.5m			
Stiff yellow Clay with occasional gravels	1.0m			
Very stiff grey/black Clay with gravels Angular shale gravels	1.5m			
Trial Pit Termitated	2.0m 2.5m 3.0m			

Comments:
Pit walls stable to completion.
No groundwater encountered.

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TRIAL PIT LOG

CONTRACT: PANDA	**TRIAL PIT NO:** TP-4
LOCATION: Beauparc, Co Meath	**DATE:** 13/08/2009.
METHOD OF EXCAVATION: Track Mounted Excavator	

DESCRIPTION	BOREHOLE DEPTH (m)	SYMBOLIC LOG	SAMPLE TYPE	DEPTH (m)/ Reading (ppm)
Topsoil	Metres (m)			
Firm brown Clay with occasional gravel.	0.5m			
Firm yellow/brown Clay.				
Stiff grey/black Clay with angular shale gravels				
Trial Pit Termitated	1.0m			
	1.5m			
	2.0m			

Comments:
Pit walls stable to completion.
No groundwater encountered.

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TP1 – Panda, Beauparc, Co Meath

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TP2 – Panda, Beauparc, Co Meath

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BRE Test Location – Panda, Beauparc, Co Meath.

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BRE Test – TP4. Panda, Beauparc, Co Meath

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APPENDIX 2

Percolation Test Results

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Soakway Design

	Parameter	SOAKWAY TP-3	SOAKWAY TP-4
Input Parameter	**Storm Duration (mins)**	60	60
	A (m^2)	5000	5000
	R (m)	0.033	0.033
Calculated Parameter	**I (m^3)**	165	165
	Soil Perm (m/s)	6.42E-06	5.93E-06
	Duration (s)	3600	3600
	Soakway L (m)	**155**	**130**
	Soakaway W (m)	**0.75**	**1**
	Soakaway Depth (m)	**1.5**	**1.5**
	Soakaway Volume (m^3)	174.375	195
Use 0.95 for Wavin Aquacells	**Free Volume**	0.95	0.95
	As50 (m^3)	233.625	196.5
	O (m^3)	5.40	4.20
	I - O	160	161
Must be greater than I - 0	**Soakaway capacity (m^3)**	**166**	**185**
Must be less than 24	**ts50 (hrs)**	**15.3**	**22.1**

BRE 365

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Beauparc

Paramter	TP-3	TP-4
Width (m)	1.2	0.8
Length (m)	3	1.5
WC Depth (m)	1.3	0.7
Test Depth (m)	0.64	0.275
Time (min)	660	330
Volume (m^3)	2.304	0.33
Surface Area (m^2)	9.06	2.81
Infiltration Rate (m/s)	6.4218342E-06	5.9311981E-06
Infiltration Rate (m/d)	0.555	0.512

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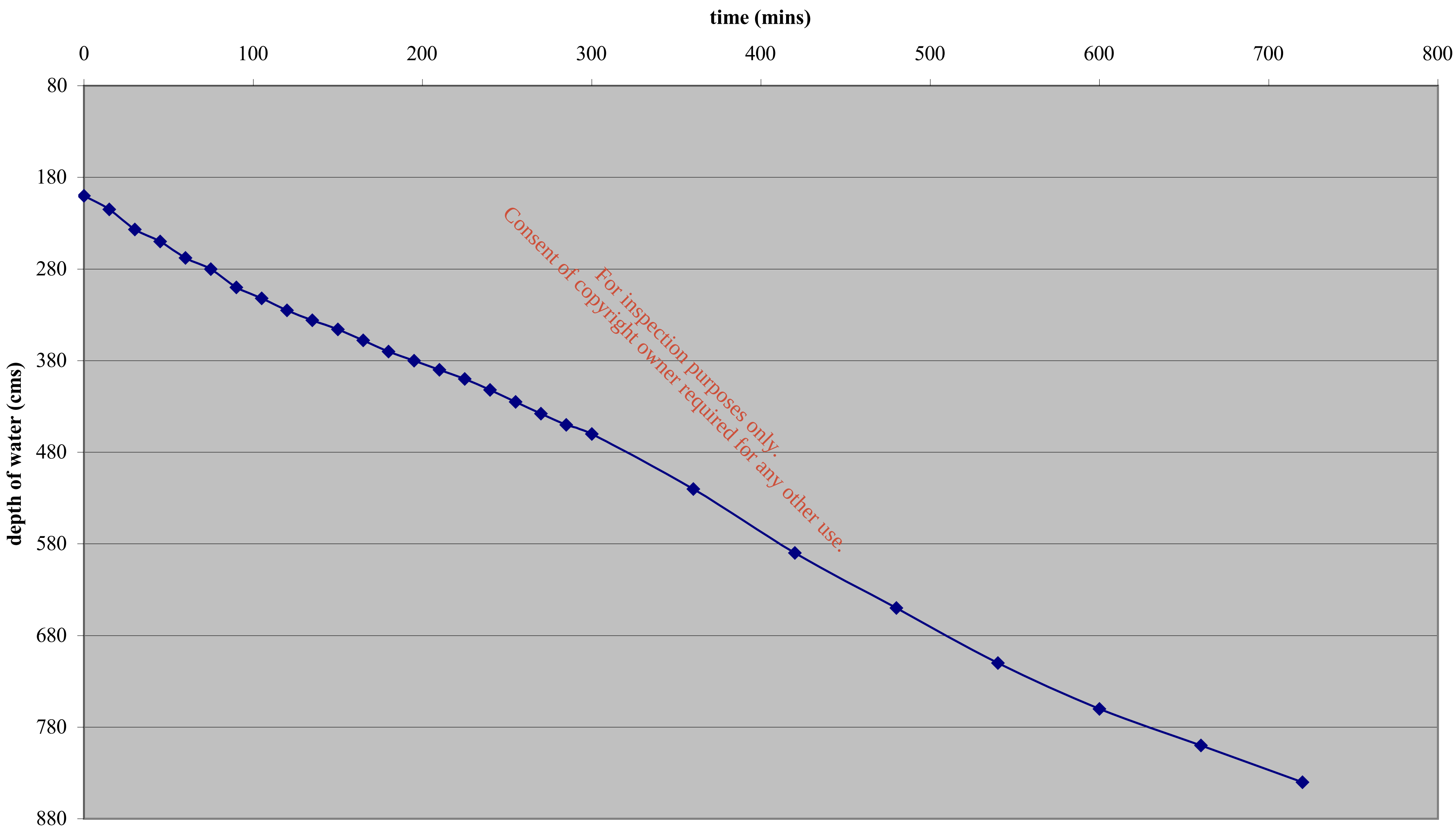
Soakway Infiltration Test Data Panda Beauparc TP3



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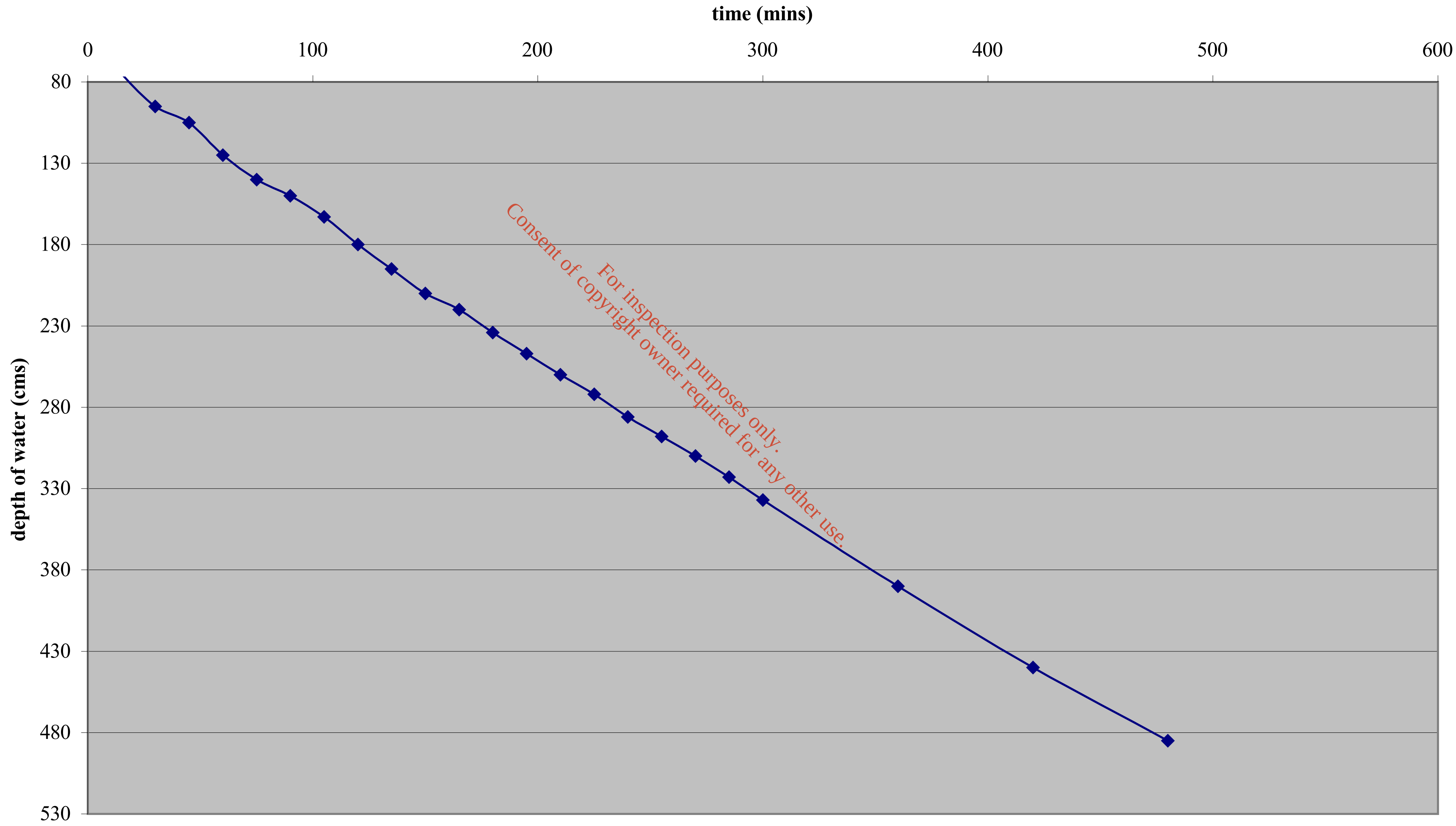
Soakway Infiltration Test Data Panda Beauparc TP4



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APPENDIX 7

Noise Report

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N&V

Noise & Vibration Consultants Ltd

Reg No: IE 8298170M
Principal: Brendan O'Reilly MSc ISEE SFA EAA

NOISE REPORT

Prepared For: Nurendale Ltd (Panda Waste)

Phase 4 Recycling Facility

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Report Prepared by: Brendan O'Reilly, Noise & Vibration Consultants Ltd (August 2009)

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TABLE OF CONTENTS

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1 Noise

1.1 Introduction

This report deals with the potential noise emission impacts associated with a proposed extension to the existing materials recycling facility at Rathdrinagh, Beauparc, Navan, Co. Meath. The development consists of the construction of phase 4 facility building, air treatment biofilter and CHP unit. Two steel and two concrete storage tanks will also be constructed which will house a waste anaerobic digestion and composting system. The purpose of this study is to:

- establish existing noise levels in the environs surrounding the proposed development prior to any activity
- project the noise levels generated by construction and completed development
- specify mitigating measures where deemed necessary

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Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment and is normally localised. Environmental noise is normally assessed in terms of A-weighted decibels, dB(A), where the A weighted filter in the measuring device elicits a response which provides a good correlation with the human ear. The criteria for environmental noise control are of annoyance or nuisance rather than damage. In general a noise level is liable to provoke a complaint whenever its level exceeds by a certain margin the pre-existing noise level or when it attains an absolute level. A change in noise level of 2 dB(A) is 'barely perceptible', while an increase in noise level of 10 dB(A) is perceived as a twofold increase in loudness.

Historically road traffic noise has been assessed using the L_{10} dB(A) parameter, the levels expressed as the arithmetic mean hourly value over specified time. Recent draft guidelines by the National Roads Authority recommend the use of the equivalent continuous levels, $L_{(Aeq)}$. For construction or industrial noise sources the assessment is usually expressed in equivalent continuous levels, $L_{(Aeq)}$. The acoustic terminology used in this report is more fully explained in the Appendix.

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2.0 The Receiving Environment

2.1 Baseline Noise Survey

A baseline noise survey was carried out at a key location nearest residents in the environs of the proposed development. Continuous monitoring was undertaken over a period from 13th to 16th August 2009. Weather was mainly dry during the survey with average wind speeds less than 5m/s. The following conditions were adhered to in undertaking the survey:

- Measurement of ambient noise levels was undertaken during varied weather conditions using instruments of Type 1 specification.
- Monitoring locations were selected to coincide with local residences.
- Measurements were undertaken during weekday and weekend periods.
- The survey was carried out in accordance with ISO 1996 Part 1 (Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures)

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Instrumentation Used

The following instrumentation was used in the baseline survey:

- Two Larson Davis 870 Precision Integrating Sound Level Analyser/Data logger with 900B Pre-amplifier and 1/2" Condenser Microphone Type 2541.
- Wind Shields Type: Larson Davis 2120 Windscreen.
- Calibration Type: Larson Davis Precision Acoustic Calibrator Model CA 250. (Serial No 1087).

Measurement Procedure

Monitoring was carried out at two locations (see noise prediction figure in Appendix) using environmental noise analysers with data logging facilities set on real time, the logged data was downloaded via a personal computer using computer software. The measurement location was as follows;

N1: Located at 35m from road edge, in garden along side of house facing existing facility

N2: Located in back garden of house facing existing facility

At monitoring location the microphone was located at 1.5m above ground level and away from reflecting surfaces. All acoustic instrumentation was calibrated before and after each survey and no drift of calibration was observed (calibration level 114 dB at 250 Hz).

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2.2 Results of Noise Survey

The existing noise levels were established during a period of continuous monitoring at a location along the boundary of the proposed development area. The result of this survey, which contains the total noise is typical of a environment which is located alongside an existing industrial site and busy National Primary Route (N2). Road traffic and industrial noise dominates the local environment. The complete dataset from the baseline study is given in the Appendix. A summary of the hourly intervals (mean values) measurements are given in Table 2.1 below.

Table 2.1 Baseline noise levels mean values – 1 hour interval data

Location	Date	Day-Time			Night-Time		
		Leq	L10	L90	Leq	L10	L90
N2	13th – 16th Aug'09	55.3	57.4	49.0	44.1	47.2	35.3
N1	13th – 16th Aug'09	52.1	54.2	46.8	47.9	50.9	42.3

Note Levels quoted are for mean (arithmetic average) for specified periods
Day-time is 08.00 to 20.00 hrs, night-time is 20.00 to 08.00 hrs

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3.0 Characteristics of Proposal

The proposed development consists of a number of noise sources (anaerobic digestion and composition system, CHP unit, air treatment biofilter system, shredder and trommel screen and front-end loaders) which will be contained inside the main building. The noise levels associated with this development would be from construction and the operation of completed facility. There will be no increased in traffic flow generated on the local road network from the completed development.

4.0 Potential Impacts of the Proposal

The proposed development consists of:

- construction of the main building and holding tanks
- the operation of the completed facility

Noise Criteria

Noise level measurement are made and assessed based on *ISO 1996 Description and Measurement of Environmental noise (3 Parts)*. This standard does not use a criterion of differentials, however, an increase in noise level of 5 dB(A) is considered as one of only

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marginal significance. In general a noise is liable to provoke a complaint whenever its level exceeds by a certain margin the pre-existing noise level or when it attains an absolute level. The method of deriving a criterion is related to the existing ambient noise level taking into account the various features of the existing noise environment at the nearer noise sensitive residences.

For outdoor noise at residential properties the basic criterion for night-time is normally less than 45 dB(A), while the day-time criterion is normally less than 55 dB(A). Local Authorities throughout Ireland and the EPA through their Licensing apply the aforementioned limits. The existing facility has a waste licence and limits are set under conditions by the EPA. For this proposed development existing limits will apply and these are: for night time (20.00 to 08.00 hrs) 30 minute Leq limit of 45 dB(A) will apply at all residences with a day time (08.00 to 20.00 hrs) 30 minute Leq limit of 55 dB(A). There should be no clearly audible tonal component or impulsive noise emission from activity at any noise sensitive location at night time.

4.1 Typical Construction Noise Sources and Noise Levels

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Leq measurements were taken of construction noise sources at other sites within the country at 20m from the geometric centre of activity when the equipment was in continuous operating mode. Noise levels of these noise sources are given in Table 4.1 and were as follows:

Table 4.1 Noise levels from construction activity at 20m

Noise Source	Noise Level Leq 1 hour
Readymix truck	70 dB(A)
Large Excavator	73 dB(A)
Vibratory Roller	68 dB(A)
Dump truck	71 dB(A)

4.2 Calculation and Prediction of Construction Noise

Methodology

The predicted noise levels generated by construction activity (or indeed any noise source) at a particular location can be calculated according to the following formula:

$$Lp2 = Lp1 + \Delta L\psi - \Sigma\Delta L \text{ where,}$$

Lp2 = Sound Pressure level in decibels at Residence.

Lp1 = Sound pressure level in decibels at 20 metres.

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$\Delta L\psi$ = correction for direction effects in a horizontal plane,

$\Sigma\Delta L = \Delta Ld + \Delta La + \Delta Lr + \Delta Ls + \Delta Lv + \Delta Lg + \Delta Lw$, and where,

ΔLd = geometric spreading (spherical radiation) and is calculated according to:

$\Delta Ld = 20 \log_{10} (d1/d2)$, where, d1 is the residence distance in metres, while d2 is 20 metres.

ΔLa = air absorption

ΔLr = reflection and diffraction

ΔLs = screening

ΔLv = vegetation

ΔLg = ground absorption

ΔLw = wind gradients

The attenuation effects due to air absorption, reflection, refraction and vegetation is small within distances of 100m and in the predictive calculation the attenuation from these factors is assumed to be zero at such distance. The other attenuating factors have been taken accounted for in the proposed development. The predicted levels are given in Table 4.2

Table 4.2 Predicted noise levels at key locations from construction activity

Receiver Position	Predicted Maximum Levels L_{AeqT} - 1 hour dB(A)	Predicted Typical Levels L_{AeqT} - 1 hour dB(A)
N1	54.5	<45
N2	52.8	<45
N3	50.5	<45
N4	49.2	<45

Note: A 4m high acoustic berm constructed on the boundary of the site using topsoil will reduce the noise emissions at house locations by more than of 8 dBA. The maximum Leq noise levels will pertain for short periods (less than one-week equivalent at any location for the entire project), while typical noise levels are for a period in excess of 50% of the total construction period.

Commentary

All construction will be carried out in accordance with BS 5228: Part 1: 2009[1]. All construction traffic to be used on site should have effective well-maintained silencers. Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery and limiting the hours of site activities that are likely to give high noise level

[1] Noise and Vibration Control on Construction and Open Sites BS5228- Part 1: 2009 *Code of Practice for Basic Information and Procedures for Noise Control*)

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emissions. Where possible the contractor will be instructed to use the least noisy equipment. With efficient use of well maintained mobile equipment considerably lower noise levels (3-6 dB(A)) than those predicted can be attained. The Project Engineer will closely supervise all construction activity. Construction activity due to its nature is a temporary activity and thus any impacts will be short term. All construction works will be carried out during daytime periods.

4.3 Noise Impacts from Operation of Completed Phase 4 Facility

The main noise sources associated with the operation of the phase 4 facility are housed inside a building structure. Table 4.3 gives the main noise sources and associated noise levels.

Table 4.3 Main noise sources and associated noise levels

Item of Plant	Noise Level (dBA) @ 1m	Comment
CHP unit- JMC 316 GS-B.L (rating 1400kva) inside	87	Unit housed inside an acoustically insulated container which will be located inside superstructure
Anaerobic digester and composition system Output fans x 8 each rated at 11kw Input fans x 8 each rated at 22kw Stack Fan	80 83 75	All fans will be housed inside acoustic housing structure (fan room) which will be located inside the superstructure At stack exit
Air treatment biofilter system Fans x 3 each at 55kw	80	Free-field having passed through acoustic ducting- Fans to be located inside fan room
Shredder Trommel screen Transfer conveyor Front-end loader x 3 Telescopic loader	96+ 95+ 80+ 98+ 95+	Measurement inside building Measurement inside building Measurement inside building Measurement inside building Measurement inside building
Biofilter pump Scrubber pump Dosing pump	75 78 80	Free-field Free-field Free-field

NB The main building is referred to as superstructure

+ Operating during day time only. All other equipment will operate at night time 24/7

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Prediction of Operational noise

The predicted noise levels are given in Table 4.4. In the calculations the transmission loss of 30 dBA provided by the superstructure (main building) was taken into consideration. The superstructure will be constructed of a base wall of minimum height of 3m with the finished height and roof of Kingspan double skinned cladding or equivalent. As a conservative measure no allowance was made for the attenuation provided by a 4.5m high acoustic earth berm.

Table 4.4 Predicted noise levels from operation of stage 4 facility

Receiver Position	Day time L_{AeqT} - 1 hour dB(A)	Night time L_{AeqT} - 1 hour dB(A)
N2	42.0	<35
N3	40.8	<35
N4	42.5	<35
N5	38.5	<35
N6	37.2	<35

NB The predicted Leq 1 hour level will be similar to a Leq 30 minute level

House N1 is owned by the developer

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5.0 Road Traffic Impacts

There will be no increase in road traffic generated by this development and accordingly there will be no increase in road traffic noise at any residence.

6.0 Ground Vibration

Ground vibration can be generated from construction traffic, light vehicles on the roadway and by construction activity. The level of ground vibration generated by the development will be below the threshold of perception (0.2-0.3mm/sec).

7.0 Mitigating Measures for Noise Control

The following mitigating measures will be put in place:

- A 4m high acoustic berm will be constructed on the perimeter of the facility using topsoil excavated from the site.

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- Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery, turn off equipment / plant when not in use and limit the hours of site activities that are likely to give high noise level emissions.

- All extraction fans, openings for cooling units/vents to the outside of the main building (superstructure) will be acoustically treated (by acoustic louvers or alternative) so that noise emissions at the complex boundary will be less than 45 dB(A) and less than 35 dBA at all residences (with no clearly audible tonal component).

- The housing envelope of main building (superstructure) will have a concrete base wall with a minimum height of 3m with the remaining height to finished height and roof, of Kingspan double skinned cladding with insulation, or equivalent. (a concrete wall of mass per unit area of 300kg/m^2 will give an average transmission loss of 50 dB[2] while a double skinned cladding of Kingspan type equivalent will give a sound transmission loss of 30 dB).

- All doors (including the roller shutter doors) to the main building will be kept shut during operations.

- Any openings for cooling or forced ventilation will have acoustic louvers or equivalent fitted.
- All fans will be housed inside the main building inside a fan room.

- The CHP container unit acoustically treated will be hosed inside the main building (superstructure).

8.0 Assessment and Conclusion

The maximum noise levels predicted will occur during the construction phase of the development and will pertain for short periods only. The noise impact from the operation of the completed phase 4 recycling facility will have a negligible noise impact by day and by night at all residences. Furthermore the noise levels at night time should be inaudible at all residences. As there is no increase in traffic being generated there should be no increase in road traffic noise at any residence

[2] Encyclopedia of Acoustics, Vol 3, Architectual Acouistics, M. J. Crocker (1997)

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APPENDIX 1

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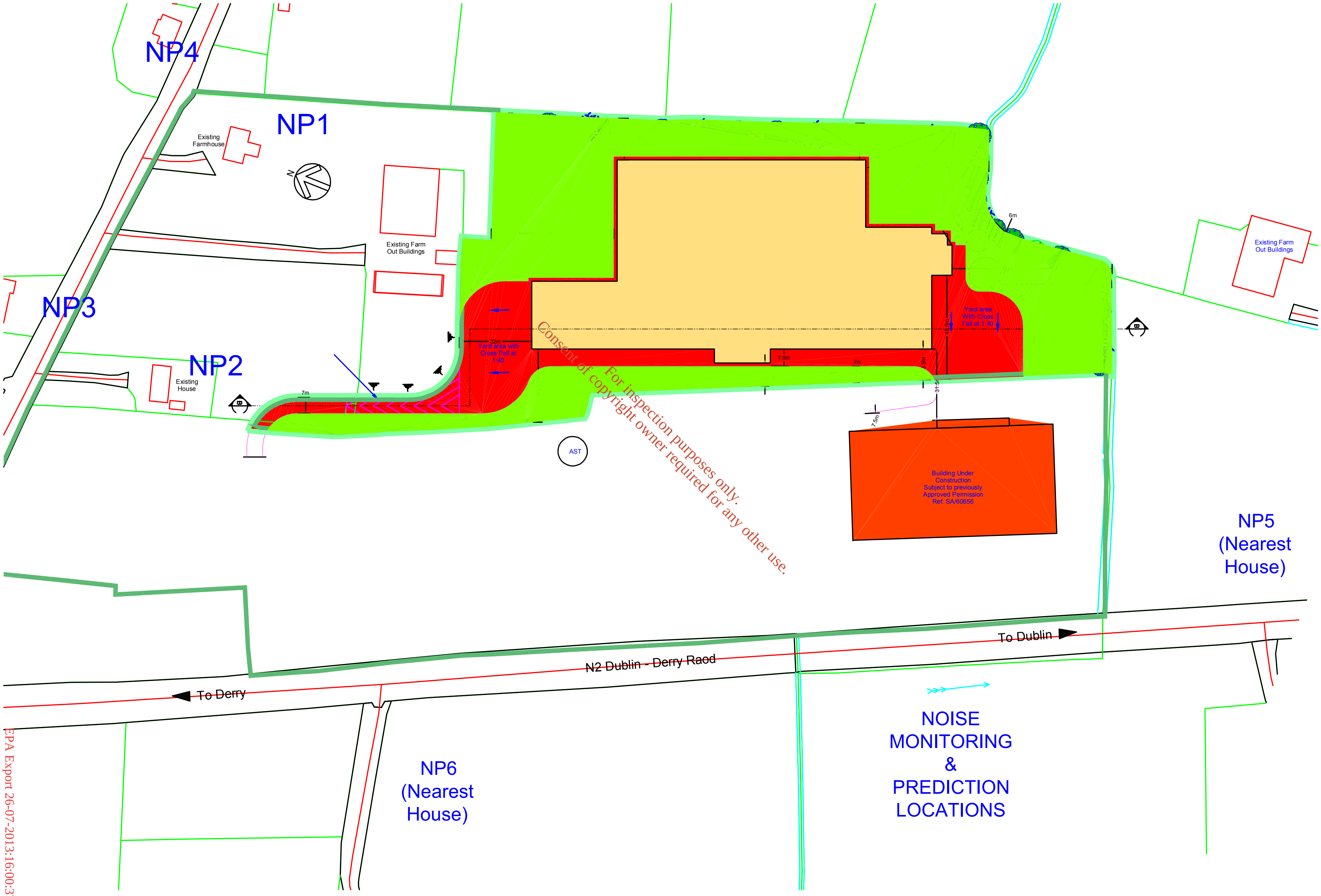

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Table 1.0 **Location N1**

Model 870 Interval Report
From File: PANDA1.870
Period = 01:00 (hh:mm)

Date	Time	Duration	Leq dBA	Lmax dBA	L5 dBA	L10 dBA	L50 dBA	L90 dBA
12Aug2009	12:55:16	04:43.9	59.3	85.2	62.2	58.6	53.7	47.1
12Aug2009	13:00:00	1:00:00	52.7	72	57.1	54	49.6	47
12Aug2009	14:00:00	1:00:00	50.8	68.7	54.6	52.5	48.6	46.3
12Aug2009	15:00:00	1:00:00	53.5	68.7	56.8	55.8	52.5	48.1
12Aug2009	16:00:00	1:00:00	60.2	80.2	64.2	61	55.1	51
12Aug2009	17:00:00	1:00:00	75.2	96	79.9	75	56.8	48.6
12Aug2009	18:00:00	1:00:00	52.3	72.2	57.2	54.1	49	45.8
12Aug2009	19:00:00	1:00:00	50.7	72.5	55.3	52.3	47.7	44.2
12Aug2009	20:00:00	1:00:00	49.8	73.7	53.3	50.1	45	41.2
12Aug2009	21:00:00	1:00:00	45.8	66.2	49.7	48	43.3	39.3
12Aug2009	22:00:00	1:00:00	44.6	62.2	48.8	47.2	42.2	37.2
12Aug2009	23:00:00	1:00:00	43.7	64.2	48.6	47.1	40.8	34.5
13Aug2009	00:00:00	1:00:00	41.6	60.8	46.3	44.6	38.6	34.2
13Aug2009	01:00:00	1:00:00	39.2	56.7	45.1	43.2	34.8	31.6
13Aug2009	02:00:00	1:00:00	38.6	52.8	43.8	42.2	35.7	31.6
13Aug2009	03:00:00	1:00:00	38	60	43.7	41.7	33.2	30.3
13Aug2009	04:00:00	1:00:00	40.1	56.8	45.7	43.8	36.7	31.1
13Aug2009	05:00:00	1:00:00	45.6	64.7	51.1	48.1	41.8	37.1
13Aug2009	06:00:00	1:00:00	48.8	72.5	52.7	51.2	46.5	41.7
13Aug2009	07:00:00	1:00:00	51.2	76.5	54.7	51.7	47.6	44.8
13Aug2009	08:00:00	1:00:00	50.5	68.5	54.5	51.8	48.3	46.2
13Aug2009	09:00:00	1:00:00	58.8	86.5	57.2	53.7	48	46
13Aug2009	10:00:00	1:00:00	50.7	74	55.8	52	47.2	44.5
13Aug2009	11:00:00	1:00:00	52.7	71	56.8	54.1	49.8	44.7
13Aug2009	12:00:00	1:00:00	53.6	72.9	58.5	55.6	50.2	46.8
13Aug2009	13:00:00	1:00:00	53.2	91.2	55.6	52.6	46.3	43.6
13Aug2009	14:00:00	1:00:00	54.1	75.4	58.2	55.7	51.7	46.2
13Aug2009	15:00:00	1:00:00	58.2	77	62.5	61.2	57.3	51.5
13Aug2009	16:00:00	1:00:00	53.6	73.2	57.3	55.6	51.2	47.6
13Aug2009	17:00:00	1:00:00	49.8	69	54	52	48.1	45.6
13Aug2009	18:00:00	1:00:00	53.7	72.2	57.2	55.5	50.7	47.2
13Aug2009	19:00:00	1:00:00	52.2	69.9	56.2	54.7	51	47.6
13Aug2009	20:00:00	1:00:00	50.7	69	55.3	53.8	48.7	44.2
13Aug2009	21:00:00	1:00:00	50	67.5	54.8	53.2	47.6	42.2
13Aug2009	22:00:00	1:00:00	47.7	65	52.7	51.1	45	37.7
13Aug2009	23:00:00	1:00:00	45.2	63.2	51	49	41.2	32.2
14Aug2009	00:00:00	1:00:00	46.5	66.9	52	48.7	39.2	30.5
14Aug2009	01:00:00	1:00:00	42.3	61.3	49.2	46.8	33.5	29
14Aug2009	02:00:00	1:00:00	42.2	59.1	49.1	46.2	35.2	29.3
14Aug2009	03:00:00	1:00:00	39.7	60.6	46.3	43	31.6	28.1
14Aug2009	04:00:00	1:00:00	41.7	61.2	47.7	45.2	35.8	31.3
14Aug2009	05:00:00	1:00:00	45.8	60.6	51.2	49.3	43.3	38.7
14Aug2009	06:00:00	1:00:00	52.7	75.2	55.7	53.7	48.8	44.2
14Aug2009	07:00:00	1:00:00	55.5	84.7	58.2	56.7	52.6	48.7
14Aug2009	08:00:00	1:00:00	55.1	69.7	58.3	57.5	53.7	50.6
14Aug2009	09:00:00	1:00:00	57.7	73.5	60.2	59.3	56.8	54.7
14Aug2009	10:00:00	1:00:00	60.2	89.4	62.2	61	57.2	52.7
14Aug2009	11:00:00	1:00:00	58.5	70.5	61.5	60.6	58	55.3
14Aug2009	12:00:00	1:00:00	58.1	71.2	61.5	60.6	57.6	53.8

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Table 1.0 Cont'd **Location N1**

Model 870 Interval Report
From File: PANDA1.870
Period = 01:00 (hh:mm)

Date	Time	Duration	Leq dBA	Lmax dBA	L5 dBA	L10 dBA	L50 dBA	L90 dBA
14Aug2009	13:00:00	1:00:00	57	70	61	59.6	55.7	52.7
14Aug2009	14:00:00	1:00:00	60.2	68.5	63.2	62.3	59.5	57.2
14Aug2009	15:00:00	1:00:00	60	71.5	62.8	62	59.2	56.8
14Aug2009	16:00:00	1:00:00	58.2	68.4	61.6	60.6	57.5	54
14Aug2009	17:00:00	1:00:00	57.2	75	60.8	59.7	56.2	53
14Aug2009	18:00:00	1:00:00	56.3	75.9	60.3	59.1	54.7	51.1
14Aug2009	19:00:00	1:00:00	53.7	66	59	57.2	51.2	46.7
14Aug2009	20:00:00	1:00:00	51.2	74.7	54.8	53	48.7	44.5
14Aug2009	21:00:00	1:00:00	53.7	95	54.5	53.1	48.2	43.3
14Aug2009	22:00:00	1:00:00	51.8	68.4	56.7	55.1	49.8	44.8
14Aug2009	23:00:00	1:00:00	52.2	66.7	57.3	55.8	50.2	44.7
15Aug2009	00:00:00	1:00:00	55.2	68.7	60.3	58.7	52.7	47
15Aug2009	01:00:00	1:00:00	54.2	69.5	59.2	57.5	52	46.7
15Aug2009	02:00:00	1:00:00	53.6	72.4	58.7	57	50.8	45.2
15Aug2009	03:00:00	1:00:00	52	66.4	57.2	55.6	49.7	44.2
15Aug2009	04:00:00	1:00:00	51.8	65.2	56.2	55	50.3	45.6
15Aug2009	05:00:00	1:00:00	50.3	65.5	55.3	53.7	47.7	43.1
15Aug2009	06:00:00	1:00:00	54.1	67.2	58.3	57.1	52.8	47
15Aug2009	07:00:00	1:00:00	55	71	58.8	57.3	53.3	50.6
15Aug2009	08:00:00	1:00:00	53.8	69	58	56.7	52.7	49.5
15Aug2009	09:00:00	1:00:00	54.3	67.5	58.8	57.1	52.6	49.2
15Aug2009	10:00:00	1:00:00	53.2	67.2	57.2	55.6	52.1	49
15Aug2009	11:00:00	1:00:00	52.1	68.2	56.2	54.6	50.7	48
15Aug2009	12:00:00	1:00:00	54.7	69.7	59.1	57.7	53.3	49.7
15Aug2009	13:00:00	1:00:00	57	85	60.2	58.7	53.8	49.7
15Aug2009	14:00:00	1:00:00	55.3	70.7	59.7	58.3	53.8	49.8
15Aug2009	15:00:00	1:00:00	54.2	69.4	59	57.5	52.3	48
15Aug2009	16:00:00	1:00:00	55.6	74.9	60.6	58.7	53.2	49.1
15Aug2009	17:00:00	1:00:00	54.2	67.7	58.7	57.2	52.3	48.7
15Aug2009	18:00:00	1:00:00	56.3	78.4	60.6	59.1	54.7	51
15Aug2009	19:00:00	1:00:00	53.6	68.7	58.2	56.7	52	48.2
15Aug2009	20:00:00	1:00:00	50.2	70.2	54.8	53.1	48	43.2
15Aug2009	21:00:00	1:00:00	49	67.4	53.8	51.7	46.2	41.7
15Aug2009	22:00:00	1:00:00	47.2	67	52.2	50.2	44.3	39.6
15Aug2009	23:00:00	1:00:00	46.1	65.2	51	49.3	43.5	38.2
16Aug2009	00:00:00	1:00:00	44.7	66.5	49.6	47.8	41.7	37
16Aug2009	01:00:00	1:00:00	44.2	60.5	49.2	47.3	41.6	36.8
16Aug2009	02:00:00	1:00:00	48	63.5	53.6	51.5	45	39.3
16Aug2009	03:00:00	1:00:00	49.2	63.3	55	52.8	46.1	40.5
16Aug2009	04:00:00	1:00:00	49.6	66.4	54.7	53	47	41.7
16Aug2009	05:00:00	1:00:00	50.8	68	56.2	54.2	47.8	42.7
16Aug2009	06:00:00	1:00:00	51.2	66.2	56.2	54.7	49.2	44
16Aug2009	07:00:00	1:00:00	53	67.7	57.7	56.2	51.1	46.7
16Aug2009	08:00:00	1:00:00	54	72.7	58.8	57.1	51.7	47.2
16Aug2009	09:00:00	1:00:00	53.6	72	58.2	56.7	51.7	47.2
16Aug2009	10:00:00	1:00:00	54.1	68.2	58.7	57.3	52.3	47.8
16Aug2009	11:00:00	1:00:00	55.1	68.5	59.6	58.2	53.5	49.2
16Aug2009	12:00:00	1:00:00	55.2	68.4	60.1	58.6	53.2	48.6
16Aug2009	13:00:00	1:00:00	54.5	67.5	59.1	57.7	52.8	48.5
16Aug2009	14:00:00	1:00:00	54.6	70.4	59	57.7	52.7	48.5
16Aug2009	15:00:00	1:00:00	54.8	79.2	59	57.6	52.5	48.1
16Aug2009	16:00:00	1:00:00	55.2	71.7	59.7	58.2	53.5	49.5

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Table 2.0 **Location N2**

Model 870 Serial Number:A0313 Interval Report

From File: PAND2.870 Mon 17Aug2009 12:27:16

Period = 01:00 (hh:mm)

Date	Time	Duration	Leq dBA	Lmax dBA	L1 dBA	L5 dBA	L10 dBA	L50 dBA	L90 dBA
12Aug2009	11:50:49	09:10.7	52.6	78.7	55.8	54	53.2	51.5	50.1
12Aug2009	12:00:00	1:00:00	50.2	74.7	54.7	52.7	51.7	49.2	47.1
12Aug2009	13:00:00	1:00:00	49.5	64.2	53.8	52.2	51.5	48.8	47
12Aug2009	14:00:00	1:00:00	49.5	62.3	53.6	51.8	51.2	49.1	46.8
12Aug2009	15:00:00	1:00:00	50.5	60.5	54.7	53	52.2	50.1	48.1
12Aug2009	16:00:00	1:00:00	49	59.8	53	51.5	50.7	48.5	46.6
12Aug2009	17:00:00	1:00:00	46.7	65	54	50.7	49.2	45.2	42.2
12Aug2009	18:00:00	1:00:00	44.6	64.5	51.2	48.2	46.8	43.3	39.7
12Aug2009	19:00:00	1:00:00	45.2	76.2	51.1	47.2	45.8	42.1	38.5
12Aug2009	20:00:00	1:00:00	39.7	54	46.2	44	42.7	38.5	35
12Aug2009	21:00:00	1:00:00	39.1	64.7	46.3	43.2	41.7	37.2	32.8
12Aug2009	22:00:00	1:00:00	40.3	73.2	47.7	43.7	42.2	35.8	29.5
12Aug2009	23:00:00	1:00:00	36.3	55.1	45.1	42.1	40.2	33.2	28
13Aug2009	00:00:00	1:00:00	33.8	53.1	44	39.7	37.3	29.8	26.1
13Aug2009	01:00:00	1:00:00	32.8	48.6	42.2	38.2	36.3	30	25.8
13Aug2009	02:00:00	1:00:00	32.2	47.2	41.7	37.8	35.6	29.3	25.1
13Aug2009	03:00:00	1:00:00	37	56.5	45.7	42.2	40.2	33.3	25.6
13Aug2009	04:00:00	1:00:00	41.7	59.6	52.1	46.8	44.7	38.5	32.2
13Aug2009	05:00:00	1:00:00	46.7	69.5	57.6	52.8	50	42	36.5
13Aug2009	06:00:00	1:00:00	50.3	72.7	60.5	54.8	51.6	46.6	43.7
13Aug2009	07:00:00	1:00:00	51.3	77.5	60.2	54.7	52.2	48.8	47
13Aug2009	08:00:00	1:00:00	50.2	76.5	56.8	52.7	51.3	48.6	46.7
13Aug2009	09:00:00	1:00:00	48	71.5	53.5	50.7	49.7	47.2	45.1
13Aug2009	10:00:00	1:00:00	49.6	66.2	55	52.5	51.2	48.7	47.1
13Aug2009	11:00:00	1:00:00	49.8	62.6	55	52.6	51.6	49.3	47.8
13Aug2009	12:00:00	1:00:00	48.7	63.7	55.6	51.8	50.6	47.7	45.3
13Aug2009	13:00:00	1:00:00	51.7	70.5	57.3	55	54	51	48.6
13Aug2009	14:00:00	1:00:00	52.5	64.7	56.7	54.7	54	52.1	50.2
13Aug2009	15:00:00	1:00:00	51.3	66.2	57	54.2	53.2	50.7	47.8
13Aug2009	16:00:00	1:00:00	50.7	73.2	61.3	53	51.5	47.8	45.8
13Aug2009	17:00:00	1:00:00	48.7	65.2	53.7	51.5	50.5	48.1	46.1
13Aug2009	18:00:00	1:00:00	50.2	62.8	56	53.7	52.6	49.5	47.2
13Aug2009	19:00:00	1:00:00	49.2	61.6	55.8	53.3	52	48.1	43.7
13Aug2009	20:00:00	1:00:00	48.3	61.2	55.7	53.1	51.6	46.7	41.5
13Aug2009	21:00:00	1:00:00	47.3	61.8	55.6	52.7	51.2	44.7	36.3
13Aug2009	22:00:00	1:00:00	45.2	63.1	54.6	51	49.1	41.5	32.2
13Aug2009	23:00:00	1:00:00	41.7	57.7	51.2	47.7	45.6	37.7	30.3
14Aug2009	00:00:00	1:00:00	39.2	70	49.3	44.5	42.2	33.6	26.3
14Aug2009	01:00:00	1:00:00	39	57	49.7	45.2	42.8	32.7	26.1
14Aug2009	02:00:00	1:00:00	37.7	57.2	48	44	41.7	31.3	25.3
14Aug2009	03:00:00	1:00:00	41.5	60.2	51.3	47.7	45.2	37.1	28
14Aug2009	04:00:00	1:00:00	44.7	60.6	53.7	50.1	48.2	41.6	34.3
14Aug2009	05:00:00	1:00:00	49.7	62.7	57.2	54.5	53	48	42.8
14Aug2009	06:00:00	1:00:00	52.6	72	58.1	56	55.1	51.7	48.3
14Aug2009	07:00:00	1:00:00	54.2	67.2	59.6	57.7	56.7	53.2	50.5
14Aug2009	08:00:00	1:00:00	56.3	72	60.7	59	58.2	55.8	53.8
14Aug2009	09:00:00	1:00:00	56.7	78.9	63.1	59	58.2	55	50.7
14Aug2009	10:00:00	1:00:00	56.6	70.4	61.3	59.7	58.8	55.8	53.2
14Aug2009	11:00:00	1:00:00	57.3	76	62.6	60.6	59.7	56.7	53.2
14Aug2009	12:00:00	1:00:00	55.3	66.9	61	59	57.8	54.5	51.7

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Table 2.0 Cont'd **Location N2**

Model 870 Interval Report
From File: PAND2.870
Period = 01:00 (hh:mm)

Date	Time	Duration	Leq dBA	Lmax dBA	L1 dBA	L5 dBA	L10 dBA	L50 dBA	L90 dBA
14Aug2009	13:00:00	1:00:00	57.7	66.5	62.3	60.7	59.8	57.2	54.5
14Aug2009	14:00:00	1:00:00	57.5	72	62.1	60.6	59.7	56.8	54.3
14Aug2009	15:00:00	1:00:00	56.6	68.5	61.6	59.7	58.8	56	53.2
14Aug2009	16:00:00	1:00:00	55.2	66	60.5	58.7	57.8	54.6	51.1
14Aug2009	17:00:00	1:00:00	53.8	73.5	60.2	57.8	56.7	52.6	48
14Aug2009	18:00:00	1:00:00	52.2	70	59.8	57.5	55.7	50.2	44.6
14Aug2009	19:00:00	1:00:00	48.5	71.5	55.8	53.2	51.8	46.6	41
14Aug2009	20:00:00	1:00:00	51.8	92.2	56.5	53.3	51.7	45.8	40
14Aug2009	21:00:00	1:00:00	47.7	66.9	56.5	53.3	51.7	44.5	37.8
14Aug2009	22:00:00	1:00:00	46.7	67	56.7	52.7	50.6	42.1	36.6
14Aug2009	23:00:00	1:00:00	46.3	66.7	56.6	52	49.7	42.1	37.6
15Aug2009	00:00:00	1:00:00	46.3	63.7	56.1	52	49.7	42.7	38.2
15Aug2009	01:00:00	1:00:00	44.2	64.2	54.7	49.6	46.8	40.2	35.7
15Aug2009	02:00:00	1:00:00	43.7	62.2	53.8	49.2	46.3	40.1	35.7
15Aug2009	03:00:00	1:00:00	45.2	60.7	54.6	50.3	48.1	42.6	39.2
15Aug2009	04:00:00	1:00:00	44.7	69.4	54.7	50	47.7	40.6	36.6
15Aug2009	05:00:00	1:00:00	48.6	65.7	57.1	53.7	52.1	46.7	38.3
15Aug2009	06:00:00	1:00:00	52.2	64.2	58.5	56	54.7	51.2	48.7
15Aug2009	07:00:00	1:00:00	53.1	68.9	60.8	56.8	55.3	51.5	49.1
15Aug2009	08:00:00	1:00:00	52.7	67.9	58.8	56.3	55.2	51.7	49.3
15Aug2009	09:00:00	1:00:00	51.2	71.9	56.8	54	53	50.2	48.1
15Aug2009	10:00:00	1:00:00	50.5	65	55.7	53.2	52.3	49.7	47.7
15Aug2009	11:00:00	1:00:00	52	70.7	57	55	54	51.2	49
15Aug2009	12:00:00	1:00:00	52.6	79.4	59.2	55.3	54.2	50.5	47.3
15Aug2009	13:00:00	1:00:00	51.3	73.7	59.1	54.8	53.5	49.7	46.2
15Aug2009	14:00:00	1:00:00	50.8	74	58	54.6	53.3	49.2	44.3
15Aug2009	15:00:00	1:00:00	53.7	83	62.3	57	56	50.3	46
15Aug2009	16:00:00	1:00:00	50	67.5	56.7	54.2	53	48.5	44.5
15Aug2009	17:00:00	1:00:00	52	81.2	58.2	55.8	54.6	50.5	46.6
15Aug2009	18:00:00	1:00:00	50	66	57.1	54.5	53.2	48.5	43.7
15Aug2009	19:00:00	1:00:00	47.8	70	55.7	52.7	51.2	45.7	39.7
15Aug2009	20:00:00	1:00:00	46.6	64.5	54.5	51.7	50.2	44.2	38.2
15Aug2009	21:00:00	1:00:00	44.2	59.7	53.2	49.8	48.1	41.3	33.7
15Aug2009	22:00:00	1:00:00	42.3	58.3	51.5	48.2	46.2	38.7	31.1
15Aug2009	23:00:00	1:00:00	42.3	62.3	52.8	48.8	46.2	36.3	29.3
16Aug2009	00:00:00	1:00:00	40.7	59.8	50.8	47	44.7	35	30
16Aug2009	01:00:00	1:00:00	41.3	61	51.8	47.2	44.8	36.3	31.6
16Aug2009	02:00:00	1:00:00	41.5	60.7	52.5	47.1	43.7	37.5	34.1
16Aug2009	03:00:00	1:00:00	43.2	64	54.6	49.1	45.8	38.2	34.2
16Aug2009	04:00:00	1:00:00	41.8	59.1	52.3	47.2	44.3	38.6	34.8
16Aug2009	05:00:00	1:00:00	46.6	72.2	56.7	52.7	50.3	41.1	36.2
16Aug2009	06:00:00	1:00:00	47.7	65.5	57.6	53.7	51.7	43.3	38.5
16Aug2009	07:00:00	1:00:00	47.6	68.5	56.3	52.7	50.8	44.7	40.6
16Aug2009	08:00:00	1:00:00	49.1	66.7	57	54.1	52.5	46.7	41.5
16Aug2009	09:00:00	1:00:00	50.2	64.2	57.8	55	53.5	48.2	42.8
16Aug2009	10:00:00	1:00:00	51.3	66.5	58.6	55.8	54.6	49.7	44.6
16Aug2009	11:00:00	1:00:00	50.7	70.2	57.8	55.1	53.7	49	44.1
16Aug2009	12:00:00	1:00:00	55.8	77.9	68.5	59.3	57.5	50.7	45.3
16Aug2009	13:00:00	1:00:00	60.2	81.5	73	65.7	59.2	51.3	46.3
16Aug2009	14:00:00	1:00:00	51.3	79.5	58.7	55.2	53.7	49	43.8

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Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment and is normally localised.

Units of Measurement

The units of measurements of noise must reflect our overall response to it. The basic difficulty in measuring noise is the huge range of sensitivity of the ear. Audible sound pressures range between the threshold of hearing (0.00002N/m^2) and the threshold of feeling (20N/m^2) which corresponds to a ratio of 1 to 1,000,000. In order to cover this wide range, a logarithmic unit, the decibel (dB) is used. The dB scale ranges from 0 to 120/140 dB. While the size of the pressure fluctuations is measured in dB, the rate of pressure fluctuations is measured in cycles per seconds or Hertz (Hz).

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The human ear has a limited frequency range from about 20 Hz to 20 kHz, the upper end depending on the age of the person and previous exposure to high levels of noise. Within that range the ear can tolerate low frequencies more than middle to high frequencies and we must ensure that any measurement device elicits a numerical value which matches the ear's response. This is achieved by introducing an electronic filter (called an A-weighted filter) into the measuring system. This weighting characteristic provides good correlation with the noise annoyance, and, since it's maximum lies in the frequency region where the ear is most sensitive, it takes into account the hearing damage potential of the noise. For this reason environmental noise levels are generally measured in terms of A weighted decibels, dB(A). A noise level in excess of 85 dB(A) gives a significant risk of hearing damage. A noise level increase of 2 dB(A) is barely perceptible while an increase in noise level of 10 dB(A) is perceived as a twofold increase in 'loudness'.

Statistical Noise Indices

Where noise levels vary in time, statistical analysis of the variation can be carried out. The results are usually stated in the form L_N (L for level), where N is the percentage of time a level is equalled or exceeded. Hence if L_{90} = 40 dB(A), the noise level exceeds 40 dB(A) for 90% of the time measured period (i.e. background noise level is 40 dB(A). Background noise level could be described as the lowest 10% of noise level over a given period

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In addition to the statistical units, the equivalent continuous level is also measured. The equivalent continuous level, $L_{eq,}$ is measured in dB(A) and is a notional steady level that has the same sound energy as the real fluctuating sound over the measurement period. It is measured using an integrating sound level meter.

Noise Criteria

The criterion is one of annoyance or nuisance rather than damage. The relevant standard presently in use is ISO 1996 (3 Parts). This standard does not use the criteria of differentials, however an increase in noise level of 5 dB(A) is considered as one of only marginal significance. In general a noise is liable to provoke a complaint whenever its level exceeds by a certain margin the pre-existing noise level or when it attains an absolute level. The method of deriving a criterion is related to the existing ambient noise level taking into account the various features of the noise environment at the nearest relevant residences to the development.

In accordance with International Standard ISO 1996 (3 Parts) and British Standard 4142: 1990, most planning criteria are now stated in terms of L_{Aeq}.

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Road traffic noise may cause annoyance and the parameter currently used in the assessment of traffic noise is the L10 dB(A) level. The parameter used in the UK (Ref; Calculation of Road Traffic Noise 1988, Dept of Transport Welsh Office: HMSO) and until recently by Local Authorities in Ireland is the 18 hour L10, this is the arithmetic mean of the hourly L10 levels in the period 06.00 to 24.00 hours. . Recent draft guidelines (Jan'04) by the National Roads Authority recommend the use of the equivalent continuous levels, $L_{(Aeq)}$ and specifying night time as23.00 to 07.00 hrs.

Construction and industrial noise is usually expressed in L_{Aeq}. The daytime criterion for industrial noise is normally between 45 - 55 dB(A) (Ref EPA's Guidance Note in Relation to Scheduled Activities). For construction development noise there are no Irish Standards applicable, however it is normal to apply one of best endeavour, which means keeping the daily Leq values as low as practicable (less than 65 dB(A)).

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APPENDIX 2

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Noise Impact Assessment: Site Fully Operational

The predicted noise levels at the monitoring locations when all four Buildings are operational are presented in Table 1. The monitoring locations are shown on the Map in the Noise & Vibrations Consultants Ltd Report

Table 1

Receiver Position	Day time L_{AeqT} . 1 hour dB(A)	Night time L_{AeqT} . 1 hour dB(A)
N2 (N2*)	50.0	<35
N3	48	<35
N4 (N2B*)	49	<35
N5	45	<35
N6	46	<35

* Monitoring point specified in the Waste Licence

The existing noise levels on the perimeter of the enlarged site will not be changed substantially due to a number of reasons

(a) all new facilities Buildings 3 and 4 will have noise sources housed
(b) the main noise sources for Building 3 are already on site and will be relocated into Building 3
(c) the wood shredder will be moved from the open yard into Building 3

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