ENVIRONMENTAL IMPACT STATEMENT FOR THE CONTINUED OPERATION OF POWERSTOWN LANDFILL, CO. CARLOW

Volume 3 – APPENDICES

FEBRUARY 2011

CARLOW COUNTY COUNCIL
COMHAIRLE CHONTAE CHEATHARLOCHA

FEHILY TIMONEY & COMPANY

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VOLUME 3 - APPENDICES

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Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
1	Issue to Client	COC/MG	ME ME	BG	10.02.2012

Client: Carlow County Council

Keywords: Landfill, time extension, cells, final contours, waste licence

Abstract: This report forms the appendices of the Environmental Impact Statement for the continued operation of the landfill at Powerstown, Co. Carlow.

Q: LW11-120-03/Rpt003-1_Appendices

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Appendix 1

Needs Assessment

NEED ASSESSMENT FOR THE CONTINUED OPERATION & INTENSIFICATION OF POWERSTOWN LANDFILL, CO. CARLOW

February 2012

CARLOW COUNTY COUNCIL

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Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
1	Revised Issue to Client	DFM/MG	BG		09.02.2012

Client: Carlow County Council

Keywords: need assessment, landfill capacity, infrastructure

Abstract: Fehily Timoney & Company was retained by Carlow County Council to carry out a needs assessment to determine the viability of applying for an extension to the time limit imposed on operations at Powerstown Landfill by An Bord Pleanála

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1. INTRODUCTION

The Powerstown facility operates under waste licence W0025-03 and has been in operation since 1975. In 2004, An Bord Pleanála granted Carlow County Council (CCC) permission (PL01.EL2020) to extend the landfill to include the development of a new site entrance, offices, a recycling centre as well as four engineered landfill cells. This permission also had a time limit imposed which requires landfilling activities to cease at the site in January 2012.

In the past number of years, there has been a marked decline in the amount of waste accepted at the facility which can be attributed, in part, to the economic downturn and in part, to the development and restructuring of the Irish waste market.

As a result of this decline, two of the four cells constructed as part of the 2004 extension remain unfilled and will not be filled within the 2012 time limit. As a consequence, CCC are applying to An Bord Pleanála for consent to continue landfilling operations at the site until such time as the two cells are filled and the final restoration contours of the site are reached. To ensure that the remaining cells are filled in an economical timeframe and to ensure sufficient aftercare funds are available (as legally required), it is proposed to increase the annual intake tonnage from 40,000 tonnes per annum (tpa) to 50,000 tpa.

It should be noted that it is not proposed to increase the footprint of the landfill, nor is it proposed to construct any additional infrastructure over and above what is already constructed. Rather, the application is for the extension of the life of the landfill until the remaining constructed cells are filled **only**.

1.1 The Assessment of Need

The structure of the waste management industry in Ireland has changed considerably since An Bord Pleanála granted the time limited permission (PL01.EL2020) in 2004. In 2004, there were c. 34 active landfills in Ireland accepting municipal solid waste (MSW)[1], with 4 located in the South East Waste Management Region (SEWMR).

In 2012, there are 16 no. active landfills accepting residual waste nationally. A dramatic drop in the number of operational landfills between 2009 and 2012 has been observed, as shown in Figures 1.1 & 1.2, with there being 27 operational facilities in the country in 2009. It is further anticipated that, by 2015, a maximum of 7 no. operational landfills will remain in Ireland, in addition to the Carranstown Energy from Waste (EfW) facility (online in Q4 of 2011) and the Poolbeg EfW (assumed online in 2016).

Of the 3 no. landfills located in the SEWMR in 2012 i.e. Powerstown, Donohill & Holmestown Wood, it is unclear what capacity will be provided by these facilities in the future.

Donohill landfill, operated by South Tipperary County Council, is due to cease waste acceptance at the end of 2012 as the remaining void is utilised.

In November 2011, it was confirmed that the operation of the Wexford County Council Holmestown Wood landfill was under review with a possible closure date of the end of February 2012 being identified[2]. While a formal decision has yet to made regarding the future of Holmestown, lack of clarity as to the future of the facility, at the very least, raises significant concerns as to its continued operation.

With no current landfilling activities at Powerstown, it is possible that there will be no landfill capacity within the SEWMR from 2012 onwards with all residual waste generated in the region being disposed of outside the Region.

Table 1-1 presents the anticipated number of operational landfills nationally over the coming years to 2020. The information presented in Table 1-1 is based on an assessment carried out by Fehily Timoney & Company (FTC) as well as information presented in the most recent annual environmental returns (AERs) for each facility. Figures 1.1 and 1.2 present this information graphically until 2015.

[1] National Waste Report 2004; www.epa.ie
[2] http://www.enniscorthyecho.ie/news/eycwaucwcw/

Table 1.1: Current and predicted future Landfill capacity

	Landfill Facility	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Balleally	Closed in 2011	-	-	-	-	-	-	-	-	-
2	Knockharley	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000
3	White River	96,000	96,000	96,000	96,000	96,000	96,000	96,000	70,000	-	-
4	Scotch Corner	39,500	39,500	36,000	-	-	-	-	-	-	-
5	KTK	90,000	30,000	-	-	-	-	-	-	-	-
6	Drehid	360,000	360,000	360,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
7	Rampere	Closed in 2011	-	-	-	-	-	-	-	-	-
8	Ballynagran	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
9	Powerstown	Landfilling activities ceased on site in early 2012	-	-	-	-	-	-	-	-	-
10	Holmestown Wood	55,000	12,500	-	-	-	-	-	-	-	-
11	Donohill	30,000	15,000	-	-	-	-	-	-	-	-
12	Gortadroma	130,000	65,000	-	-	-	-	-	-	-	-
13	Inagh	Closed in 2011	-	-	-	-	-	-	-	-	-
15	North Kerry	35,000	35,000	33,000	-	-	-	-	-	-	-
16	Youghal	Closed in Jan 2012	-	-	-	-	-	-	-	-	-
17	Derryclure	Closed in 2011	-	-	-	-	-	-	-	-	-
18	Kyletelesha	47,100	47,100	47,100	47,100	47,100	47,100	-	-	-	-
19	East Galway	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	-	-
20	Derrinumera	10,000	2,000	-	-	-	-	-	-	-	-
21	Rathroeen	35,000	35,000	35,000	35,000	35,000	35,000	30,000	-	-	-
22	Ballynacarrick	29,000	15,000	-	-	-	-	-	-	-	-
Available Landfill Capacity (tonnes)		**-**	**1,090,100**	**945,100**	**636,100**	**636,100**	**636,100**	**584,000**	**528,000**	**358,000**	**358,000**

Figure 1.1: Landfill Distribution 2002 - 2009

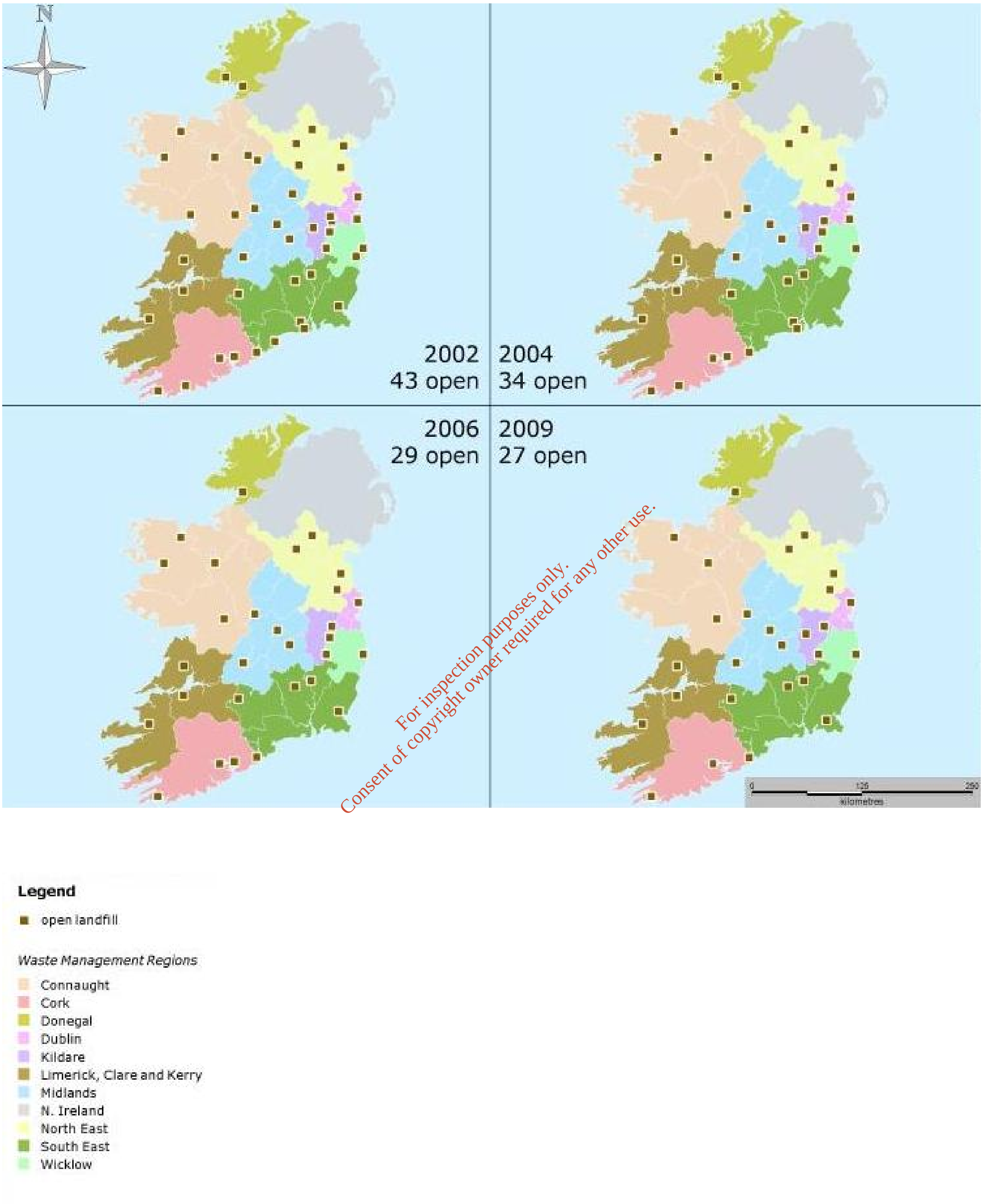
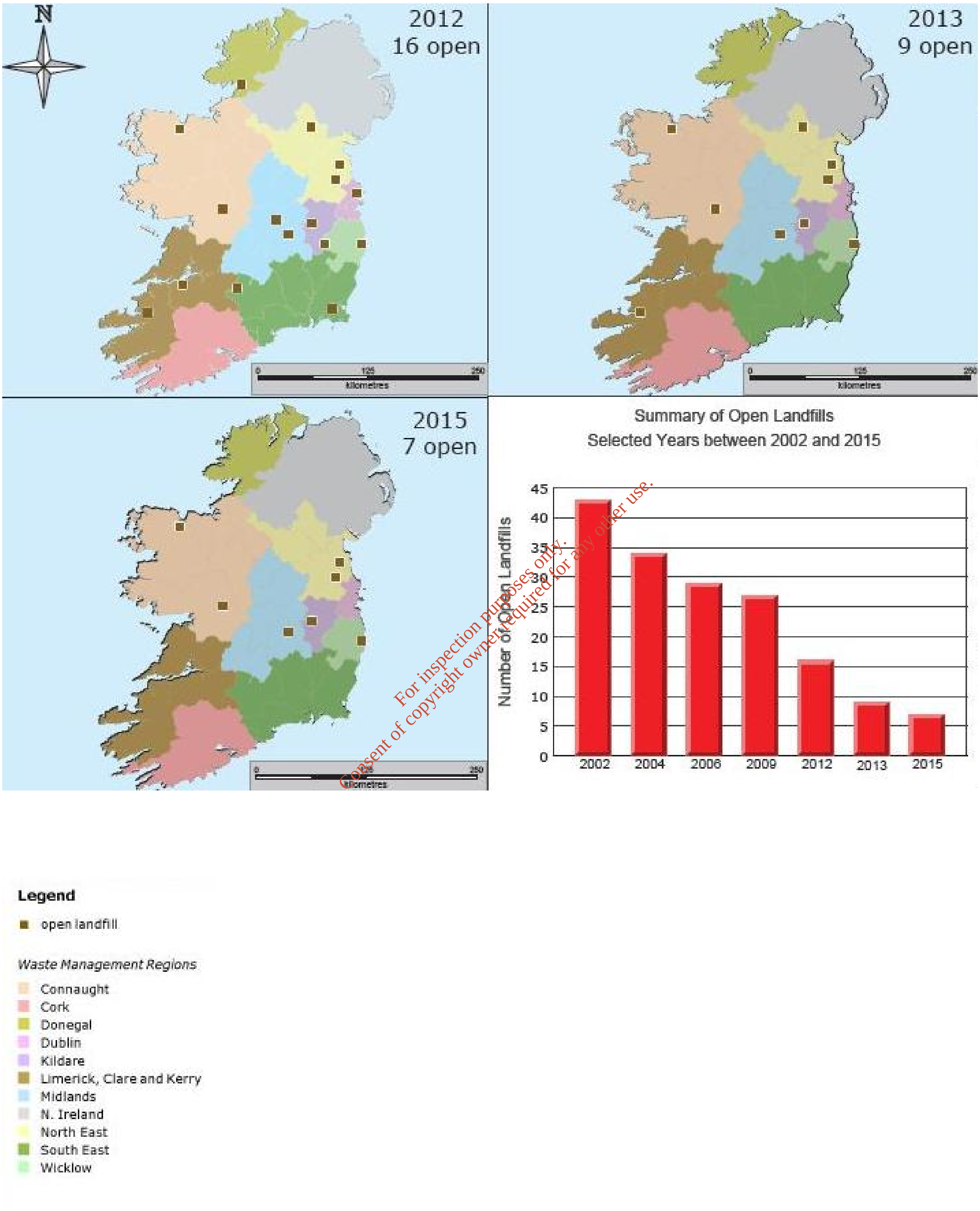


Figure 1.2: Landfill Distribution 2012 - 2015



A number of assumptions have been made in relation to the facilities listed in Table 1-1, as follows:

1. Knockharley landfill continues to accept waste at a rate of 88,000 tpa following the recent withdrawal of an intensification application to An Bord Pleanála[3]
2. Whiteriver landfill continues operations until 2018
3. Scotch Corner landfill fills its final cell and ceases waste acceptance at the end of 2013
4. KTK landfill operates until the end of 2012 after been given permission by the EPA to accept 150,000 m^3 waste until its final contours have been achieved – it is assumed that 30,000 tonnes of waste is accepted in 2012
5. Waste acceptance at Drehid landfill decreases to 120,000 tonnes per annum from 2014 in line with the existing permission
6. Holmestown landfill is modelled as continuing waste acceptance until the end of quarter 1, 2012
7. Donohill landfill closes at the end of 2012, 15,000 tonnes assumed accepted in 2012
8. Gortadroma landfill utilises its remaining void and closes at the end of 2012
9. North Kerry landfill closes at the end of 2013
10. Kyletalesha landfill operates until the end of 2016[4]
11. It is assumed that East Galway landfill accepts waste until 2018 such that the available development area is maximised
12. Derrinumera landfill closes during the first quarter of 2012 with an assumed 2,000 tonnes accepted in 2012
13. Rathroeen landfill continues to operate until the end of 2017
14. Ballynacarrick landfill closes mid 2012 with an assumed 15,000 tonnes accepted in 2012[5]

In addition:

- It is assumed that no further operations are carried out in Corranure Landfill further to this facility closure in March 2011
- The landfill development at the Naul by Murphy Environmental is not included in this assessment as it will not accept MSW
- Landfilling activities at Powerstown landfill has not been modelled
- Bottlehill landfill does not commence operations in the foreseeable future

Table 1-1 demonstrates the reduced national landfill capacity in 2012. As landfill capacity reduces, the remaining landfills will play a more important role in providing landfill capacity on a national basis, as is evident in Table 1-1, where, in 2015, only 5 of the 10 waste management regions will have landfill facilities.

In order to assess the impact of the proposed extension and intensification of waste acceptance for landfilling in Powerstown on a regional and national level, it is necessary to examine the following elements:

- Waste generation nationally and in the South East region
- Residual waste treatment capacity nationally and in the South East region
- The requirements of national waste policy and the Joint Waste Management Plan for the South East 2006

[3] http://www.irishtimes.com/newspaper/ireland/2011/0910/1224303850573.html
[4] http://www.leinsterexpress.ie/news/local/council_to_spend_3m_on_kyletalesha_before_closing_it_1_2391845
[5] As per facility AER 2010

2. PREDICTED WASTE GENERATION

To determine the requirement for the extension of the lifetime of Powerstown landfill, as proposed, it is necessary to assess the likely future waste generation so that demand for landfill capacity can be determined.

Waste generation forecasting is an activity that can be influenced by a number of factors including population growth, economic activity and socio-economic issues. The most recent validated data in relation to waste generation in Ireland is the most current national waste report prepared by the Environmental Protection Agency (EPA), the National Waste Report (NWR) 2009. At the time of writing, the National Waste Report for 2010 is not available.

In order to predict the waste generation in the coming years regionally and nationally, the Economic and Social Research Institute (ESRI) ISus model is used and applied to the data presented in the NWR 2009. The ISus model incorporates environmental, economic and demographic data to predict a range of parameters, one of which is waste growth. At the time of writing, source data for Version 0.5 of the model is available.

2.1 Municipal Solid Waste (MSW) Generation

2.1.1 National MSW Generation

MSW generation on a national basis is modeled from a starting point of 2,952,977 tonnes of MSW generated in the country, as per Table 2 of Section 2 of the NWR 2009. ISus Version 5 presents expected growth rates for MSW generation for the forthcoming years and, when starting from a baseline of 2009, the figures presented in Table 2-1 are generated. Figures are projected to 2020 only as the expected timeline relating to this application occurs within this timeframe. In addition, to account for a situation whereby the growth rates envisaged by the ISus model Version 5.0 may not be achieved, a sensitivity analysis is carried out with projected growth rates at a 1% lower rate that those envisaged by ISUs, and the resultant figures are also presented in Table 2.1

Table 2.1: Predicted National MSW Generation 2009 – 2020 (including sensitivity analysis)

Year	Isus Projected[6] MSW Growth Rates *	Projected MSW Generation (tonnes)	ISus Sensitivity Growth Rates	Sensitivity Projected MSW Generation (tonnes)
2009	-	2,952,977	-	2,952,977
2010	0.1%	2,955,930	-0.9%	2,926,400
2011	2.0%	3,015,049	1.0%	2,955,664
2012	1.5%	3,059,506	0.5%	2,970,443
2013	2.0%	3,120,696	1.0%	3,000,147
2014	2.2%	3,189,352	1.2%	3,036,149
2015	2.5%	3,269,085	1.5%	3,081,691
2016	2.0%	3,334,467	1.0%	3,112,508
2017	2.0%	3,401,157	1.0%	3,143,633
2018	2.3%	3,479,383	1.3%	3,184,500
2019	2.4%	3,562,888	1.4%	3,229,083
2020	2.4%	3,648,398	1.4%	3,274,290

* presents growth rate on the previous year

[6] Available from: http://www.esri.ie/research/research_areas/environment/isus/:File: 'AccountsWaste.xls', Worksheet 'MSW'

2.1.2 South East Region MSW Generation

Given the location of Powerstown landfill within the South East Waste Management Region (SEWMR), MSW generation within the SEWMR is examined. In order to present a comparable projection, a baseline for MSW generation in 2009 in the SEWMR should be determined. This can be done is a number of ways, based on and/or derived from a number of information sources.

Population Information

Census 2006 (www.cso.ie) indicated that the population of the South East Region was 460,838 persons from an overall nation population of 4,239,848, giving a rate of 10.86%. Preliminary results from Census 2011 indicate that the South East Region currently has a population of 497,305 persons from a national population of 4,581,269, giving a virtually identical rate of 10.85%. When compared with the national MSW generation rate of 2,952,977 tonnes, a proportionate calculation would indicate MSW generation in the SEWMR to be **320,398** tonnes.

NWR 2009

The National Waste Report 2009 indicates that MSW generation per person equates to 0.66 tonnes. Applying this to the preliminary Census 2011 results would indicate MSW generation in the SEWMR as being **328,221** tonnes.

Waste Collection Permit Returns

Based on information provided to the EPA as part of the annual returns from the local authorities of the South East Region, data derived from the waste collection permits annual returns indicate a residual waste tonnage of **345,458** tonnes.

An average of the figures identified above gives a figure of **331,359 tonnes** (11.2% of the national total) which can be considered a relatively accurate estimation of MSW generation in the SEWMR in 2009. Applying the ISus projected waste generation rates, and corresponding sensitivity rates, to this figure until 2020 results in Table 2-2.

Table 2.2: Predicted SEWMR MSW Generation 2009 – 2020 (including sensitivity analysis)

Year	Isus Projected MSW Growth Rates *	Projected MSW Generation (tonnes)	ISus Sensitivity	Sensitivity Projected MSW Generation (tonnes)
2009	-	331,359	-	331,359
2010	0.1%	331,690	-0.9%	328,377
2011	2.0%	338,324	1.0%	331,661
2012	1.5%	343,313	0.5%	333,319
2013	2.0%	350,179	1.0%	336,652
2014	2.2%	357,883	1.2%	340,692
2015	2.5%	366,830	1.5%	345,802
2016	2.0%	374,167	1.0%	349,260
2017	2.0%	381,650	1.0%	352,753
2018	2.3%	390,428	1.3%	357,339
2019	2.4%	399,798	1.4%	362,341
2020	2.4%	409,393	1.4%	367,414

* presents growth rate on the previous year

2.2 Residual MSW Generation

Once MSW generation is determined, an estimate as to residual waste generation must be made, in order to assess the demand for landfill, as it is the residual fraction that goes to landfill. The estimation of residual waste generation is a function of the level of recycling and recovery achieved within an area versus the level of MSW generated and disposed of.

2.2.1 National Residual MSW Generation

National recycling and recovery performance for 2009 is reported in the NWR 2009 as being 39%. Therefore, the national disposal rate in 2009 was 61%. Progress in increasing the recycling and recovery rate on a national scale has been steady, growing from a recycling and recovery rate of approximately 8% in 1995 to the 2009 rate of 39%. This steady progress may be attributed to a focus on the more readily recyclable materials like paper, card and plastics. However, in order to grow the national rate beyond the 2009 level, a focus on the less readily recoverable/recyclable materials is required i.e. brown bin organics and further treatment of the residual waste.

The most relevant outstanding target on a national basis is that of 50% recycling of MSW by 2020, as per the requirements of the Waste Framework Directive (2008/90/EC)(as implemented by the Waste Management (Waste Directive) Regulations 2011 (S.I. 126 0f 2011)). In order to achieve this target, continued steady growth in recycling/recovery rates is required, at a rate of approximately 1% per year. Whether or not this target will be achieved will be dependent on a number of factors, not least investment by the private sector, in particular, to provide the infrastructure required for the treatment of these materials. However, in order to provide a conservative estimate, it is assumed in the following tables that the target of 50% recycling of the Waste Framework Directive is achieved on a national basis.

Predicted residual waste generation at a national level has been modeled, using ISus and sensitivity analysis figures, and is presented in the following tables.

Table 2.3: Predicted National Residual MSW Generation (as per ISus Version 5.0)

Year	Projected MSW Generation (as per ISus 5.0) (tonnes)	Assumed Recycling Rate %	Remaining residual MSW (tonnes)
2009	2,952,977	39	1,801,316
2010	2,955,930	40	1,773,558
2011	3,015,049	41	1,778,879
2012	3,059,506	42	1,774,514
2013	3,120,696	43	1,778,797
2014	3,189,352	44	1,786,037
2015	3,269,085	45	1,797,997
2016	3,334,467	46	1,800,612
2017	3,401,157	47	1,802,613
2018	3,479,383	48	1,809,279
2019	3,562,888	49	1,817,073
2020	3,648,398	50	1,824,199

Table 2.4: Predicted National Residual MSW Generation (as per Sensitivity Analysis)

Year	Projected MSW Generation (as per Sensitivity Analysis) (tonnes)	Assumed Recycling Rate %	Remaining residual MSW (tonnes)
2009	2,952,977	39	1,801,316
2010	2,926,400	40	1,755,840
2011	2,955,664	41	1,743,842
2012	2,970,443	42	1,722,857
2013	3,000,147	43	1,710,084
2014	3,036,149	44	1,700,243
2015	3,081,691	45	1,694,930
2016	3,112,508	46	1,680,754
2017	3,143,633	47	1,666,125
2018	3,184,500	48	1,655,940
2019	3,229,083	49	1,646,832
2020	3,274,290	50	1,637,145

2.2.2 SEWMR Residual Waste Generation

Data derived from the information provided to the EPA as part of the waste collection permit annual returns from the local authorities of the South East Region indicates that in 2009, 225,131 tonnes of MSW was collected as residual MSW.

Taking the average figure of 331,359 tonnes from Table 2.2 for MSW generation in the SEWMR in 2009, and using the residual figure collected in 2009, this gives an approximate recycling rate of 32.1% in the SEWMR in 2009. An assumed steady increase in recycling rates generates the figures presented in Table 2.3.

While the SEWMR recycling performance is not modelled as reaching 50% by 2020, as per the Waste Framework Directive targets, it is assumed that, in the achievement of a national target of 50%, some regions will exceed this target and other will not, depending on, *inter alia*, infrastructure provisions, collection schemes available, population densities. The achievement of a 45% recycling rate in 2020 from a starting point of c. 32% in 2009 can be considered a reasonable performance.

Table 2.5: Predicted SEWMR Residual MSW Generation (as per ISus Version 5.0)

Year	Projected MSW Generation (tonnes)	Assumed Recycling Rate %	Remaining residual MSW (tonnes)
2009	331,359	32.1	225131
2010	331,690	33	222,233
2011	338,324	34	223,294
2012	343,313	35	223,153
2013	350,179	36	224,115
2014	357,883	37	225,466
2015	366,830	38	227,435
2016	374,167	40	224,500
2017	381,650	41	225,174
2018	390,428	43	222,544
2019	399,798	44	223,887
2020	409,393	45	225,166

Table 2.6: Predicted SEWMR Residual MSW Generation (as per Sensitivity Analysis)

Year	Projected MSW Generation (tonnes)	Assumed Recycling Rate %	Remaining residual MSW (tonnes)
2009	331,359	32.1	225131
2010	328,377	33	220,012
2011	331,661	34	218,896
2012	333,319	35	216,657
2013	336,652	36	215,457
2014	340,692	37	214,636
2015	345,802	38	214,397
2016	349,260	40	209,556
2017	352,753	41	208,124
2018	357,339	43	203,683
2019	362,341	44	202,911
2020	367,414	45	202,078

3. POLICY & TREATMENT CAPACITY

3.1 Joint Waste Management Policy for the South East Region 2006 - 2011

The Joint Waste Management Plan for the South East (JWMPSE) 2006 – 2011 sets out the following policy in relation to final disposal in the region.

"The specific policy for final disposal details necessary actions to be undertaken by the Region as follows:

- *Non-combustible residual waste is to be disposed of in residual landfills in the region.*
- *Non- hazardous bottom ash from the thermal treatment process to be disposed of in residual landfills in the region.*
- *Untreated fly ash (hazardous waste) from the thermal treatment process to be managed in an environmentally secure manner at an appropriate facility.*
- *Excess residual waste which cannot otherwise be dealt with is consigned to residual landfill in the region, pending provision of alternative or additional treatment/recovery facilities in accordance with the Landfill Directive.*
- *The Region will promote the provision of residual landfill capacity to deal with either inert, non-combustible waste streams, bottom ash or excess residual waste by the public and/or private sector.*
- *Provision of other residual waste disposal facilities within the Region must demonstrate compliance with the diversion targets set out in the Plan and the Landfill Directive"*

The primary means for treatment of residual waste, as identified in the JWMPSE 2006 – 2011, is through thermal treatment of residual MSW with energy recovery, with a nominal treatment capacity of 150,000 tonnes per annum suggested in Table 8.5 of the JWMPSE.

At time of writing, procurement for the provision of this thermal facility is ongoing. However, no tender submissions have been made to date and it can be considered that the provision of thermal capacity in the region will not be in place for at least 5 years i.e. not before 2017.

Section 8.2.1 of the JWMPSE 2006 – 2011 identifies that 'in the short term':

"To cater for this short term deficiency within the region, landfill capacity should be maintained and/or developed either by extension and/or development of at least one significant (capacity >150,000 tpa) facility. It may also be prudent to progress a second new facility to preconstruction stage (in the event of delays in the procurement process of the regional integrated facility) and to ensure the region is self sufficient in this transition period"

'Short term', in this context, refers to the timeline for the provision of further waste infrastructure i.e. thermal treatment, biological treatment, materials recovery facilities such that recycling and /or recovery rates are increased to rates suggested in the JWMPSE.

However, given the lack of development for the provision of the thermal treatment infrastructure, in particular, this 'short term' duration has, by default, extended indefinitely up to the time of writing and likely to extend until such time as thermal treatment capacity is provided. Therefore, the maintenance of landfill capacity within the region continues to be a requirement of the JWMPSE 2006 – 2011.

3.2 National Policy

National waste policy is outlined in 4 main documents:

- *Changing Our Ways (1998)*
- *Delivering Change – Preventing & Recycling Waste (2002)*
- *Taking Stock & Moving Forward (2004)*
- *National Biodegradable Waste Strategy (2006)*

However, since the publication of the *National Biodegradable Waste Strategy* in 2006, no further policy documents have been published. An International Review of Waste Management Policy was carried out in September 2009 with the intention of guiding future policy development.

A draft statement on Waste Policy was published in 2010 which proposed policy measures, based on the findings of the International Review, for the alternation of the waste market structure and proposed recycling targets for a variety of wastestreams.

The most recent publication by the Department of Environment, Community and Local Government, in August of 2011, is a discussion document entitled 'Towards a New National Waste Policy'. In relation to disposal, it is stated that:

"However, we must also be realistic as it will take some time to develop fully the alternative infrastructure necessary to achieve sufficient diversion of waste from landfill. Therefore, in the short term, the continued focus must be on the prevention, diversion and recycling of waste which might otherwise end up in landfill and the management and pre-treatment of those wastes which must continue to be sent to landfill pending the delivery of alternative infrastructure."

In keeping with Section 8.2.1 of the JWMPSE, there is recognition at a national policy development levels that landfill must continue to play a key role in the management of waste, while alternative treatment infrastructure is being developed.

3.3 Available Residual Waste Treatment Capacity

Table 1.1 identifies national landfill capacity in the coming years. While this capacity will be available, consideration must be given to the impact of the Landfill Directive (99/31/EC) targets which outline the amount of biodegradable municipal waste (BMW) which can be landfilling in Ireland as a whole.

While the Landfill Directive targets are measured in BMW, they must be related to residual MSW in order to give an accurate assessment of the quantity of residual waste that can be landfilled. This is due to the fact that BMW is a component of residual MSW and describes the biodegradable content of the waste but which is not a component which can be readily separated out of the residual MSW.

Using a figure of 56.9% BMW content for MSW[7], corresponding residual MSW figures to the BMW targets are presented in Table 3.1.

Table 3.1: Allowable BMW/MSW to landfill

Target Year	Landfill Directive Target	Maximum allowable BMW to landfill (tonnes)	Corresponding MSW total (tonnes)
2010	75% of 1995 levels	916,000	1,609,000
2013	50% of 1995 levels	610,000	1,072,000
2016	35% of 1995 levels	427,000	750,000

[7] Taken from presentation entitled 'Diversion Targets for Biodegradable Waste – An update on Progress in their Implementation & Likely Future Trends' presented at CIWM event. 29th April 2011; available from: http://www.ciwm.co.uk/CIWM/RegionalCentres/ROI/ROICentreMeetingsandEvents/ROIPastEvents.aspx; Value presented as a pre-verified figure.

As identified in Section 1.1, Carranstown and Poolbeg remain the only thermal treatment facilities for the treatment of residual waste currently under development in Ireland. Carranstown, at 200,000 tonnes per annum capacity, is due to commence waste acceptance in Q4 of 2011 while it is assumed that Poolbeg, at 600,000 tonnes, will be online in 2016. A combined thermal treatment capacity of 800,000 tonnes will therefore be available from 2016 onwards.

In the same manner that the reducing number of landfill will play a more prominent role the disposal of waste on a national basis, so too will the thermal treatment facilities identified. Both Carranstown and Poolbeg will, due to their scale, act as national residual waste treatment facilities.

4. LANDFILL CAPACITY VERSUS WASTE GENERATION

Table 4.1 presents an assessment of national landfill capacity versus the likely residual waste generation, as modeled using ISus Version 5.0., taking available thermal capacity into account.

Table 4.1: Likely National Required Landfill Capacity

1	2	3	4	5	6	7	8
Year	Remaining Residual MSW (tonnes)	Allowable MSW to landfill (tonnes)	Waste to thermal treatment (tonnes)	Thermal treatment capacity (tonnes)	Waste for other treatment means (tonnes)	Output from alternative treatments (tonnes)	Total Required landfill capacity (tonnes)
2012	1,774,513	1,609,000	165,513	200,000	-34,487	-10,346	1,598,654
2013	1,778,797	1,072,000	706,797	200,000	506,797	152,039	1,224,039
2014	1,786,037	1,072,000	714,037	200,000	514,037	154,211	1,226,211
2015	1,797,997	1,072,000	725,997	200,000	525,997	157,799	1,229,799
2016	1,800,612	750,000	1,050,612	500,000	550,612	165,184	915,184
2017	1,802,613	750,000	1,052,613	800,000	252,613	75,784	825,784
2018	1,809,279	750,000	1,059,279	800,000	259,279	77,784	827,784
2019	1,817,073	750,000	1,067,073	800,000	267,073	80,122	830,122
2020	1,824,199	750,000	1,074,199	800,000	274,199	82,260	832,260

Note: Ash from thermal treatment is not modeled in this table as it is assumed that the majority of this material will be accepted at the Murphy Environmental landfill at the Naul, given its proximity to Carranstown. Poolbeg facility proposes to ship its ash to UK or the continent for further treatment.

Column 1 presents data from 2011 onwards. While information is modeled from 2009 in previous tables, the presentation of capacity from 2009 onwards is not required as this timeline has passed.

Column 2 shows the remaining residual MSW from Table 2.3, assuming the achievement of the Waste Framework Directive target of 50%.

Column 3 presents the allowable MSW to landfill assuming achievement of the Landfill Directive targets and assuming a BMW content of residual MSW of 56.9%,

Column 4 shows the remaining residual waste that must be treated, once the Landfill Directive targets are achieved. Thermal treatment capacity is indicated in Column 5 assuming Poolbeg is commissioned midway through 2016.

Column 6 presents the residual waste remaining for treatment by alternative means after the thermal treatment capacity is utilised to its capacity. Alternative treatment methods for the treatment of residual MSW are generally a combination of mechanical and biological methods.

Column 7 presents an assumption of a quantity of outputs from the alternative treatment means. While there are many different mechanical biological treatment configurations, these processes, in general, produce, among other outputs, a stabilised biowaste material for landfilling, that can account for up to 30% of the input quantity. Again, an assumption is made here that such alternative treatment infrastructure will be available in the forthcoming years.

This output material, combined with the allowable residual MSW to landfill, as per Column 3, presents a national landfill capacity requirement in the coming years in Column 8. When compared with the expected landfill capacities as presented in Table 1.1, the graph shown in Figure 4.1 results.

Figure 4.2 presents the national landfill capacity versus expected landfill capacities, when the sensitivity analysis carried out is taken in to account.

Figure 4.1: Required Landfill Capacity versus Available Landfill Capacity

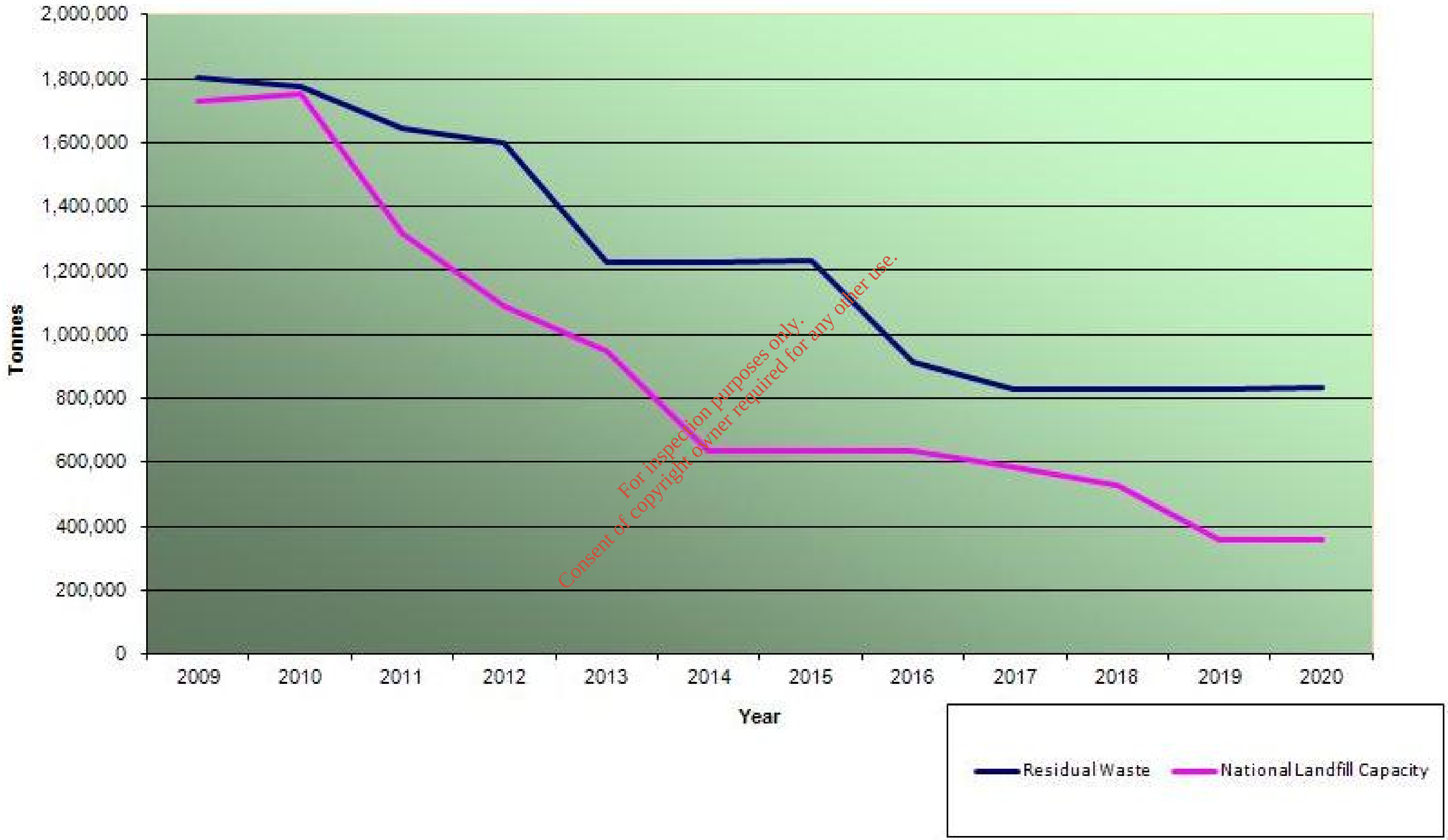
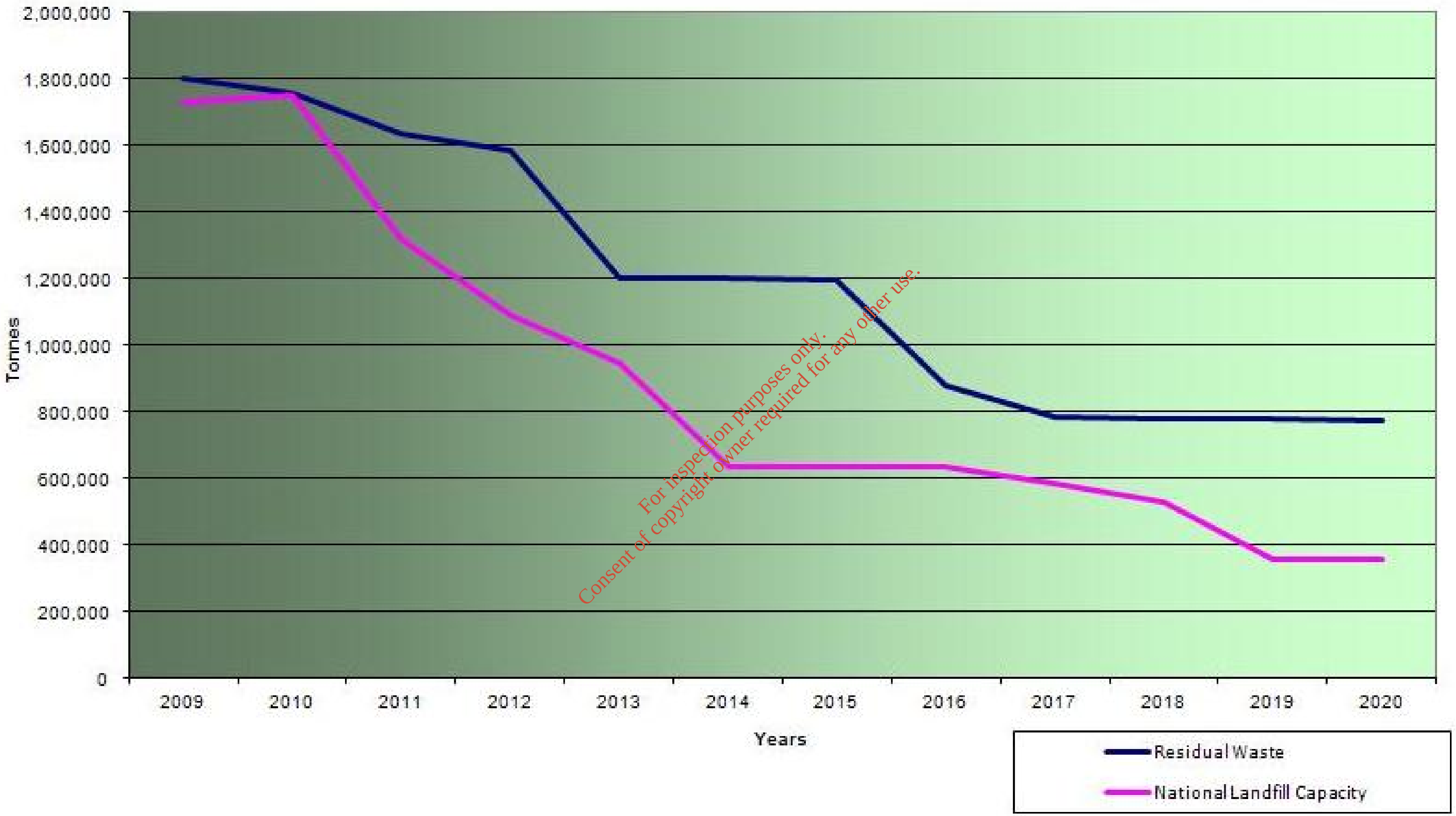


Figure 4.2: Required Landfill Capacity versus Available Landfill Capacity (Sensitivity Analysis)



4.1 Discussion

Figure 4.1 presents the likely future progression of residual waste generation on a national basis versus the likely remaining landfill capacity. Figure 4.2 presents the potential future progression of residual waste generation versus likely remaining landfill capacity, should waste generation rates be lower than those predicted in ISus Version 5.0.

While the exact figures presented in these graphs may vary in actuality, depending on a number of factors such as the likelihood of increased rates of recycling, the likelihood of Landfill Directive targets being achieved, the roll out of residual waste treatment infrastructure being realised etc., the identified trend of landfill demand outstripping capacity in the coming years is certain given the number of landfill facilities that are due to close in the coming years from 2012. This is especially evident until 2016.

As landfills close, the arguments in support of regional self sufficiency in terms of waste management are reduced as the remaining landfills, by default, must provide capacity to the country as a whole. This is acknowledged in the NWR 2009 where, in relation to remaining landfill capacity, it is stated in Section 10.2 that:

"The number of landfills is expected to continue to decline, with 16 of the currently 28 active MSW disposal facilities expected to close in the next three years (unless extensions are applied for and then granted). This contraction will likely lead to significant inter-regional movement of waste."

and

"Significantly, this (landfill) capacity is not distributed evenly around the State. Some regions such as Donegal are at critical capacity shortage stage (Donegal is expected to have no residual municipal landfill capacity by the end of 2011). "

Given the uncertainty surrounding the future of Holmestown Wood landfill, it is also quite possible that the South East Region will enter a "*critical capacity shortage stage*" when Donohill closes and if Holmestown also ceases waste acceptance.

The issue of the proximity principle and its consideration were a reduced number of landfills to serve a national need was addressed in the Department of the Environment, Heritage & Local Government Circular WIR 04/05 which states:

"However, relevant authorities, in preparing waste management plans, determining that necessary statutory authorisations and in regard to other associated waste management functions, should recognise that the application of the proximity principle does not entail interpreting administrative waste management planning boundaries in such a manner as to inhabit the development infrastructure which will support the attainment of national waste management policy objectives through the rational development and use of such infrastructure."

In this instance, the "*rational development and use of such infrastructure"* can be deemed to directly relate to how the remaining landfill capacity should be viewed.

Furthermore, the NWR 2009 acknowledges that the inter-regional movement of waste results in "*regional planning or administrative boundaries (that) are somewhat artificial as waste does move between waste planning regions for disposal".*

National policy, or the most recent indications of same, recognises the role that landfill must continue to play in the 'short term' while sufficient infrastructure and legislative provisions are made to ensure diversion of wastes from landfill, a recognition that is echoed in the JWMPSE which also recognises the transitional period between moving from landfill-centric to other residual waste treatment means. How long the 'short term' period, referenced in both the JWMPSE and the recent national policy discussion document, will last is unknown at this point but it will be required to be supported by sufficient landfill capacity.

As identified at the outset, this application is in relation to the extension of the lifetime of the landfill until such time as the existing constructed capacity is filled. Approximately 165,000 m^3 of constructed capacity remains in Powerstown landfill, equivalent to c. 140,000 tonnes. The capacity that would be provided by the extension of the lifetime of the Powerstown landfill will provide much needed capacity at a regional and national level.

Appendix 2

Submissions Received

An Roinn
Ealaíon, Oidhreachta agus Gaeltachta
Department of
Arts, Heritage and the Gaeltacht

23rd August 2011

Your Ref: **Q:LW11-120-03/Let001/ME/MG**
Our Ref: **G Pre 00030/2011**

Ms. Maeve English,
Fehily Timoney and Company,
Core House,
Pouladuff Road,
Cork.

Re: EIS Scoping - continued use of Powerstown Landfill

A Chara,

I refer to your recent correspondence. Outlined below are the natural heritage observations with respect to the above-proposed development application.

With regard to any EIS for this proposed development, an ecological survey should be carried out of the proposed development site to survey the habitats and species present. Such surveys should be carried out by suitably qualified persons at an appropriate time of the year depending on the species being surveyed for. The EIS should include the results of the surveys. With regard to any existing records, the data of the National Parks and Wildlife Service (NPWS) should be consulted at www.npws.ie and the data of the National Biodiversity Data Centre should be consulted at http://www.biodiversityireland.ie/ . The EIS should also address the issue of invasive alien species, such as Japanese Knotweed, and detail the methods required to ensure they are not accidentally introduced or spread during construction.

The impact of the development on the flora, fauna and habitats present should be assessed. In particular, the impact of the proposed development should be assessed with regard to:

- Natura 2000 sites, i.e. Special Areas of Conservation (SAC) designated under the EC Habitats Directive (Council Directive 92/42/EEC) and Special Protection Areas designated under the EC Birds Directive (Council Directive 79/409 EEC),
- Other designated sites, or sites proposed for designation, such as Natural Heritage Areas, Nature Reserves and Refuges for Fauna or Flora, designated under the Wildlife Acts of 1976 and 2000,
- Habitats listed on annex I of the Habitats Directive,
- Species listed on Annexes II and IV of the Habitats Directive,
- Habitats important for birds,
- Birds listed on Annex I of the EC Birds Directive,

- Species protected under the Wildlife Acts including protected flora,
- Habitats that can be considered to be corridors or stepping stones for the purpose of article 10 of the Habitats Directive,
- Red data book species,
- and biodiversity in general.

In order to assess the above impacts it may be necessary to obtain hydrological and/or geological data. The EIS should assess cumulative impacts with other plans or projects if applicable. Where negative impacts are identified, suitable mitigation measures should be detailed if appropriate.

Where there are impacts on protected species and their habitats, resting or breeding places, licenses may be required under the Wildlife Acts or derogations under the Habitats Regulations. In particular, bats and otters are strictly protected under annex IV of the Habitats Directive and a copy of Circular Letter NPWS 2/07 entitled "*Guidance on Compliance with Regulation 23 of the Habitats Regulations 1997 – strict protection of certain species / applications for derogation licences*" can be found on our web site www.npws.ie . In addition, licenses will be required if there are any impacts on other protected species such as on protected plants, badger setts or birds nests. In order to apply for any such licenses or derogations, a detailed survey, carried out by appropriately qualified person/s, should be submitted to NPWS.

This proposed development is close to the River Barrow and River Nore candidate Special Area of Conservation (cSAC) (site code 0002162), designated under the Habitats Directive, and the impact on the site should be assessed. It is our understanding that a stream connects the landfill site with the cSAC. We recommend that the EIS addresses the issue of any spills that may accidentally enter this stream and that mitigation and emergency plans would include notifying local NPWS staff. In addition, NPWS would like to be made aware of any bird control methods used for the landfill including contracts using birds of prey. You should note that birds of prey in captivity are subject to licensing by NWPS.

Because this project has the potential to impact on a Natura 2000 site, in accordance with article 6.3 of the Habitats Directive, this project should be subject to appropriate assessment of its implications for the site in view of the sites conservation objectives. We refer you to the Departmental guidance document on Appropriate Assessment, which was launched by the Minister on 10th December 2009 and since revised. It is available on the NPWS web site at http://www.npws.ie/media/npws/publications/codesofpractice/AA%20Guidance%2010-12-09.pdf .

We also refer you to the EU Commission guidance entitled "*Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*", which can be downloaded from http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf.

In order to carry out the appropriate assessment you will need to collect information about the relevant Natura 2000 sites including their conservation objectives. Details of designated sites and species can be found on www.npws.ie while conservation objectives, if not yet available on our web site, can be obtained upon request by completing the data request form on our website at http://www.npws.ie/en/media/Media,6687,en.doc .

We recommend that you consult with the relevant Local Authorities to determine if there are any projects or plans, which, alone or in combination could impact on any Natura sites.

Built and Archaeological heritage observations, if any, will follow in due course.

Kindly forward any further information to the following address:

The Manager,
Development Applications Unit,
Department of Arts, Heritage and the Gaeltacht,
Newtown Road,
Wexford

Alternatively, documentation associated with the above can be referred electronically to the DAU at the following address:

manager.dau@ahg.gov.ie

Finally, the above observations and recommendations are based on the papers submitted to this Department on a pre-planning basis and are made without prejudice to any observations the Minister may make in the context of any consultation arising on foot of any development application referred to the Minister, by the planning authority, in his role as statutory consultee under the Planning and Development Act 2000, as amended.

Is mise le meas,

Yvonne Nolan,
Development Applications Unit
Tel: (053) 911 7382
E-mail: yvonne.nolan@ahg.gov.ie

Please note the change to e-mail addresses, which take effect from Monday, 15th August 2011

2011-120-03

FEHILY TIMONEY & Co.
Received by ME
Date
Action
Distribution 24 AUG 2011
Job No:
Correspondence No:

NRA
An tÚdarás um Bóithre Náisiúnta
National Roads Authority

Teach Naomh Máirtín / Bóthar Waterloo / Baile Átha Cliath 4
St. Martin's House / Waterloo Road / Dublin 4
Teil: / Tel: + 353 1 660 2511 Facs: / Fax: + 353 1 668 0009

Maeve English
Fehily Timoney & Co
Core House
Pouladuff Road
Cork

Dáta | Date 22nd August 2011 Ár dTag. | Our Ref. NRA11-82941 Bhur dTag. | Your Ref.

Re: Preparation of an Environmental Impact Statement for the continued use of Powerstown Landfill, Co. Carlow.

Dear Ms English,

The Authority wishes to advise that it is not in a position to engage directly with planning applicants in respect to proposed developments. The Authority will endeavour to consider and respond to planning applications referred to it given its status and duties as a statutory consultee under the Planning Acts. The approach to be adopted by the Authority in making such submissions or comments will seek to uphold official policy and guidelines as outlined in NRA Circular 6/2006 "*Policy Statement on Development Management and Access to National Roads*" and other relevant circulars, which are available at www.nra.ie. Regard should also be had to the Department of Environment, Heritage and Local Government *Spatial Planning and National Roads (Consultation Draft) Guidelines for Planning Authorities*.

The issuing of this correspondence is provided as best practice guidance only and does not prejudice the NRA's statutory right to make any observations, requests for further information, objections or appeals following the examination of any valid planning application referred.

With respect to EIS scoping issues, the recommendations indicated below provide only general guidance for the preparation of EIS, which may affect the National Roads Network.

The developer should have regard, *inter alia*, to the following;

- Consultations should be had with the relevant Local Authority/National Roads Design Office with regard to locations of existing and future national road schemes,
- The Authority would be specifically concerned as to potential significant impacts the development would have on any national roads (and associated junctions) in the proximity of the proposed development
- The developer should assess visual impacts from existing national roads,
- The developer should have regard to any Environmental Impact Statement and all conditions and/or modifications imposed by An Bord Pleanála regarding road schemes in the area. The developer should in particular have regard to any potential cumulative impacts,
- The developer, in conducting Environmental Impact Assessment, should have regard to the NRA DMRB and the NRA Manual of Contract Documents for Road Works,

Rphost / Email: info@nra.ie Idirlíon / Website: www.nra.ie

- The developer, in conducting Environmental Impact Assessment, should have regard to the NRA's Environmental Assessment and Construction Guidelines, including the *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* (National Roads Authority, 2006),
- The EIS should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the relevant competent authority. The developer may need to consider the incorporation of noise barriers to reduce noise impacts (see *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (1st Rev., National Roads Authority, 2004)),
- It would be important that, where appropriate, subject to meeting the appropriate thresholds and criteria and having regard to best practice, a Traffic and Transport Assessment be carried out in accordance with relevant guidelines, noting traffic volumes attending the site and traffic routes to/from the site with reference to impacts on the national road network and junctions of lower category roads with national roads. The Authority's Traffic and Transport Assessment Guidelines (2007) should be referred to in this regard. The TTA should also consider the cumulative effects of development planned in the area and the implications on the national road junction (M9 Junction 6),
- The designers are asked to consult the National Roads Authority's DMRB *Road Safety Audit* (NRA HD 19/09) to determine whether a Road Safety Audit is required,
- In the interests of maintaining the safety and standard of the national road network, the EIS should identify the methods/techniques proposed for any works traversing/in proximity to the national road network.

Notwithstanding, any of the above, the developer should be aware that this list is non-exhaustive, thus site and development specific issues should be addressed in accordance with best practise.

I hope that the above comments are of use in your scoping process.

Yours faithfully

pp Sophie S

Michael McCormack
Planner

Maeve English

From: Ray Spain [rspain@carlowcoco.ie]
Sent: 02 August 2011 14:20
To: Maeve English
Cc: Ray Spain
Subject: EIS for Powerstown Landfill Co. CArlow

Dear Ms English,

I wish to acknowledge receipt of your letter re the above. We have no comments to make at this time.

Yours Sincerely,
Ray Spain

Ray Spain
Coordinator
South Eastern River Basin District
Carlow County Council
Athy Road
Carlow
Ph. 059 917 0381
rspain@carlowcoco.ie
www.serbd.ie

Maeve English

From: Jill Stewart [Jill.Stewart@failteireland.ie]
Sent: 11 August 2011 16:24
To: maeve.english@ftco.ie.
Subject: FW: EIS and Tourism Guidelines 2009.doc
Attachments: EIS and Tourism Guidelines 2009.doc

Dear Ms English,

I wish to acknowledge receipt of your recent letter to Fáilte Ireland in relation to the proposed an Environment Impact Statement for the continued use of Powerstation Landfill, Co Carlow.

I attach a copy of Fáilte Ireland's EIS and Tourism Guidelines on the treatment of Tourism in an Environment Impact Statement.

Please note Fáilte Ireland (formerly Bord Fáilte) have moved offices to Amien Street and forward all future correspondence to Mr Paddy Mathews, Destinations Manager, Fáilte Ireland, 85-95 Amiens Street, Dublin 1.

Yours sincerely,
Jill Stewart.

Jill Stewart
Fáilte Ireland
88-95 Amiens Street
Dublin 1
Tel: 01 8847202
Jill.Stewart@failteireland.ie
www.failteireland.ie
Help save paper - do you need to print this email?

LW11-120-03

Office of the Minister for Agriculture, Fisheries and Food, Dublin 2.

Oifig an Aire Talmhaíochta, Iascaigh agus Bia, Baile Átha Cliath 2.

FEHILY TIMONEY & Co.
Received by UE
Date
Action
Distribution 5 AUG 2011
Job No:
Correspondence No: 14
Comment:

2 August 2011

Ms Maeve English
Fehily Timoney & Co
Consultants in Engineering & Environmental Sciences
Core House
Pouladuff Road
Co. Cork

PLEASE QUOTE REF NUMBER ON ALL CORRESPONDENCE.
Our Ref: 2011/40791N /JC HO
Your Ref: Q:LW11-120-03/let001/ME/MG

Dear Ms English

I wish to acknowledge receipt of your recent correspondence addressed to the Minister for Agriculture, Food and the Marine, Simon Coveney, TD concerning Preparation of an Environmental Impact Statement for the continued use of Powerstown Landfill, Co Carlow.

I will bring your letter to the Minister's attention.

Yours sincerely,

pp. R Joyce
Kevin Galligan
Private Secretary

Telephone: (01) 607 2884 LoCall 1890 200 510 Facsimile (01) 661 1013
E-mail minister@agriculture.gov.ie

L2011-120-03

HSE South,
ENVIRONMENTAL HEALTH DEPARTMENT

11 Patrick Street,
Kilkenny,
Ireland.

Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

Telephone 056 7784742
Fax 056 7762741

St. Dympna's Hospital,
Athy Road,
Carlow,
Ireland.

Telephone 059 9136574
Fax 059 9136508

23/8/2011

Ms Maeve English
Fehily Timoney & Company
Core House
Pouladuff Road
Cork
Ireland.

Re: Preparation of an Environmental Impact Statement for the continued use of Powerstown Landfill, Co. Carlow.

Dear Ms. English,

I refer to correspondence dated 29/7/2011 issued to Health Service Executive, Millenium Park, Naas, Co. Kildare seeking submissions or comments relating to the proposed development.
The matter has been forwarded to this office for appropriate action. I have visited the site in question and met with Mary Walsh, Deputy Landfill Manager. A tour of the entire site was conducted and a review of relevant documentation was carried out.

The objective of the Environmental Health Service in scoping this proposal is to identify key areas of concern from a public health viewpoint, so that concerns can be assessed and evaluated by the proposer at an appropriate level in the EIS. The concerns listed identify environmental health issues likely to arise from the proposed construction and operational phases of the project.

Consideration has been given to the fact that the landfill site has been in operation since 1977 and the proposal is for the extension of the life of the landfill only until the remaining constructed cells are filled. For this reason, construction phase impacts will not be significant.

General

1. The EIS shall address the issue of undertaking and completing meaningful public consultation with the local community. Such consultation should give the local community an opportunity to comment on the proposal. It is necessary to ensure that formal structures are put in place to deal with queries and complaints from the general public.

2. The EIS shall indicate the consideration given to identifying alternatives to the continued use of the landfill

3. The EIS shall indicate proposed closure date of the landfill.

4. The Closure, Restoration and Aftercare Management Plan (CRAMP) shall be assessed in EIS and updated as necessary.

Construction Phase

Assessments should be undertaken and detailed in EIS on the following likely impacts during construction phase.

1. The EIS shall indicate and identify the presence and location of any private water supply sources which may be at risk from activities generated in connection with the continued use of the landfill.

   It is recommended that a detailed site "walk through" survey is undertaken so that comprehensive and accurate information is procured.

2. The potential impacts on surface water and groundwater arising from on site run-off, silting etc. during construction phase shall be addressed in EIS.

3. The impact of dust generation from construction should be assessed and a Dust Minimisation Plan or similar mitigation measure that meets current National Standards for construction sites should be addressed in EIS.

4. EIS should contain a Construction Management Plan for the proposed site. This management plan is necessary to provide reassurance for the planning authority, neighbouring residents and concerned third party interests that best practice measures and appropriate monitoring (where necessary) are being implemented.

5. Potential impacts of noise pollution (including vibration) from construction phase should be clearly identified in EIS. The identification of potential noise sensitive locations, predicted noise level exposure and duration is sought in order to protect the amenity of any noise sensitive locations.

Operational Phase

1. Existing on-site traffic control measures should be assessed by EIS.

2. Consideration should be given to assessing and updating, if necessary, the Odour Management Plan to include the activation of cells 17 and 18. Consideration should be given to improving the landfill gas collection system, particularly at cell 17 and 18 to provide for increased landfill gas emissions and potential odour problems as these cells become active.

3. EIS shall include commitment to continued monitoring of surface water and groundwater quality at existing monitoring stations.

   Consideration should be given to increased monitoring at all water monitoring points during construction and early operational stage as cells 17 and 18 become active.

   Mitigation measures for impacts on groundwater and surface water quality should be considered in EIS.

4. On site arrangements for the storage of fuels, oils lubricants and proposed mitigation measures in the event of accidental spillage shall be outlined in EIS.

5. Consideration should be given to assessing and updating pest and bird control measures in EIS.

6. Fly and wasp control measures, particularly in the Civic Amenity Area should be assessed by EIS.

7. Daily capping measures should be assessed by EIS to ensure best practice.

8. Current dust monitoring measures should be assessed by EIS.

9. Litter patrol procedures around the boundary of the site should be assessed by EIS. Mitigation measures to prevent illegal dumping should be addressed in EIS.

10. General site management operations within the existing landfill should be assessed by EIS and improvements introduced in mitigation, if deemed necessary.

11. Consideration should be given in EIS to management of the site and efficiency of the Flare during harsh climate conditions.

12. Procedures for final capping should be assessed by EIS. Best practice in installation of the final cap by competent staff and supervised by an external approved contractor should be included in EIS.

13. The current Complaints Procedure should be assessed by EIS

If you have any queries with regard to this submission, please contact the undersigned.

Yours sincerely

Tracey Morris

Tracey Morris
Environmental Health Officer

Agreed, Richard McGrath

Richard McGrath
Acting Principal Environmental Health Officer.

Appendix 3

Waste acceptance procedures - biodegradable waste

Powerstown Landfill & Civic Amenity Site

Waste Acceptance Procedure

September 2010

CONTENTS

1. INTRODUCTION

The Environmental Protection Agency (The Agency) issued a waste licence, W0025-03, to Carlow County Council on 21-12-09. Condition 5.2, on Waste Acceptance and Characterisation Procedures, requires that the following measures be put in place:

- Waste shall only be accepted at the facility from local authority waste collection or transport vehicles or holders of waste permits, unless exempted or excluded, issued under the Waste Management (Collection Permit) Regulations 2007. Copies of these waste collection permits must be maintained at the facility.

- Whole used tyres (other than bicycle tyres and tyres with an outside diameter greater than 1400mm) shall not be disposed of at the facility. Shredded tyres shall not be disposed of at the facility.

- No hazardous wastes, liquid wastes or asbestos wastes shall be disposed of at the facility.

- Within one month of the date of grant of this licence, the licensee shall submit to the Agency for its agreement updated written procedures for the acceptance and handling of all wastes. These procedures shall include details of the treatment of all waste to be carried out in advance of acceptance at the facility and shall also include methods for the characterisation, classification and coding of waste. The procedures shall have regard to Council Decision (2003/33/EC) establishing the criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex I1 to Directive (1999/31/ EC) on the landfill of waste. No waste which in the conditions of the landfill, is explosive, corrosive, oxidising, highly flammable or flammable as defined in EU Council Directive 91/689/EEC shall be accepted at the landfill.

In addition, conditions 5.3 – 5.8 require the following:

- Only waste that has been subject to treatment shall be accepted for disposal at the landfill facility.

- Treatment shall reflect published EPA technical guidance as set out in "**Municipal Solid Waste - Pre-treatment and Residuals Management",** EPA, 2009.

- With the agreement of the Agency, this condition shall not apply to inert wastes for which treatment is not technically feasible and other waste for which such treatment does not contribute to the objectives of the Landfill Directive as set out in Article 1 of the Directive by reducing the quantity of the waste or the hazards to human health or the environment.

- Gypsum wastes shall not be placed in any landfill cell accepting biodegradable waste.

- The dilution or mixture of waste solely in order to fulfil relevant waste acceptance criteria established under Condition 5.2.4 is prohibited,

- From 1 July 2010 to 30 June 2013 inclusive, a maximum of 47% by weight of municipal solid waste (MSW) accepted for disposal to the body of the landfill shall comprise biodegradable municipal waste (BMW), measured on a calendar year basis or, in 2010 and 2013, part thereof

- From 1 July 2013 to 30 June 2016 inclusive, a maximum of 30% by weight of MSW accepted for disposal to the body of the landfill shall comprise BMW, measured on a calendar year basis or, in 2013 and 2016, part thereof

- From 1 July 2016, a maximum of 15% by weight of MSW accepted for disposal to the body of the landfill shall comprise BMW, measured on a calendar year basis or, in 201 6, part thereof unless an alternative has been agreed in writing by the Agency in accordance with Condition 5.6.2.

- The licensee shall determine the biodegradable municipal waste content of MSW accepted at the landfill. Waste that has been bio-stabilised in accordance with Condition 5.7.4 shall not be considered BMW.

- Bio-stabilised residual wastes meeting the requirements of Condition 5.7.4, or an alternative protocol as may be agreed with the Agency based on biological treatment process parameters (e.g. validated residence time and temperature parameters at the treatment facility), received at the landfill facility may be included in the determination of MSW quantities accepted at the facility for the purposes of Condition 5.6.1.

- In determining BMW content, the licensee shall use approved calculation factors for BMW content of municipal waste streams published by the EPA. With the agreement of the EPA, alternative factors can be used if they have been determined following waste characterisation carried out in accordance with EPA-approved characterisation protocols including, where appropriate, the use of EPA-approved contractors.

- In the case of bio-stabilised residual wastes, stabilisation means the reduction of the decomposition properties of the waste to such an extent that offensive odours are minimised and that the respiration activity after four days is <10 mg O2/g DM until 1 January 2016 and <7mg 02/g DM thereafter.

- The licensee is required to maintain on-site as part of their waste acceptance procedures and associated documentation, evidence to demonstrate compliance with Conditions 5.3.1

In order to assist in the waste characterisation process required by the above conditions the Agency has produced a draft report entitled "**Protocol for the Evaluation of Biodegradable Municipal Waste sent to Landfill by Pre-treatment Facilities**".

In addition, note should be taken of the following reports produced by the Agency:

- Municipal Waste Characterisation Manual 1996
- Municipal Waste Characterisation Reports 2005, 2009

2. PERMITTED WASTE TYPES

Waste Licence W0025-03 allows for the following waste types and tonnages:

Waste Type	Maximum tonnes per annum
Household (residual)	31,000 (includes 300 tonnes green waste)
Commercial	7,000
Treated Sewage Sludge	500

Construction & Demolition	1,000
Industrial Non-Hazardous Solids	500
Total	**40,000**

The Agency has been requested to permit the following revised waste types and tonnages:

Waste Type	Proposed annual intake tonnes
Residual household waste	30,000
Commercial	7,000
Construction and demolition	1,000
Industrial non-hazardous solids	1,500 (comprising drinking water treatment sludges)
Treated sewage sludge	500

3. GENERAL WASTE ACCEPTANCE CRITERIA

Council Decision 2003/33/EC sets out procedures for the acceptance of waste at landfills in three stages:

- Basic characterisation
- Compliance testing
- On-site verification

Basic Characterisation

Basic characterisation is the first step in the acceptance procedure and constitutes a full characterisation of the waste by gathering all the necessary information for a safe disposal of the waste in the long term. Basic characterisation is required for each type of waste.

Functions of basic characterisation

(a) Basic information on the waste (type and origin, composition, consistency, leachability and, where necessary and available, other characteristic properties)

(b) Basic information for understanding the behaviour of waste in landfills and options for treatment as laid out in Article 6(a) of the Landfill Directive

(c) Assessing waste against limit values

(d) Detection of key variables (critical parameters) for compliance testing and options for simplification of compliance testing (leading to a significant decrease of constituents to be measured, but only after demonstration of relevant information). Characterisation may deliver ratios between basic characterisation and results of simplified test procedures as well as frequency for compliance testing.

If the basic characterisation of waste shows that the waste fulfils the criteria for a landfill class as laid down in section 2 of this Annex, the waste is deemed to be acceptable at this landfill class. If this is not the case, the waste is not acceptable at this landfill class. The producer of the waste or, in default, the person responsible for its management, is responsible for ensuring that the characterisation information is correct. The operator shall keep records of the required information for a period to be defined by the Member State.

Fundamental requirements for basic characterisation of the waste

(a) Source and origin of the waste

(b) Information on the process producing the waste (description and characteristics of raw materials and products)

(c) Description of the waste treatment applied in compliance with Article 6(a) of the Landfill Directive, or a statement of reasons why such treatment is not considered necessary

(d) Data on the composition of the waste and the leaching behaviour, where relevant

(e) Appearance of the waste (smell, colour, physical form)

(f) Code according to the European waste list (Commission Decision 2001/118/EC)

(g) For hazardous waste in case of mirror entries: the relevant hazard properties according to Annex III to Council Directive 91/689/EEC of 12 December 1991 on hazardous waste

(h) Information to prove that the waste does not fall under the exclusions of Article 5(3) of the Landfill Directive

(i) The landfill class at which the waste maybe accepted

(j) If necessary, additional precautions to be taken at the landfill

(k) Check if the waste can be recycled or recovered.

Testing

As a general rule waste must be tested to obtain the above information. In addition to the leaching behaviour, the composition of the waste must be known or determined by testing. The tests used for basic characterisation must always include those to be used for compliance testing. The content of the characterisation, the extent of laboratory testing required and the relationship between basic characterisation and compliance checking depends on the type of waste. A differentiation can be made between:

(a) wastes that are regularly generated in the same process;

(b) wastes that are not regularly generated.

The characterisations outlined in points (a) and (b) will provide information that can be directly compared with acceptance criteria for the relevant class of landfill and, in addition, descriptive information can be supplied (e.g.the consequences of depositing with municipal waste).

(a) Wastes regularly generated in the same process

These are individual and consistent wastes regularly generated in the same process, where:
— the installation and the process generating the waste are well known and the input materials to the process and the process itself are well defined,
— the operator of the installation provides all necessary information and informs the operator of the landfill of changes to the process (especiallychanges to the input material). The process will often be at a single installation. The waste can also be from different installations, if it can be identified as single stream with common characteristics within known boundaries (e.g. bottom ash from the incineration of municipal waste).

For these wastes the basic characterisation will comprise the fundamental requirements listed above and especially the following:
— compositional range for the individual wastes,
— range and variability of characteristic properties,
— if required, the leachability of the wastes determined by a batch leaching test and/or a percolation test and/or a pH dependence test,
— key variables to be tested on a regular basis.

If the waste is produced in the same process in different installations, information must be given on the scope of the evaluation. Consequently, a sufficient number of measurements must be taken to show the range and variabilityof the characteristic properties of the waste. The waste can then be considered characterised and shall subsequently be subject to compliance testing only, unless significant change in the generation processes occur.

For wastes from the same process in the same installation, the results of the measurements may show only minor variations of the properties of the waste in comparison with the appropriate limit values. The waste can then be considered characterised, and shall subsequently be subject to compliance testing only, unless significant changes in the generation process occur.
Waste from facilities for the bulking or mixing of waste, from waste transfer stations or mixed waste streams.

Material submitted from waste collectors, can vary considerably in their properties. This must be taken into consideration in the basic characterisation. Such wastes may fall under case (b).

(b) Wastes that are not regularly generated
These wastes are not regularly generated in the same process in the same installation and are not part of a well-characterised waste stream. Each batch produced of such waste will need to be characterised. The basic characterisation shall include the fundamental requirements for basic characterisation. As each batch produced has to be characterised, no compliance testing is needed.

Cases where testing is not required

Testing for basic characterisation can be dispensed with in the following cases:

(a) the waste is on a list of wastes not requiring testing as laid down in section 2 of this Annex;

(b) all the necessary information, for the basic characterisation, is known and duly justified to the full satisfaction of the competent authority;

(c) certain waste types where testing is impractical or where appropriate testing procedures and acceptance criteria are unavailable. This must be justified and documented, including the reasons why the waste is deemed acceptable at this landfill class.

Compliance testing

When waste has been deemed acceptable for a landfill class on the basis of a basic characterisation pursuant to section 1, it shall subsequently be subject to compliance testing to determine if it complies with the results of the basic characterisation and the relevant acceptance criteria as laid down in section 2.

The function of compliance testing is periodically to check regularly arising waste streams.

The relevant parameters to be tested are determined in the basic characterisation. Parameters should be related to basic characterisation information; only a check on critical parameters (key variables), as determined in the basic characterisation, is necessary. The check has to show that the waste meets the limit values for the critical parameters.

The tests used for compliance testing shall be one or more of those used in the basic characterisation. The testing shall consist at least of a batch leaching test. For this purpose the methods listed under section 3 shall be used.

Wastes that are exempted from the testing requirements for basic characterisation are also exempted from compliance testing. They will, however, need checking for compliance with basic characterisation information other than testing.

Compliance testing shall be carried out at least once a year and the operator must, in any event, ensure that compliance testing is carried out in the scope and frequency determined by basic characterisation.

Records of the test results shall be kept for a period that will be determined by the Member State.

On-site verification

Each load of waste delivered to a landfill shall be visually inspected before and after unloading. The required documentation shall be checked.

For waste deposited by the waste producer at a landfill in his control, this verification maybe made at the point of dispatch.

The waste maybe accepted at the landfill, if it is the same as that which has been subjected to basic characterisation and compliance testing and which is described in the accompanying documents. If this is not the case, the waste must not be accepted.

Member States shall determine the testing requirements for on-site verification, including where appropriate rapid test methods.

Upon delivery, samples shall be taken periodically. The samples taken shall be kept after acceptance of the waste for a period that will be determined by the Member State (not less than one month.

4. PRE-TREATMENT REQUIREMENTS

- The waste licence requires that all waste is pre-treated in advance of landfill disposal. The minimum acceptable requirement, as advised by the Agency, is for a source segregated collection system (2-bin or equivalent) for all waste. For urban areas greater than 1,500 populations, diversion or separate collection of biowaste is required. This is required in order to comply with the BMW targets in section 1.

- Biodegradable Municipal Waste (BMW) means the biodegradable component of municipal waste, and does not include bio-stabilised waste. Biodegradable municipal waste is typically composed of food and garden waste, wood, paper, cardboard and textiles.

- The biodegradable factor is the estimated percentage (wet weight) of organics, paper, cardboard and 50% of the estimated percentage (wet weight) of textiles, unclassified combustibles, wood and fines found in MSW.

- The Annual Environmental Report will contain a section on waste acceptance and audit policy to satisfy the Agency that only pre-treated waste has been accepted at the facility.

- In order to assist in the process the Agency has developed a protocol for the evaluation of biodegradable municipal waste sent to landfill by pre-treatment facilities. Facilities which send waste to Powerstown Landfill are required to report BMW content of waste in accordance with the requirements of the above document. Such facilities include Transfer Stations and MBT plants.

- Transfer Stations will be evaluated using pre-determined BMW factors as shown below. Street cleaning waste should be included as “one-bin waste” with the same factor.

Waste Type	Household	Commercial
One Bin	0.645	0.772
Two Bin	0.620	0.752
Three Bin	0.470	0.752

- MBT facilities are required to carry out quarterly waste characterisation surveys as described in the draft protocol.

- For Biological Treatment plants such as composting the Respiration Activity Test (AT4) will be required (or equivalent agreed by the Agency) in order to demonstrate that the material is a stabilised biowaste. Material which reaches the standard of 10 mg O^2/g DM will not be considered BMW.

- For waste which is delivered directly to the landfill by the public (and small contractors) evidence will be required that the waste has been segregated into equivalent 3-bin components. It is felt that diversion of food waste, paper, cardboard, textiles and wood will be sufficient to meet the pre-treatment targets, this is based on the most recent Agency Waste Characterisation reports for household and commercial waste.

- For WSW waste delivered directly from kerbside collections to the landfill quarterly characterisation reports will be required as described in the draft protocol.

- At Powerstown Landfill the system to be operated will be the equivalent of a three-bin system and the above factors will be used for reporting purposes.

5. ON-SITE CHARACTERISATION

- Where required, as detailed in Section 3, waste will be subject to compliance and verification tests. Two waste quarantine areas are provided for this work. The procedures shall have regard to Council Decision 2003/33/EC establishing the criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex I1 to Directive (1999/31/EC) on the landfill of waste.

- Sampling will be carried out using updated Agency guidelines to be developed in 2010.

- Testing will primarily be carried out in order to:

    - Check on BMW contents of deliveries from the public, kerbside collections and treatment facilities

    - Check leaching limit values contained in section 2.2.2 of Council Decision 2003/33/EC where this is required for non-municipal waste

    - Check that the wastes are allowable under licence conditions

- Samples taken for on-site verification testing shall be retained on site for two months

6. PARTICULAR WASTE TYPES

- Whole used tyres (other than bicycle tyres and tyres with an outside diameter greater than 1400mm) shall not be disposed of at the facility. Shredded tyres shall not be disposed of at the facility.

- No hazardous wastes shall be disposed of at the facility.

- No asbestos wastes shall be disposed of at the facility.

- No liquid wastes shall be disposed of at the facility.

- Gypsum wastes shall not be placed in the landfill, a separate collection container has been provided

- Sewage and drinking water sludge shall be subject to treatment and must achieve a minimum solids content of 17% prior to acceptance at the facility. All sludge must be covered immediately with other waste. This waste is limited to 500 tonnes per annum for sewage sludge and 1,500 for other sludges.

- Street sweeping wastes and other similar wastes wastes generated by local authority activities shall be pre-treated prior to acceptance at the landfill. This pre-treatment will be the equivalent of a three-bin system.

- Wastes which originate from fly-tipping and which are collected by the local authority will not be pre-treated. This decision is based on health and safety advice, it is felt the segregation process would pose an unacceptable risk to workers.

- The following wastes are not subject to a charge at the landfill:

  Fly-tipping wastes collected by Carlow County Council
  Street-cleaning wastes and similar wastes generated by Carlow County Council
  Cover material if deemed suitable for covering purposes (if deemed unsuitable the relevant gate fee will apply)
  C&D materials used for road construction if deemed suitable for construction purposes (if deemed unsuitable the relevant gate fee will apply)

7. ENTRY TO SITE

- All vehicles entering the site should adhere to the speed limit of 15km/hr and approach the weighbridge taking due caution for other site users.

- All waste contractors shall be in possession of a current waste Collection permit and shall maintain a copy in the waste vehicle.

- Loads being delivered must be in a secure container with hard sides and, at a minimum, a net type cover. Vehicles not in compliance will be advised and not allowed access to the site.

- Unsafe vehicles, plant or equipment will not be allowed access to the landfill site.

- Drivers and visitors must follow site operators' directions or instructions whilst on the site area.

- All drivers/Contractors entering the active area, when outside the confines of their vehicle, must wear approved safety footwear, high visibility vests/jackets and safety helmets. This applies both at the tipping face and when off-loading or loading containers at designated storage areas.

- Access to the site outside of normal operational hours shall not be permitted unless specifically authorised and supervised by Carlow County Council.

- The entrance gates shall be locked at all times when the site is not in operation.

- Smoking is not permitted on the site.

8. USE OF THE SITE WEIGHBRIDGE

- Vehicles must approach the entry weighbridge with caution.

- The weighbridge operatives shall check waste documentation on receipt at the weighbridge

- For non pre-cleared customers a visual inspection of waste will be carried out at the waste disposal area

- The driver must stop at the ticket machine located at the entry barrier. Once the weighbridge is clear the driver should press the button to obtain an entry ticket. If the customer is a licensed haulier in possession of a valid swipe card the driver should swipe the card at the swipe card machine and follow the on screen instructions.

- When the entry barrier lifts the driver should drive carefully onto the weighbridge ensuring that the vehicle is safely positioned. The driver should then press the yellow button while on the weighbridge and the second barrier will lift to permit entry to the site. If the driver has used a swipe card at barrier #1 they should also swipe the card at the swipe card machine while on the weighbridge and follow the on screen instructions. When barrier #2 lifts the driver may should exit the weighbridge and proceed to the appropriate tipping area.

9. GENERAL PUBLIC WASTE DISPOSAL AREA

- Drivers must not enter or manoeuvre onto or around the disposal area until it is clear to do so.

- Loads may be discharged only where directed by site staff, taking care to use prepared areas. **IF IN DOUBT, ASK.**

- Waste should be directed into the biodegradable / paper, cardboard / residual skips as appropriate. Unsegregated waste will not be accepted.

- Periodic checks will be carried out on the waste composition by directing loads to the waste quarantine area for analysis. These checks will be documented for reporting to the Agency.

- Container / trailer doors must be secured open prior to unloading, then closed and re-secured immediately after the load is unloaded.

- A landfill operative will visually inspect the waste deposited and check that the waste load only consists of non-hazardous waste.

- If the landfill operative suspects that hazardous waste has been deposited he will contact the Facility Manager who will determine whether the load should be rejected, suspended or re-defined

- After off-loading, vehicles must clear the disposal area immediately and leave the site without unnecessary delay.

- All vehicles must return to the weighbridge to weigh out before leaving the site.

10. WASTE DISPOSAL WITHIN THE ACTIVE AREA

- Driver / hauliers unloading large quantities of waste and / or in possession of a trailer / container that may be tipped should proceed, after the weighbridge, directly with residual waste to the waste acceptance area within the active area of the landfill.

- Prior to this it will be a requirement that waste should be directed into the biodegradable / paper, cardboard / active cells as appropriate. Unsegregated waste will not be accepted.

- Periodic checks will be carried out on the waste composition by directing loads to the waste quarantine area for analysis. These checks will be documented for reporting to the Agency.

- Drivers must follow all instructions by plant operators and landfill employees while in the Active Area.

- Drivers must take care when reversing at the tip face, looking out for obstructions or unstable ground. Drivers should observe and take care in respect of the movement of landfill equipment and other personnel on site.

- Drivers must remain up-wind while the load is being discharged.

- Drivers/operators must take care when releasing jammed loads.

- Once the load has been discharged the driver must clean, if necessary, any excess mud from the vehicle tailgate within the operational area.

- Drivers must lower and secure the body of the vehicle before moving out of the tipping area.

- All vehicles should return to the weighbridge to weigh out, passing through the wheel wash before leaving the site.

- In the event that mud and debris is carried from the active site onto the asphalt roads due to inclement weather conditions, the Facility Manager shall arrange that the road be cleaned with a road sweeper.

- The compaction plant will level and compact the deposited waste over and down the flanks of the working face. The working face of the landfill shall be no more than 2.5 meters in height after compaction, no more than 25 meters wide and have a slope no greater than 1:3.

- The compaction plant will progressively cover the waste with suitable material as soon as is practicable and in any event at the end of the working day.

- Drivers/operators must maintain at least one vehicle's length between their vehicle and others using the site.

- If a vehicle becomes stuck, the landfill operatives will endeavour to free the vehicle using the landfill plant. The driver must attach the tow chain to the vehicle. Any vehicle, which is stuck, must not be pushed by any other vehicle or landfill plant.

- Drivers should report any breach of this procedure to the weighbridge clerk or the facility manager before departing the location.

- All waste shall be checked at the working face. Any waste deemed unsuitable for acceptance at the facility and/or in contravention of this licence shall be immediately separated and removed from the facility at the earliest possible time. Temporary storage of such wastes shall be in a designated Waste Quarantine Area. Waste shall be stored under appropriate conditions in the quarantine area to avoid putrefaction, odour generation, the attraction of vermin and any other nuisance or objectionable condition.

11. LOAD REJECTION PROCEDURE

- When a problem is identified with a waste load the Facility Manager will be notified immediately.

- Problem loads may be identified at a number of points, with the measures to be implemented as follows:

  (a) Within the public area:- the waste load will be isolated by the landfill operative, where necessary using a cordon.

  (b) At the weighbridge: the weighbridge operator will direct the vehicle to the designated waiting area, or the container will have a "Quarantine waste" sign placed on it.

  (c) At the active area: the waste should not be unloaded or disturbed. Site staff should report the issue to the manager and a visual inspection of the load should be carried out. The manager will then decide whether or not it is ok to proceed with the unloading of the material or whether the load should be removed to quarantine for further inspection.

- When a waste load is placed under quarantine and subsequently rejected the landfill manager will isolate and suitably sign the load. A waste rejection form will be completed and a copy of this form will be kept for weighbridge records.

- If after inspection, testing or paperwork check, it is decided that the waste can be accepted, the sign or cordon will be removed.

- Before rejecting a load the Facility Manager considers the following:

  (a) At what point in the process has the waste been isolated, i.e. has the load just arrived on site, is the load in a designated waiting /holding area or has it been deposited.
  (b) Is the basis for rejection because the waste description/analysis does not meet the existing description (non-conforming) and/or the waste does not comply with the sites waste licence application or a regulation (non-compliant).
  (c) The safety and environmental implications of rejecting a load, rather than holding in quarantine at the site whilst the Environmental Protection Agency is informed.

- Deposited waste which is to be rejected will be loaded onto the transport vehicle under the supervision of the Facility Manager/Deputy Manager who will ensure that it is safe for transport.

- If the rejected waste is classified as hazardous, the Facility Manager will contact the Environmental Protection Agency.

- The Facility Manager may, at his/her discretion direct that a waste load be tipped in the waste inspection area. If the suspect load is considered to be a problem load then the procedures outlined above are carried out.

- All rejected loads of waste are recorded in a weighbridge record book and the report of the incident is sent to the waste enforcement section of Carlow County Council. This will be investigated under the Waste Management Act 1996 -2008 and followed up with a section 18 Notice. Findings from this notice are reported to the landfill manager who in turn notifies the EPA of the final destination of the load.

12. CIVIC AMENITY AREA

- Materials accepted at the Civic Amenity Area are as follows:

  - Paper
  - Cardboard
  - Glass bottles
  - Glass sheet
  - Timber
  - Textiles
  - Cans
  - Polystyrene
  - WEEE
  - Scrap Metal

- The Civic Waste Facility shall be used only by private vehicles. The facility shall not be used as a transfer station for disposal of waste by commercial waste disposal contractors or local authority waste collection vehicles.

- All waste deposited in the Civic Waste Facility shall be either:- a) Into a skip; b) Into the hopper of a compactor for disposal; c) Into a receptacle for recovery; and d) In the case where inspection is required, into a designated inspection area.

- Each container at the Civic Waste Facility will be clearly labelled to indicate their contents.

- At the end of the working day the ground around the Civic Waste Facility shall be cleared of waste.

- Pets are not allowed out of the vehicle in the civic amenity area.

- Children are allowed to participate in the recycling of household waste in the Civic Amenity Area only under the supervision of a responsible adult and must be kept under such supervisions at all times in the Civil Amenity Area. All users of the civic amenity area should adhere to the designated pedestrian routes.

- The operatives will routinely check and clean the area of any debris, broken glass, metals etc. which may be scattered about the general area and not in the containers.

- Operatives will notify the relevant collection bodies when skips, containers and bottle banks are nearing their full capacity.

- The civic amenity area will be visually inspected on a daily basis and a documented inspection will be carried out on a weekly basis. These reports will be filed on site for inspection by staff of the Agency

- When skips are being changed, the area shall be cordoned off from the public.

- Due to the proximity of the civic amenity area to the weighbridge and site entrance drivers are to take care when travelling in the vicinity of the civic amenity area.

13. TRAVELLING ON SITE

- Drivers must follow all site routing instructions and direction signs, on entering and leaving the site.

- The speed limit for vehicles on site is restricted to 15 km/hr, however drivers must drive at a lower speed if prevailing conditions so demand.

- All vehicles, plant and equipment will be operated in a manner showing due care and attention to safety, having regard to all circumstances prevailing at the time.

- Drivers must travel on signposted and prepared site roads only and must not deviate from these routes unless under the direction of site staff.

- Drivers must take care of personnel, plant and other vehicles when reversing.

- All plant on site must have reversing beepers fitted.

- Drivers must not overtake another vehicle on the haul road unless it has broken down.

- In conditions of fog or darkness or poor visibility dipped headlights must be used.

- Site plant shall use flashing beacons.

- Drivers parking and leaving vehicles must ensure the brakes are full on, the engine is stopped and the vehicle is in gear.

- Any damage or accidents occurring on this site involving personnel or vehicles must be reported to the Facility Manager at the time of the incident.

14. GENERAL PROCEDURES

- Care should be taken when handling waste; as a minimum, gloves should be worn.

- In the interest of safety and hygiene, persons should wash their hands after leaving the site and before eating or drinking.

- Apart from those authorised to collect recovered recyclables, no person shall remove materials from the site.

- No vehicles or plant will be operated during the hours of darkness unless adequate artificial lighting is provided for operating conditions.

- Spot checks will be carried out on a random basis by authorised persons, in order to check and assess the integrity of loads, and to comply with the site waste licence conditions. Appropriate records of such checks will be maintained.

- No material will be burned on the site. In the event that fire breaks out it will be treated as an emergency and dealt with immediately.

- Internal site access roads will be maintained in a satisfactory condition at all times. The primary site access road shall be cleaned at intervals consistent with preventing the deposition of mud on the public highway and minimising the generation of dust.

- Routine litter patrols will be carried out as necessary around the site perimeter along the access road from the filling area to the site entrance off the public highway. Any fly tipping which occurs at the site entrance or on the access road shall be immediately cleaned up. Every attempt shall be made to identify those responsible for such fly tipping.

- Site rules will be reviewed annually.

15. ACCIDENTS AND BREAKDOWNS

- Any accident or incident must be reported to site staff and will be dealt with in accordance with the Emergency Response Procedure for the site.

- In the event of breakdown in the active fill area of the tip face, if possible, the vehicle should be moved to a safe area, where it does not obstruct other site users. The incident should be reported to site staff and arrangements should be made for the recovery/repair of the vehicle.

- If the vehicle is unable to move off the site under its own power the vehicle must not be pushed. Assistance should be requested from the site staff to recover the vehicle.

- It is the vehicle driver's responsibility to affix and detach from his vehicle any tow chain. Take care to ensure that any tow chain is fixed securely prior to being towed.

This form should be completed by the facility manager

Powerstown Landfill
Powerstown, Co. Carlow
Telephone 059 9172406 Fax 059 9146356
Waste Licence: W0025-03

WASTE REJECTION FORM

CUSTOMER	
Name	
Address	
Contact Name	
Telephone Number	**Fax Number**
WASTE CARRIER	
Name	***As above Yes*** ☐ ***No*** ☐
Address	
Waste Collection Permit Number	
Please submit copy of collection permit	
Contact Name	
Telephone Number	**Fax Number**
WASTE DETAILS	
Description of the Process from which Waste Arises	

Physical Description of the Waste(Colour , Physical Form, Odour)

Chemical Composition of the Waste -

Description of Treatment of Waste

European Waste Catalogue Number (EWC) // (6 Digit)

Is the waste classified as Hazardous Waste under the EU Hazardous Waste List Yes ☐ No ☐

Waste Quantity (Tonnage/No of bags etc)

Delivery Method (All vehicles must have automatic nettings if the nets are above 1.5 m high. Articulated tipping trucks are prohibited)

Does the Waste Contain any of the Following?
Hazardous Waste Yes ☐ No ☐

Liquid Waste **Filtercakes**	**Yes** ☐ **No** ☐ **Yes** ☐ **No** ☐	For Filtercakes please specify the % solids content and attach analysis.
Additional Information / Reason for Rejecting Load		
AUTHORISED PERSONS		
Signed on behalf of customer		
Name:	**Date: / /**	
Position		
Contact number:		
Signed on behalf of Carlow County Council		
Name:	**Date: / /**	
Position		
Contact number:		

Appendix 4

Leachate production calculations

Powerstown Landfill - Leachate Production Estimates for 40,000 and 50,000 tonne intake rates.

40,000 tonnes/annum

Year	Active Cell No.	Active Area (m²)	Waste Input (t)	Active Infiltration (m³)	Intermediate Restoration Cell No.	Intermediate Restored Area (m²)	Intermediate Infiltration (m³)	Final Restoration Cell No.	Final Restored Area (m²)	Restored Infiltration (m³)	Total Infiltration (m³)	Waste Absorptive Capacity (m³)	Total Leachate Landfill Only (m³)	Leachate from Paved Area (m3)	Total Leachate (m³)
2012	17	6,399	40,000	3999	15,16	19,100	2984	Cells 1-13 & unlined	76,900	2,403	9,387	2,800	6,587	3,718	10,305
2013	17	6,399	40,000	3999	15,16	19,100	2984	Cells 1-13 & unlined	76,900	2,403	9,387	2,800	6,587	3,718	10,305
2014	18	8,289	40,000	5181	15,16,17	25,499	3984	Cells 1-13 & unlined	76,900	2,403	11,568	2,800	8,768	3,718	12,486
2015	18	8,289	15,524	5181	15,16,17	25,499	3984	Cells 1-13 & unlined	76,900	2,403	11,568	1,087	10,481	3,718	14,199
2016	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2017	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2018	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2019	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2020	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2021	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177

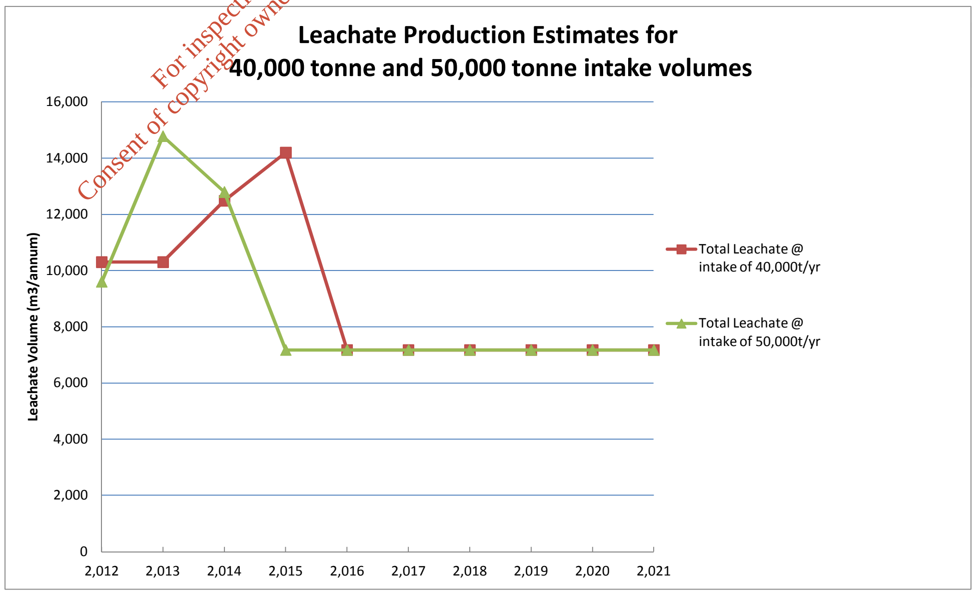
Year	Total Leachate @ intake of 40,000t/yr	Total Leachate @ intake of 50,000t/yr
2,012	10,305	9,605
2,013	10,305	14,786
2,014	12,486	12,799
2,015	14,199	7,177
2,016	7,177	7,177
2,017	7,177	7,177
2,018	7,177	7,177
2,019	7,177	7,177
2,020	7,177	7,177
2,021	7,177	7,177
	90,359	87,430

50,000 tonnes/annum

Year	Active Cell No.	Active Area (m²)	Waste Input (t)	Active Infiltration (m³)	Intermediate Restoration Cell No.	Intermediate Restored Area (m²)	Intermediate Infiltration (m³)	Final Restoration Cell No.	Final Restored Area (m²)	Restored Infiltration (m³)	Total Infiltration (m³)	Waste Absorptive Capacity (m³)	Total Leachate Landfill Only (m³)	Leachate from Paved Area (m3)	Total Leachate (m³)
2012	17	6,399	50,000	3999	15,16	19,100	2984	Cells 1-13 & unlined	76,900	2,403	9,387	3,500	5,887	3,718	9,605
2013	17 and 18	14,688	50,000	9180	15,16	19,100	2984	Cells 1-13 & unlined	76,900	2,403	14,568	3,500	11,068	3,718	14,786
2014	18	8,289	35,524	5181	15,16,17	25,499	3984	Cells 1-13 & unlined	76,900	2,403	11,568	2,487	9,081	3,718	12,799
2015	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2016	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2017	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2018	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2019	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2020	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177
2021	-	0	0	0	-	0	0	Cells 1-18 & unlined	110,688	3,459	3,459	0	3,459	3,718	7,177

Unlined Cell Area (m2)	42,200
Cell 1-5 Area (m2)	9,500
Cell 6- 13 Area (m2)	25,200
Cell 15 & 16 Area (m2)	19,100
Cell 17 Area (m2)	6,399
Cell 18 Area (m2)	8,289
Paved Area	3,151
Remaining Void in m^3 (at end of 2011)	169,405
Void expressed as a tonnage (t) =	135,524
Total rainfall (m/year) based in 2006/7 readings at Kilkenny	1.180
Effective Rainfall (m/year) based in 2007/7 readings at Kilkenny	0.625
Density of *in-situ* waste (t/m³)	0.800
Absorptive capacity "standard MSW" (m³/t)	0.070

Infiltration	
Active	1
Temp Cap	0.25
Perm Cap	0.05



Appendix 5

Landfill Gas Predictions

Carlow County Council

Powerstown Landfill Gas Model

Prepared for:

Carlow County Council
Powerstown Landfill & Recycling Centre
Powerstown, Co. Carlow

Revision: 2 ***Date: 30.09.11***

Prepared by:

Fehily Timoney & Co.
Core House,
Pouladuff Road,
Cork.

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CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES
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DESIGNED:	COC	CHECKED:	
DATE:	30.09.11	REVISION:	2
JOB NUMBER:	LW11-120-03		
CALC NUMBER:	C-01		
FILE	\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_Calc Set 01 LFG Calc Summary.xls		
SHEET	Calc cover		

PROJECT: Carlow County Council

DESCRIPTION: Powerstown Landfill Gas Model

Rev	Date	Purpose and Description	Prepared	Checked
1	30.09.11	Preparation of landfill gas model calculations	COC	
2	30.09.11	Revision of Gas Model to calibrate against gas flow data received from site	COC	SM

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JOB NUMBER:	LW11-120-03		
CALC NUMBER:	C-01		
FILE	Q:\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_Calc Set 01 LFG Calc Summary.xls		
SHEET	Calc Sheet		

PROJECT: Carlow County Council

DESCRIPTION: Powerstown Landfill Gas Model

Ref. | Output

i references

1 LandGEM-v302-guide by US EPA
2 2010 FTC gas model calculation for Powerstown (J:*\2011\120\02\Calculations\C-01 Gas Model\LW1112002_Calc-01_Gas Model rev 1.xls*)
3 Waste Input data from CCC for 2011
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Monthly Tonnage
4 LandGEM Model
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_LandGEM model Scenario 1 Do Nothing.xls
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_LandGEM model Scenario 2.xls
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_LandGEM model Scenario 3.xls
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_LandGEM model Scenario 4.xls
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Rev 2\LW1112003_LandGEM model Scenario 5.xls
5 Flare records 2009, 2010
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\LW1112003_Summary of Landfill gas Flared 2009 and 2010.xls
Note: Average Flow rates recorded over 2009 and 2010 were corrected by 90 m^3/hr due a flow meter error. This value was provided by Carlow County Council personell.
\\Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\Powerstown gas survey_2009v2.xls
Ftc05\rcp\2011\LW11\120\03\Calculations\Calc Set 01 Gas Model\W025 Landfill gas survey_2010v2.x
6 FTC calculation of closure year for various scenarios
\\Ftc05\rcp\2011\LW11\120\03\Calculations\LW1112003_Void details and Closure Years _0.9 density.xls

ii List of FTC Drawings

iii List of Appendices
Appendix A - Landfill Gas Predicted Volumes
Appendix B - Graph
Appendix C - LandGEM output files

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SHEET	Calc Sheet		

PROJECT: Carlow County Council
DESCRIPTION: Powerstown Landfill Gas Model

Ref. | Output

1.0 Introduction

The purpose of this calculation is to prepare a landfill gas model for use in the EIS for the proposed development at Powerstown Waste Management Facility.

2.0 Input Data

Opening Year: 1975
Closure Year: varies based on waste input scenario

2.1 Waste input data

2,3 The waste input data for the site is as shown below. These figures are based on communications with Carlow County Council and from previous calculations for the site carried

For future waste inputs, five scenarios will be examined.

The first scenario is the 'do nothing' scenario. The waste inputs for this scenario will be as per the existing planning permission, i.e. 40,000 tpa to end of December 2011, and thereafter the closure of the landfill. However, actual waste quantities accepted has been used in this scenario.

The second scenario will model the effects of waste inputs as per the existing planning permission, i.e. 40,000 tpa. This scenario will assume that the landfill accepted 40,000 from 2008 onwards and extend the life of the landfill until the remaining constructed cells are filled.

The third scenario will model the effects of proposed development, i.e. continue annual tonnage at 40,000 tpa and assume that this tonnage is received onsite from 2012 and extend the life of the landfill only until the remaining constructed cells are filled.

The fourth scenario will model the effects of proposed development, i.e. increase the annual tonnage from 40,000 tpa to 50,000 tpa and assume that this tonnage is received onsite from 2012 and extend the life of the landfill only until the remaining constructed cells are filled.

The fifth scenario will model the effects of proposed development, i.e. increase the annual tonnage from 40,000 tpa to 50,000 tpa and assume that only 10,000 tpa is received onsite from 2012 (considered worst-case scenario) and extend the life of the landfill only until the remaining constructed cells are filled.

The future waste inputs are adjusted as shown overleaf.

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SHEET	Calc Sheet		

PROJECT: Carlow County Council

DESCRIPTION: Powerstown Landfill Gas Model

Ref.

Output

Waste Input Data

2,3,6

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Year	Waste Input	Waste Input	Waste Input	Waste Input	Waste Input
	tonnes	tonnes	tonnes	tonnes	tonnes
1975	10,800	10,800	10,800	10,800	10,800
1976	10,800	10,800	10,800	10,800	10,800
1977	10,800	10,800	10,800	10,800	10,800
1978	10,800	10,800	10,800	10,800	10,800
1979	10,800	10,800	10,800	10,800	10,800
1980	10,800	10,800	10,800	10,800	10,800
1981	10,800	10,800	10,800	10,800	10,800
1982	10,800	10,800	10,800	10,800	10,800
1983	10,800	10,800	10,800	10,800	10,800
1984	10,800	10,800	10,800	10,800	10,800
1985	10,800	10,800	10,800	10,800	10,800
1986	10,800	10,800	10,800	10,800	10,800
1987	10,800	10,800	10,800	10,800	10,800
1988	10,800	10,800	10,800	10,800	10,800
1989	10,800	10,800	10,800	10,800	10,800
1990	14,961	14,961	14,961	14,961	14,961
1991	14,961	14,961	14,961	14,961	14,961
1992	14,961	14,961	14,961	14,961	14,961
1993	14,961	14,961	14,961	14,961	14,961
1994	14,961	14,961	14,961	14,961	14,961
1995	14,961	14,961	14,961	14,961	14,961
1996	14,961	14,961	14,961	14,961	14,961
1997	22,441	22,441	22,441	22,441	22,441
1998	29,922	29,922	29,922	29,922	29,922
1999	29,922	29,922	29,922	29,922	29,922
2000	40,394	40,394	40,394	40,394	40,394
2001	40,394	40,394	40,394	40,394	40,394
2002	40,394	40,394	40,394	40,394	40,394
2003	28,307	28,307	28,307	28,307	28,307
2004	39,853	39,853	39,853	39,853	39,853
2005	49,010	49,010	49,010	49,010	49,010
2006	42,638	42,638	42,638	42,638	42,638
2007	43,130	43,130	43,130	43,130	43,130
2008	36,177	40,000	36,177	36,177	36,177
2009	21,684	40,000	21,684	21,684	21,684
2010	13,697	40,000	13,697	13,697	13,697
2011	10,088	40,000	10,088	10,088	10,088
2012		40,000	40,000	50,000	10,000
2013		8,689	40,000	50,000	10,000
2014			40,000	27,043	10,000
2015			7,043		10,000
2016					10,000
2017					10,000
2018					10,000
2019					10,000
2020					10,000
2021					10,000
2022					10,000
2023					10,000
2024					7,043

5044 First 6 months of 2011

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SHEET	Calc Sheet		

PROJECT: Carlow County Council
DESCRIPTION: Powerstown Landfill Gas Model

 Output

2.2 Model Parameters

1

2.2.1 Methane Generation Rate (k)

1

The Methane Generation Rate, k, determines the rate of methane generation for the mass of

- Moisture content of the waste mass,
- Availability of the nutrients for micro organisms that break down the waste to form methane and carbon dioxide
- pH of the waste mass, and
- Temperature of the waste mass.

year^{-1}. There are 5 k values given as options in Land Gem. The default k value is the CAA k

1 ### 2.2.2 Potential Methane Generation Capacity (Lo)

The Potential Methane Generation Capacity, Lo, depends only on the type and composition of waste placed in the landfill. The higher the cellulose content of the waste, the higher the value of Lo. The default Lo values used by LandGem are representative of MSW. The Lo value, as it is used in the first-order decomposition rate equation, is measured in metric units of cubic metres per megagram to be consistent with the CAA.

The default Lo value is the CAA Lo value for conventional landfills.

1 ### 2.2.3 Non-methane Organic Compound Concentration

The NMOC Concentration in landfill gas is a function of the types of waste in the landfill and the extent of the reaction that produce various compounds from the anaerobic decomposition of waste. NMOC concentration is measured in units of parts per million by volume (ppmv) and is used by LandGem only when NMOC emissions are being estimated. The NMOC concentration for the CAA default is 4,000 ppmv as hexane. The NMOC Concentration for the Inventory default is 600 ppmv where co-disposal of hazardous waste has either not occurred or is unknown and 2,400 ppmv where co-disposal of hazardous waste has occurred. The default NMOC concentration is the CAA value. If you use a site-specific value for NMOC concentration, then you must correct for air infiltration.

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Ref. | Output

2.2.4 Methane Content

1

For LandGem, landfill gas is assumed to be 50 percent methane and 50 percent carbon dioxide, with additional, trace constituents of NMOC's and other air pollutants. When using LandGem for complying with the CAA, methane content must remain fixed at 50 percent by volume (the model default value).

You can choose other methane amounts for the methane content using the User-specified selection if data exist to support using another concentration. However, using LandGem at landfills that have methane content outside the range 40 to 60 percent is not recommended. The first-order decomposition rate equation used by LandGem to determine emissions may not be valid outside this range.

The production of methane is determined using the first-order decomposition rate equation and is not affected by the concentration of methane. However, the concentration of methane affects the calculated production of carbon dioxide. The production of carbon dioxide (Q_{CO2}) is calculated from the production of methane (Q_{CH4}) and the methane content percentage (P_{CH4} using the equation overleaf.

$$Q_{CO2} = Q_{CH4} \times \{[1/(P_{CH4}/100)] - 1\}$$

This equation is derived as follows:

$$Q_{total} = Q_{CH4} + Q_{CO2}$$
$$Q_{CH4} = Q_{total} \times (P_{CH4}/100)$$
$$Q_{CO2} = Q_{total} - Q_{CH4} = [Q_{CH4}/(P_{CH4}/100)] - Q_{CH4}$$
$$Q_{CO2} = Q_{CH4} \times \{[1/(P_{CH4}/100)] - 1\}$$

where Q_{total} is the total production of landfill gas.

Where site specific data is available for the actual quantities of gas produced, the model can be

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DESCRIPTION: Powerstown Landfill Gas Model

2.3 Actual gas production at the site

Values of landfill gas produced are taken from data submitted by Carlow County Council to the EPA on quantites of methane flared or recovered in utilisation plants 2009 and 2010. On foot of clarification recieved from Carlow County Council, the actual flared volumes were adjusted by the addition of 90 m^3/hr of landfill gas flared. Collection efficiencies have been assumed as shown.

5

Year	Flared LFG (m^3/yr)	Actual Generated LFG (m^3/yr)	Flared LFG (m^3/hr)	Actual Generated LFG (m^3/hr)
2009	3,449,630	4,312,038	394	492
2010	3,275,665	4,094,581	374	467

Assumed collection efficiency 0.8

The parameters used in the LandGEM model will be adjusted to match the assumed 'actual generated LFG' volumes as closely as possible.

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3.0 Calculations

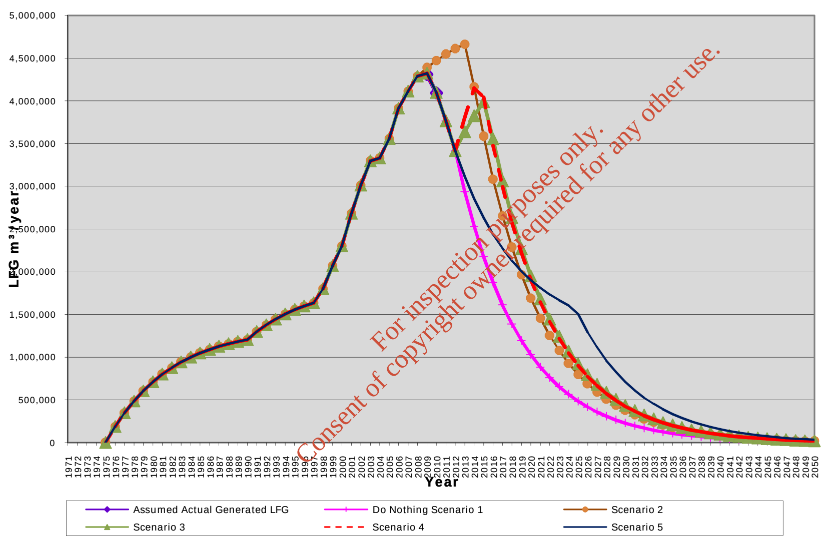
The following calculation was carried out to predict the volumes of gas arising from the landfill. The parameters used by LandGEM were adjusted to match the predicted curve to the recorded data as shown.

The parameters used were as follows:

Methane Generation Rate, k	0.15 $year^{-1}$
Potential Methane Generation Capacity, L_o	62 m^3/Mg
NMOC Concentration	600 ppmv as hexane
Methane Content	50 % by volume

Results of Landfill Gas Calculations

App A, B, C



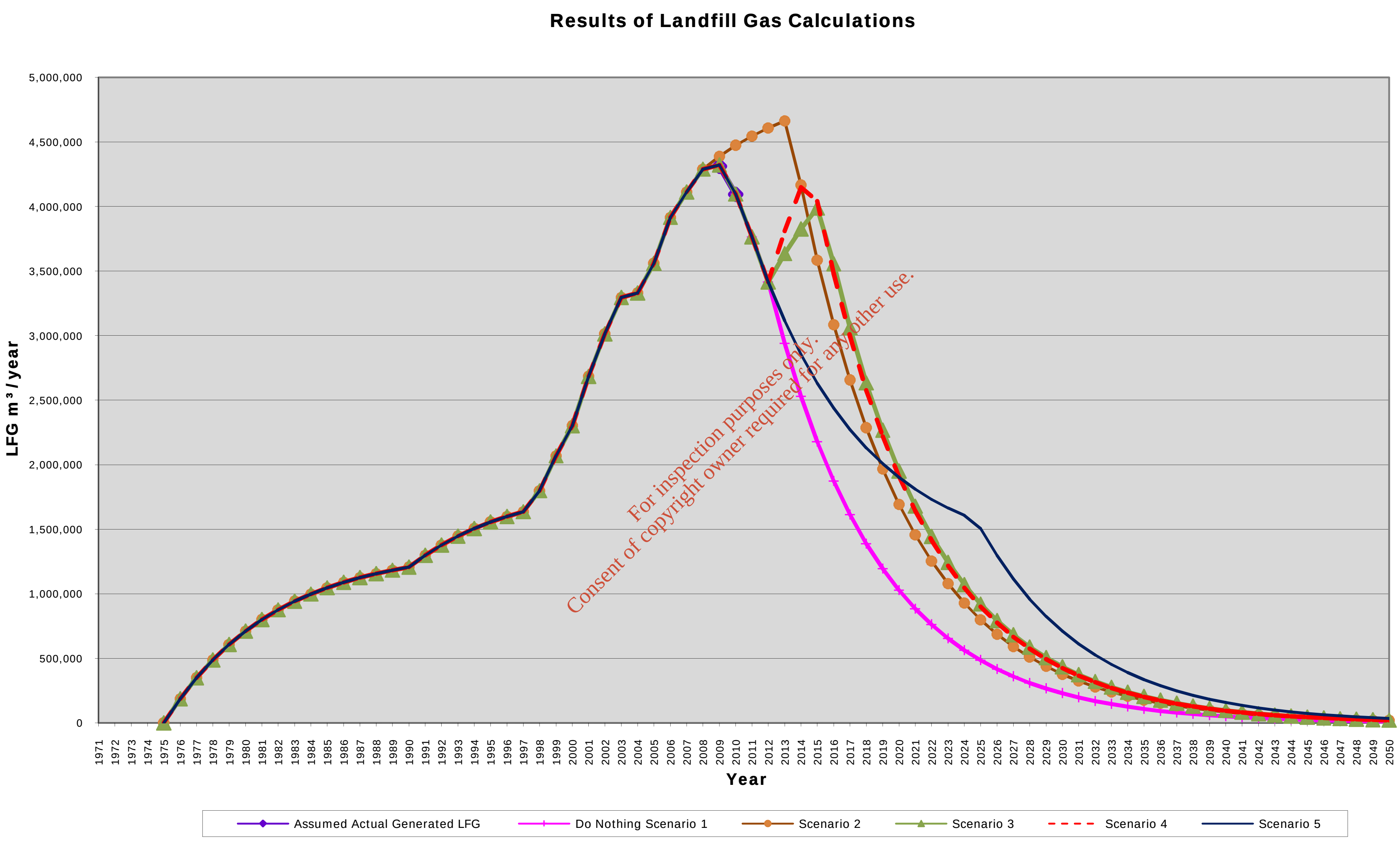
The results of the calculations are included in Appendix A. The graph above is reproduced in Appendix B at larger scale, and the output files from LandGEM are included in Appendix C.

Appendix A - Landfill Gas Predicted Volumes

as Model\Rev 2\LW1112003_Calc Set 01 LFG Calc Summary.xls App A

A - LandGEM results									
Scenario 1 - Do Nothing		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
Year	LFG (m³/yr)	Year	LFG (m³/yr)	Year	LFG (m³/yr)	Year	LFG (m³/yr)	Year	LFG (m³/yr)
1975	0	1975	0	1975	0	1975	0	1975	0
1976	1.879E+05	1976	1.879E+05	1976	1.879E+05	1976	1.879E+05	1976	1.879E+05
1977	3.497E+05	1977	3.497E+05	1977	3.497E+05	1977	3.497E+05	1977	3.497E+05
1978	4.889E+05	1978	4.889E+05	1978	4.889E+05	1978	4.889E+05	1978	4.889E+05
1979	6.088E+05	1979	6.088E+05	1979	6.088E+05	1979	6.088E+05	1979	6.088E+05
1980	7.119E+05	1980	7.119E+05	1980	7.119E+05	1980	7.119E+05	1980	7.119E+05
1981	8.007E+05	1981	8.007E+05	1981	8.007E+05	1981	8.007E+05	1981	8.007E+05
1982	8.771E+05	1982	8.771E+05	1982	8.771E+05	1982	8.771E+05	1982	8.771E+05
1983	9.429E+05	1983	9.429E+05	1983	9.429E+05	1983	9.429E+05	1983	9.429E+05
1984	9.995E+05	1984	9.995E+05	1984	9.995E+05	1984	9.995E+05	1984	9.995E+05
1985	1.048E+06	1985	1.048E+06	1985	1.048E+06	1985	1.048E+06	1985	1.048E+06
1986	1.090E+06	1986	1.090E+06	1986	1.090E+06	1986	1.090E+06	1986	1.090E+06
1987	1.126E+06	1987	1.126E+06	1987	1.126E+06	1987	1.126E+06	1987	1.126E+06
1988	1.157E+06	1988	1.157E+06	1988	1.157E+06	1988	1.157E+06	1988	1.157E+06
1989	1.184E+06	1989	1.184E+06	1989	1.184E+06	1989	1.184E+06	1989	1.184E+06
1990	1.207E+06	1990	1.207E+06	1990	1.207E+06	1990	1.207E+06	1990	1.207E+06
1991	1.299E+06	1991	1.299E+06	1991	1.299E+06	1991	1.299E+06	1991	1.299E+06
1992	1.379E+06	1992	1.379E+06	1992	1.379E+06	1992	1.379E+06	1992	1.379E+06
1993	1.447E+06	1993	1.447E+06	1993	1.447E+06	1993	1.447E+06	1993	1.447E+06
1994	1.506E+06	1994	1.506E+06	1994	1.506E+06	1994	1.506E+06	1994	1.506E+06
1995	1.556E+06	1995	1.556E+06	1995	1.556E+06	1995	1.556E+06	1995	1.556E+06
1996	1.600E+06	1996	1.600E+06	1996	1.600E+06	1996	1.600E+06	1996	1.600E+06
1997	1.637E+06	1997	1.637E+06	1997	1.637E+06	1997	1.637E+06	1997	1.637E+06
1998	1.800E+06	1998	1.800E+06	1998	1.800E+06	1998	1.800E+06	1998	1.800E+06
1999	2.070E+06	1999	2.070E+06	1999	2.070E+06	1999	2.070E+06	1999	2.070E+06
2000	2.302E+06	2000	2.302E+06	2000	2.302E+06	2000	2.302E+06	2000	2.302E+06
2001	2.685E+06	2001	2.685E+06	2001	2.685E+06	2001	2.685E+06	2001	2.685E+06
2002	3.014E+06	2002	3.014E+06	2002	3.014E+06	2002	3.014E+06	2002	3.014E+06
2003	3.297E+06	2003	3.297E+06	2003	3.297E+06	2003	3.297E+06	2003	3.297E+06
2004	3.330E+06	2004	3.330E+06	2004	3.330E+06	2004	3.330E+06	2004	3.330E+06
2005	3.560E+06	2005	3.560E+06	2005	3.560E+06	2005	3.560E+06	2005	3.560E+06
2006	3.917E+06	2006	3.917E+06	2006	3.917E+06	2006	3.917E+06	2006	3.917E+06
2007	4.113E+06	2007	4.113E+06	2007	4.113E+06	2007	4.113E+06	2007	4.113E+06
2008	4.291E+06	2008	4.291E+06	2008	4.291E+06	2008	4.291E+06	2008	4.291E+06
2009	4.323E+06	2009	4.389E+06	2009	4.323E+06	2009	4.323E+06	2009	4.323E+06
2010	4.098E+06	2010	4.474E+06	2010	4.098E+06	2010	4.098E+06	2010	4.098E+06
2011	3.765E+06	2011	4.547E+06	2011	3.765E+06	2011	3.765E+06	2011	3.765E+06
2012	3.417E+06	2012	4.610E+06	2012	3.417E+06	2012	3.417E+06	2012	3.417E+06
2013	2.941E+06	2013	4.664E+06	2013	3.637E+06	2013	3.811E+06	2013	3.115E+06
2014	2.531E+06	2014	4.165E+06	2014	3.826E+06	2014	4.150E+06	2014	2.855E+06
2015	2.178E+06	2015	3.585E+06	2015	3.989E+06	2015	4.043E+06	2015	2.631E+06
2016	1.875E+06	2016	3.086E+06	2016	3.556E+06	2016	3.479E+06	2016	2.439E+06
2017	1.614E+06	2017	2.656E+06	2017	3.061E+06	2017	2.995E+06	2017	2.273E+06
2018	1.389E+06	2018	2.286E+06	2018	2.635E+06	2018	2.578E+06	2018	2.130E+06
2019	1.196E+06	2019	1.967E+06	2019	2.268E+06	2019	2.219E+06	2019	2.008E+06
2020	1.029E+06	2020	1.693E+06	2020	1.952E+06	2020	1.910E+06	2020	1.902E+06
2021	8.857E+05	2021	1.458E+06	2021	1.680E+06	2021	1.644E+06	2021	1.811E+06
2022	7.623E+05	2022	1.255E+06	2022	1.446E+06	2022	1.415E+06	2022	1.733E+06
2023	6.561E+05	2023	1.080E+06	2023	1.244E+06	2023	1.218E+06	2023	1.666E+06
2024	5.647E+05	2024	9.294E+05	2024	1.071E+06	2024	1.048E+06	2024	1.608E+06
2025	4.861E+05	2025	7.999E+05	2025	9.219E+05	2025	9.020E+05	2025	1.506E+06
2026	4.184E+05	2026	6.885E+05	2026	7.935E+05	2026	7.764E+05	2026	1.296E+06
2027	3.601E+05	2027	5.926E+05	2027	6.830E+05	2027	6.682E+05	2027	1.116E+06
2028	3.099E+05	2028	5.101E+05	2028	5.878E+05	2028	5.752E+05	2028	9.604E+05
2029	2.668E+05	2029	4.390E+05	2029	5.060E+05	2029	4.950E+05	2029	8.266E+05
2030	2.296E+05	2030	3.779E+05	2030	4.355E+05	2030	4.261E+05	2030	7.115E+05
2031	1.976E+05	2031	3.252E+05	2031	3.748E+05	2031	3.667E+05	2031	6.124E+05
2032	1.701E+05	2032	2.799E+05	2032	3.226E+05	2032	3.157E+05	2032	5.271E+05
2033	1.464E+05	2033	2.409E+05	2033	2.777E+05	2033	2.717E+05	2033	4.537E+05
2034	1.260E+05	2034	2.074E+05	2034	2.390E+05	2034	2.338E+05	2034	3.905E+05
2035	1.085E+05	2035	1.785E+05	2035	2.057E+05	2035	2.013E+05	2035	3.361E+05
2036	9.335E+04	2036	1.536E+05	2036	1.771E+05	2036	1.732E+05	2036	2.893E+05
2037	8.035E+04	2037	1.322E+05	2037	1.524E+05	2037	1.491E+05	2037	2.490E+05
2038	6.916E+04	2038	1.138E+05	2038	1.312E+05	2038	1.283E+05	2038	2.143E+05
2039	5.952E+04	2039	9.796E+04	2039	1.129E+05	2039	1.105E+05	2039	1.844E+05
2040	5.123E+04	2040	8.431E+04	2040	9.717E+04	2040	9.507E+04	2040	1.588E+05
2041	4.410E+04	2041	7.257E+04	2041	8.363E+04	2041	8.183E+04	2041	1.366E+05
2042	3.795E+04	2042	6.246E+04	2042	7.198E+04	2042	7.043E+04	2042	1.176E+05
2043	3.267E+04	2043	5.376E+04	2043	6.196E+04	2043	6.062E+04	2043	1.012E+05
2044	2.812E+04	2044	4.627E+04	2044	5.333E+04	2044	5.218E+04	2044	8.713E+04
2045	2.420E+04	2045	3.983E+04	2045	4.590E+04	2045	4.491E+04	2045	7.499E+04
2046	2.083E+04	2046	3.428E+04	2046	3.951E+04	2046	3.865E+04	2046	6.454E+04
2047	1.793E+04	2047	2.950E+04	2047	3.400E+04	2047	3.327E+04	2047	5.555E+04
2048	1.543E+04	2048	2.539E+04	2048	2.927E+04	2048	2.864E+04	2048	4.782E+04
2049	1.328E+04	2049	2.186E+04	2049	2.519E+04	2049	2.465E+04	2049	4.116E+04
2050	1.143E+04	2050	1.881E+04	2050	2.168E+04	2050	2.121E+04	2050	3.542E+04
2051	9.839E+03	2051	1.619E+04	2051	1.866E+04	2051	1.826E+04	2051	3.049E+04
2052	8.469E+03	2052	1.394E+04	2052	1.606E+04	2052	1.572E+04	2052	2.624E+04
2053	7.289E+03	2053	1.200E+04	2053	1.382E+04	2053	1.353E+04	2053	2.259E+04
2054	6.274E+03	2054	1.032E+04	2054	1.190E+04	2054	1.164E+04	2054	1.944E+04
2055	5.400E+03	2055	8.886E+03	2055	1.024E+04	2055	1.002E+04	2055	1.673E+04
2056	4.648E+03	2056	7.649E+03	2056	8.815E+03	2056	8.625E+03	2056	1.440E+04
2057	4.000E+03	2057	6.583E+03	2057	7.587E+03	2057	7.423E+03	2057	1.240E+04
2058	3.443E+03	2058	5.666E+03	2058	6.530E+03	2058	6.389E+03	2058	1.067E+04
2059	2.964E+03	2059	4.877E+03	2059	5.621E+03	2059	5.499E+03	2059	9.183E+03
2060	2.551E+03	2060	4.198E+03	2060	4.838E+03	2060	4.733E+03	2060	7.904E+03
2061	2.195E+03	2061	3.613E+03	2061	4.164E+03	2061	4.074E+03	2061	6.803E+03
2062	1.890E+03	2062	3.110E+03	2062	3.584E+03	2062	3.507E+03	2062	5.855E+03
2063	1.626E+03	2063	2.677E+03	2063	3.085E+03	2063	3.018E+03	2063	5.040E+03
2064	1.400E+03	2064	2.304E+03	2064	2.655E+03	2064	2.598E+03	2064	4.338E+03
2065	1.205E+03	2065	1.983E+03	2065	2.285E+03	2065	2.236E+03	2065	3.734E+03
2066	1.037E+03	2066	1.707E+03	2066	1.967E+03	2066	1.924E+03	2066	3.213E+03
2067	8.926E+02	2067	1.469E+03	2067	1.693E+03	2067	1.656E+03	2067	2.766E+03
2068	7.683E+02	2068	1.264E+03	2068	1.457E+03	2068	1.426E+03	2068	2.381E+03
2069	6.613E+02	2069	1.088E+03	2069	1.254E+03	2069	1.227E+03	2069	2.049E+03
2070	5.691E+02	2070	9.366E+02	2070	1.079E+03	2070	1.056E+03	2070	1.764E+03
2071	4.899E+02	2071	8.062E+02	2071	9.291E+02	2071	9.090E+02	2071	1.518E+03
2072	4.216E+02	2072	6.939E+02	2072	7.997E+02	2072	7.824E+02	2072	1.306E+03
2073	3.629E+02	2073	5.972E+02	2073	6.883E+02	2073	6.734E+02	2073	1.125E+03
2074	3.124E+02	2074	5.140E+02	2074	5.924E+02	2074	5.796E+02	2074	9.679E+02
2075	2.688E+02	2075	4.424E+02	2075	5.099E+02	2075	4.989E+02	2075	8.331E+02
2076	2.314E+02	2076	3.808E+02	2076	4.389E+02	2076	4.294E+02	2076	7.170E+02
2077	1.992E+02	2077	3.278E+02	2077	3.777E+02	2077	3.696E+02	2077	6.171E+02
2078	1.714E+02	2078	2.821E+02	2078	3.251E+02	2078	3.181E+02	2078	5.312E+02
2079	1.475E+02	2079	2.428E+02	2079	2.798E+02	2079	2.738E+02	2079	4.572E+02
2080	1.270E+02	2080	2.090E+02	2080	2.409E+02	2080	2.357E+02	2080	3.935E+02
2081	1.093E+02	2081	1.799E+02	2081	2.073E+02	2081	2.028E+02	2081	3.387E+02
2082	9.408E+01	2082	1.548E+02	2082	1.784E+02	2082	1.746E+02	2082	2.915E+02
2083	8.097E+01	2083	1.333E+02	2083	1.536E+02	2083	1.503E+02	2083	2.509E+02
2084	6.970E+01	2084	1.147E+02	2084	1.322E+02	2084	1.293E+02	2084	2.160E+02
2085	5.999E+01	2085	9.872E+01	2085	1.138E+02	2085	1.113E+02	2085	1.859E+02
2086	5.163E+01	2086	8.497E+01	2086	9.793E+01	2086	9.581E+01	2086	1.600E+02
2087	4.444E+01	2087	7.313E+01	2087	8.429E+01	2087	8.247E+01	2087	1.377E+02
2088	3.825E+01	2088	6.295E+01	2088	7.255E+01	2088	7.098E+01	2088	1.185E+02
2089	3.292E+01	2089	5.418E+01	2089	6.244E+01	2089	6.109E+01	2089	1.020E+02
2090	2.834E+01	2090	4.663E+01	2090	5.374E+01	2090	5.258E+01	2090	8.780E+01
2091	2.439E+01	2091	4.014E+01	2091	4.626E+01	2091	4.526E+01	2091	7.557E+01
2092	2.099E+01	2092	3.455E+01	2092	3.981E+01	2092	3.895E+01	2092	6.505E+01
2093	1.807E+01	2093	2.973E+01	2093	3.427E+01	2093	3.353E+01	2093	5.599E+01
2094	1.555E+01	2094	2.559E+01	2094	2.949E+01	2094	2.886E+01	2094	4.819E+01
2095	1.339E+01	2095	2.203E+01	2095	2.539E+01	2095	2.484E+01	2095	4.148E+01
2096	1.152E+01	2096	1.896E+01	2096	2.185E+01	2096	2.138E+01	2096	3.570E+01
2097	9.916E+00	2097	1.632E+01	2097	1.881E+01	2097	1.840E+01	2097	3.073E+01
2098	8.535E+00	2098	1.405E+01	2098	1.619E+01	2098	1.584E+01	2098	2.645E+01
2099	7.346E+00	2099	1.209E+01	2099	1.393E+01	2099	1.363E+01	2099	2.276E+01
2100	6.323E+00	2100	1.040E+01	2100	1.199E+01	2100	1.173E+01	2100	1.959E+01
2101	5.442E+00	2101	8.956E+00	2101	1.032E+01	2101	1.010E+01	2101	1.686E+01
2102	4.684E+00	2102	7.708E+00	2102	8.884E+00	2102	8.692E+00	2102	1.451E+01
2103	4.031E+00	2103	6.634E+00	2103	7.646E+00	2103	7.481E+00	2103	1.249E+01
2104	3.470E+00	2104	5.710E+00	2104	6.581E+00	2104	6.439E+00	2104	1.075E+01
2105	2.987E+00	2105	4.915E+00	2105	5.664E+00	2105	5.542E+00	2105	9.254E+00
2106	2.571E+00	2106	4.230E+00	2106	4.875E+00	2106	4.770E+00	2106	7.965E+00
2107	2.213E+00	2107	3.641E+00	2107	4.196E+00	2107	4.106E+00	2107	6.856E+00
2108	1.904E+00	2108	3.134E+00	2108	3.612E+00	2108	3.534E+00	2108	5.901E+00
2109	1.639E+00	2109	2.697E+00	2109	3.109E+00	2109	3.042E+00	2109	5.079E+00
2110	1.411E+00	2110	2.322E+00	2110	2.676E+00	2110	2.618E+00	2110	4.371E+00
2111	1.214E+00	2111	1.998E+00	2111	2.303E+00	2111	2.253E+00	2111	3.763E+00
2112	1.045E+00	2112	1.720E+00	2112	1.982E+00	2112	1.939E+00	2112	3.238E+00
2113	8.995E-01	2113	1.480E+00	2113	1.706E+00	2113	1.669E+00	2113	2.787E+00
2114	7.742E-01	2114	1.274E+00	2114	1.468E+00	2114	1.437E+00	2114	2.399E+00
2115	6.664E-01	2115	1.097E+00	2115	1.264E+00	2115	1.237E+00	2115	2.065E+00
TOTAL	**94,296,166**		**110,167,941**		**110,167,940**		**110,167,940**		**110,167,935**

Appendix B - Graph


Results of Landfill Gas Calculations
LFG m³ / year
Year
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1971
2050
Assumed Actual Generated LFG
Do Nothing Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 5

Appendix C - LandGEM output files

Summary Report

Landfill Name or Identifier: Powerstown Landfill Calibrated

Date: 11 November 2011

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where,

Q_{CH_4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1975**	
Landfill Closure Year (with 80-year limit)	**2012**	
Actual Closure Year (without limit)	***2012***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.150**	*year* $^{-1}$
Potential Methane Generation Capacity, L_o	**62**	*m^3/Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1975	10,800	11,880	0	0
1976	10,800	11,880	10,800	11,880
1977	10,800	11,880	21,600	23,760
1978	10,800	11,880	32,400	35,640
1979	10,800	11,880	43,200	47,520
1980	10,800	11,880	54,000	59,400
1981	10,800	11,880	64,800	71,280
1982	10,800	11,880	75,600	83,160
1983	10,800	11,880	86,400	95,040
1984	10,800	11,880	97,200	106,920
1985	10,800	11,880	108,000	118,800
1986	10,800	11,880	118,800	130,680
1987	10,800	11,880	129,600	142,560
1988	10,800	11,880	140,400	154,440
1989	10,800	11,880	151,200	166,320
1990	14,961	16,457	162,000	178,200
1991	14,961	16,457	176,961	194,657
1992	14,961	16,457	191,922	211,114
1993	14,961	16,457	206,883	227,571
1994	14,961	16,457	221,844	244,028
1995	14,961	16,457	236,805	260,486
1996	14,961	16,457	251,766	276,943
1997	22,441	24,685	266,727	293,400
1998	29,922	32,914	289,168	318,085
1999	29,922	32,914	319,090	350,999
2000	40,394	44,433	349,012	383,913
2001	40,394	44,433	389,406	428,347
2002	40,394	44,433	429,800	472,780
2003	28,307	31,138	470,194	517,213
2004	39,853	43,838	498,501	548,351
2005	49,010	53,911	538,354	592,189
2006	42,638	46,902	587,364	646,100
2007	43,130	47,443	630,002	693,002
2008	36,177	39,795	673,132	740,445
2009	21,684	23,852	709,309	780,240
2010	13,697	15,067	730,993	804,092
2011	10,088	11,097	744,690	819,159
2012	0	0	754,778	830,256
2013	0	0	754,778	830,256
2014	0	0	754,778	830,256

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2015	0	0	754,778	830,256
2016	0	0	754,778	830,256
2017	0	0	754,778	830,256
2018	0	0	754,778	830,256
2019	0	0	754,778	830,256
2020	0	0	754,778	830,256
2021	0	0	754,778	830,256
2022	0	0	754,778	830,256
2023	0	0	754,778	830,256
2024	0	0	754,778	830,256
2025	0	0	754,778	830,256
2026	0	0	754,778	830,256
2027	0	0	754,778	830,256
2028	0	0	754,778	830,256
2029	0	0	754,778	830,256
2030	0	0	754,778	830,256
2031	0	0	754,778	830,256
2032	0	0	754,778	830,256
2033	0	0	754,778	830,256
2034	0	0	754,778	830,256
2035	0	0	754,778	830,256
2036	0	0	754,778	830,256
2037	0	0	754,778	830,256
2038	0	0	754,778	830,256
2039	0	0	754,778	830,256
2040	0	0	754,778	830,256
2041	0	0	754,778	830,256
2042	0	0	754,778	830,256
2043	0	0	754,778	830,256
2044	0	0	754,778	830,256
2045	0	0	754,778	830,256
2046	0	0	754,778	830,256
2047	0	0	754,778	830,256
2048	0	0	754,778	830,256
2049	0	0	754,778	830,256
2050	0	0	754,778	830,256
2051	0	0	754,778	830,256
2052	0	0	754,778	830,256
2053	0	0	754,778	830,256
2054	0	0	754,778	830,256

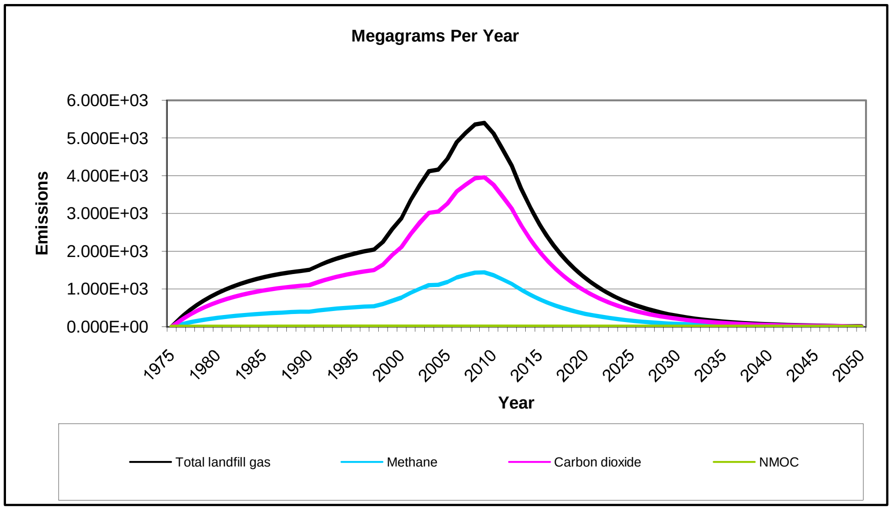
Pollutant Parameters

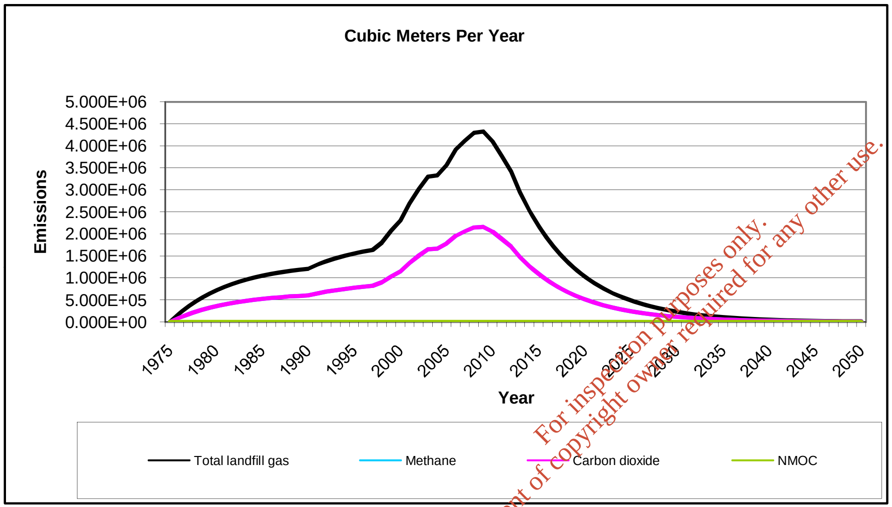
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

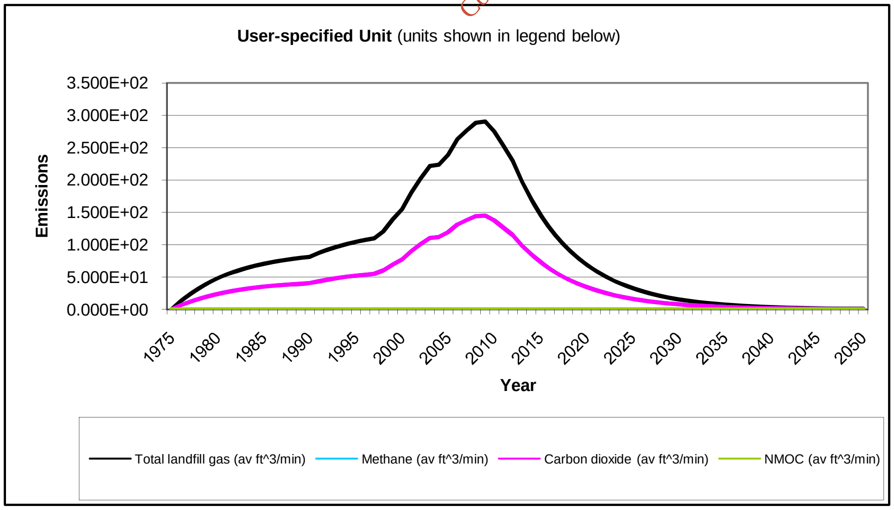
Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
6.000E+03
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
5.000E+06
4.500E+06
4.000E+06
3.500E+06
3.000E+06
2.500E+06
2.000E+06
1.500E+06
1.000E+06
5.000E+05
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
3.500E+02
3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
1975	0	0	0	0	0	0
1976	2.347E+02	1.879E+05	1.263E+01	6.269E+01	9.397E+04	6.314E+00
1977	4.367E+02	3.497E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1978	6.106E+02	4.889E+05	3.285E+01	1.631E+02	2.445E+05	1.643E+01
1979	7.603E+02	6.088E+05	4.090E+01	2.031E+02	3.044E+05	2.045E+01
1980	8.891E+02	7.119E+05	4.783E+01	2.375E+02	3.560E+05	2.392E+01
1981	9.999E+02	8.007E+05	5.380E+01	2.671E+02	4.003E+05	2.690E+01
1982	1.095E+03	8.771E+05	5.893E+01	2.926E+02	4.386E+05	2.947E+01
1983	1.177E+03	9.429E+05	6.335E+01	3.145E+02	4.714E+05	3.168E+01
1984	1.248E+03	9.995E+05	6.716E+01	3.334E+02	4.997E+05	3.358E+01
1985	1.309E+03	1.048E+06	7.043E+01	3.497E+02	5.241E+05	3.521E+01
1986	1.361E+03	1.090E+06	7.325E+01	3.636E+02	5.451E+05	3.662E+01
1987	1.406E+03	1.126E+06	7.567E+01	3.757E+02	5.631E+05	3.784E+01
1988	1.445E+03	1.157E+06	7.776E+01	3.860E+02	5.787E+05	3.888E+01
1989	1.479E+03	1.184E+06	7.956E+01	3.950E+02	5.920E+05	3.978E+01
1990	1.507E+03	1.207E+06	8.110E+01	4.026E+02	6.035E+05	4.055E+01
1991	1.623E+03	1.299E+06	8.730E+01	4.334E+02	6.496E+05	4.365E+01
1992	1.722E+03	1.379E+06	9.263E+01	4.599E+02	6.893E+05	4.632E+01
1993	1.807E+03	1.447E+06	9.722E+01	4.827E+02	7.235E+05	4.861E+01
1994	1.880E+03	1.506E+06	1.012E+02	5.023E+02	7.529E+05	5.059E+01
1995	1.944E+03	1.556E+06	1.046E+02	5.192E+02	7.782E+05	5.229E+01
1996	1.998E+03	1.600E+06	1.075E+02	5.337E+02	8.000E+05	5.375E+01
1997	2.045E+03	1.637E+06	1.100E+02	5.462E+02	8.187E+05	5.501E+01
1998	2.248E+03	1.800E+06	1.209E+02	6.004E+02	8.999E+05	6.047E+01
1999	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2000	2.875E+03	2.302E+06	1.547E+02	7.680E+02	1.151E+06	7.734E+01
2001	3.352E+03	2.685E+06	1.804E+02	8.955E+02	1.342E+06	9.019E+01
2002	3.763E+03	3.014E+06	2.025E+02	1.005E+03	1.507E+06	1.012E+02
2003	4.117E+03	3.297E+06	2.215E+02	1.100E+03	1.648E+06	1.108E+02
2004	4.159E+03	3.330E+06	2.237E+02	1.111E+03	1.665E+06	1.119E+02
2005	4.446E+03	3.560E+06	2.392E+02	1.187E+03	1.780E+06	1.196E+02
2006	4.891E+03	3.917E+06	2.632E+02	1.307E+03	1.958E+06	1.316E+02
2007	5.137E+03	4.113E+06	2.764E+02	1.372E+03	2.057E+06	1.382E+02
2008	5.358E+03	4.291E+06	2.883E+02	1.431E+03	2.145E+06	1.441E+02
2009	5.398E+03	4.323E+06	2.904E+02	1.442E+03	2.161E+06	1.452E+02
2010	5.118E+03	4.098E+06	2.753E+02	1.367E+03	2.049E+06	1.377E+02
2011	4.702E+03	3.765E+06	2.530E+02	1.256E+03	1.883E+06	1.265E+02
2012	4.267E+03	3.417E+06	2.296E+02	1.140E+03	1.708E+06	1.148E+02
2013	3.672E+03	2.941E+06	1.976E+02	9.809E+02	1.470E+06	9.879E+01
2014	3.161E+03	2.531E+06	1.701E+02	8.443E+02	1.266E+06	8.503E+01
2015	2.721E+03	2.178E+06	1.464E+02	7.267E+02	1.089E+06	7.319E+01
2016	2.342E+03	1.875E+06	1.260E+02	6.255E+02	9.375E+05	6.299E+01
2017	2.015E+03	1.614E+06	1.084E+02	5.383E+02	8.069E+05	5.422E+01
2018	1.735E+03	1.389E+06	9.333E+01	4.634E+02	6.945E+05	4.667E+01
2019	1.493E+03	1.196E+06	8.033E+01	3.988E+02	5.978E+05	4.017E+01
2020	1.285E+03	1.029E+06	6.914E+01	3.433E+02	5.145E+05	3.457E+01
2021	1.106E+03	8.857E+05	5.951E+01	2.954E+02	4.429E+05	2.976E+01
2022	9.520E+02	7.623E+05	5.122E+01	2.543E+02	3.812E+05	2.561E+01
2023	8.194E+02	6.561E+05	4.409E+01	2.189E+02	3.281E+05	2.204E+01
2024	7.053E+02	5.647E+05	3.795E+01	1.884E+02	2.824E+05	1.897E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2025	6.070E+02	4.861E+05	3.266E+01	1.621E+02	2.430E+05	1.633E+01
2026	5.225E+02	4.184E+05	2.811E+01	1.396E+02	2.092E+05	1.406E+01
2027	4.497E+02	3.601E+05	2.420E+01	1.201E+02	1.800E+05	1.210E+01
2028	3.871E+02	3.099E+05	2.082E+01	1.034E+02	1.550E+05	1.041E+01
2029	3.331E+02	2.668E+05	1.792E+01	8.899E+01	1.334E+05	8.962E+00
2030	2.867E+02	2.296E+05	1.543E+01	7.659E+01	1.148E+05	7.714E+00
2031	2.468E+02	1.976E+05	1.328E+01	6.592E+01	9.881E+04	6.639E+00
2032	2.124E+02	1.701E+05	1.143E+01	5.674E+01	8.505E+04	5.714E+00
2033	1.828E+02	1.464E+05	9.837E+00	4.884E+01	7.320E+04	4.918E+00
2034	1.574E+02	1.260E+05	8.467E+00	4.203E+01	6.301E+04	4.233E+00
2035	1.354E+02	1.085E+05	7.287E+00	3.618E+01	5.423E+04	3.644E+00
2036	1.166E+02	9.335E+04	6.272E+00	3.114E+01	4.668E+04	3.136E+00
2037	1.003E+02	8.035E+04	5.399E+00	2.680E+01	4.017E+04	2.699E+00
2038	8.636E+01	6.916E+04	4.647E+00	2.307E+01	3.458E+04	2.323E+00
2039	7.433E+01	5.952E+04	3.999E+00	1.986E+01	2.976E+04	2.000E+00
2040	6.398E+01	5.123E+04	3.442E+00	1.709E+01	2.562E+04	1.721E+00
2041	5.507E+01	4.410E+04	2.963E+00	1.471E+01	2.205E+04	1.481E+00
2042	4.740E+01	3.795E+04	2.550E+00	1.266E+01	1.898E+04	1.275E+00
2043	4.080E+01	3.267E+04	2.195E+00	1.090E+01	1.633E+04	1.097E+00
2044	3.511E+01	2.812E+04	1.889E+00	9.379E+00	1.406E+04	9.446E-01
2045	3.022E+01	2.420E+04	1.626E+00	8.073E+00	1.210E+04	8.130E-01
2046	2.601E+01	2.083E+04	1.400E+00	6.948E+00	1.041E+04	6.998E-01
2047	2.239E+01	1.793E+04	1.205E+00	5.980E+00	8.964E+03	6.023E-01
2048	1.927E+01	1.543E+04	1.037E+00	5.147E+00	7.716E+03	5.184E-01
2049	1.659E+01	1.328E+04	8.924E-01	4.430E+00	6.641E+03	4.462E-01
2050	1.428E+01	1.143E+04	7.681E-01	3.813E+00	5.716E+03	3.840E-01
2051	1.229E+01	9.839E+03	6.611E-01	3.282E+00	4.920E+03	3.305E-01
2052	1.058E+01	8.469E+03	5.690E-01	2.825E+00	4.234E+03	2.845E-01
2053	9.103E+00	7.289E+03	4.898E-01	2.431E+00	3.645E+03	2.449E-01
2054	7.835E+00	6.274E+03	4.215E-01	2.093E+00	3.137E+03	2.108E-01
2055	6.744E+00	5.400E+03	3.628E-01	1.801E+00	2.700E+03	1.814E-01
2056	5.804E+00	4.648E+03	3.123E-01	1.550E+00	2.324E+03	1.561E-01
2057	4.996E+00	4.000E+03	2.688E-01	1.334E+00	2.000E+03	1.344E-01
2058	4.300E+00	3.443E+03	2.313E-01	1.149E+00	1.722E+03	1.157E-01
2059	3.701E+00	2.964E+03	1.991E-01	9.886E-01	1.482E+03	9.956E-02
2060	3.185E+00	2.551E+03	1.714E-01	8.509E-01	1.275E+03	8.569E-02
2061	2.742E+00	2.195E+03	1.475E-01	7.323E-01	1.098E+03	7.376E-02
2062	2.360E+00	1.890E+03	1.270E-01	6.303E-01	9.448E+02	6.348E-02
2063	2.031E+00	1.626E+03	1.093E-01	5.425E-01	8.132E+02	5.464E-02
2064	1.748E+00	1.400E+03	9.406E-02	4.670E-01	6.999E+02	4.703E-02
2065	1.505E+00	1.205E+03	8.096E-02	4.019E-01	6.024E+02	4.048E-02
2066	1.295E+00	1.037E+03	6.968E-02	3.459E-01	5.185E+02	3.484E-02
2067	1.115E+00	8.926E+02	5.997E-02	2.977E-01	4.463E+02	2.999E-02
2068	9.594E-01	7.683E+02	5.162E-02	2.563E-01	3.841E+02	2.581E-02
2069	8.258E-01	6.613E+02	4.443E-02	2.206E-01	3.306E+02	2.221E-02
2070	7.108E-01	5.691E+02	3.824E-02	1.899E-01	2.846E+02	1.912E-02
2071	6.118E-01	4.899E+02	3.291E-02	1.634E-01	2.449E+02	1.646E-02
2072	5.265E-01	4.216E+02	2.833E-02	1.406E-01	2.108E+02	1.416E-02
2073	4.532E-01	3.629E+02	2.438E-02	1.211E-01	1.815E+02	1.219E-02
2074	3.901E-01	3.124E+02	2.099E-02	1.042E-01	1.562E+02	1.049E-02
2075	3.357E-01	2.688E+02	1.806E-02	8.968E-02	1.344E+02	9.032E-03

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	2.890E-01	2.314E+02	1.555E-02	7.719E-02	1.157E+02	7.774E-03
2077	2.487E-01	1.992E+02	1.338E-02	6.644E-02	9.958E+01	6.691E-03
2078	2.141E-01	1.714E+02	1.152E-02	5.718E-02	8.571E+01	5.759E-03
2079	1.843E-01	1.475E+02	9.914E-03	4.922E-02	7.377E+01	4.957E-03
2080	1.586E-01	1.270E+02	8.533E-03	4.236E-02	6.350E+01	4.266E-03
2081	1.365E-01	1.093E+02	7.344E-03	3.646E-02	5.465E+01	3.672E-03
2082	1.175E-01	9.408E+01	6.321E-03	3.138E-02	4.704E+01	3.161E-03
2083	1.011E-01	8.097E+01	5.441E-03	2.701E-02	4.049E+01	2.720E-03
2084	8.704E-02	6.970E+01	4.683E-03	2.325E-02	3.485E+01	2.341E-03
2085	7.491E-02	5.999E+01	4.031E-03	2.001E-02	2.999E+01	2.015E-03
2086	6.448E-02	5.163E+01	3.469E-03	1.722E-02	2.582E+01	1.735E-03
2087	5.550E-02	4.444E+01	2.986E-03	1.482E-02	2.222E+01	1.493E-03
2088	4.777E-02	3.825E+01	2.570E-03	1.276E-02	1.912E+01	1.285E-03
2089	4.111E-02	3.292E+01	2.212E-03	1.098E-02	1.646E+01	1.106E-03
2090	3.539E-02	2.834E+01	1.904E-03	9.452E-03	1.417E+01	9.519E-04
2091	3.046E-02	2.439E+01	1.639E-03	8.136E-03	1.219E+01	8.193E-04
2092	2.622E-02	2.099E+01	1.410E-03	7.002E-03	1.050E+01	7.052E-04
2093	2.256E-02	1.807E+01	1.214E-03	6.027E-03	9.034E+00	6.070E-04
2094	1.942E-02	1.555E+01	1.045E-03	5.187E-03	7.776E+00	5.224E-04
2095	1.672E-02	1.339E+01	8.993E-04	4.465E-03	6.693E+00	4.497E-04
2096	1.439E-02	1.152E+01	7.741E-04	3.843E-03	5.760E+00	3.870E-04
2097	1.238E-02	9.916E+00	6.662E-04	3.308E-03	4.958E+00	3.331E-04
2098	1.066E-02	8.535E+00	5.734E-04	2.847E-03	4.267E+00	2.867E-04
2099	9.174E-03	7.346E+00	4.936E-04	2.450E-03	3.673E+00	2.468E-04
2100	7.896E-03	6.323E+00	4.248E-04	2.109E-03	3.161E+00	2.124E-04
2101	6.796E-03	5.442E+00	3.656E-04	1.815E-03	2.721E+00	1.828E-04
2102	5.849E-03	4.684E+00	3.147E-04	1.562E-03	2.342E+00	1.574E-04
2103	5.035E-03	4.031E+00	2.709E-04	1.345E-03	2.016E+00	1.354E-04
2104	4.333E-03	3.470E+00	2.331E-04	1.157E-03	1.735E+00	1.166E-04
2105	3.730E-03	2.987E+00	2.007E-04	9.963E-04	1.493E+00	1.003E-04
2106	3.210E-03	2.571E+00	1.727E-04	8.575E-04	1.285E+00	8.636E-05
2107	2.763E-03	2.213E+00	1.487E-04	7.380E-04	1.106E+00	7.433E-05
2108	2.378E-03	1.904E+00	1.280E-04	6.352E-04	9.522E-01	6.398E-05
2109	2.047E-03	1.639E+00	1.101E-04	5.468E-04	8.195E-01	5.506E-05
2110	1.762E-03	1.411E+00	9.479E-05	4.706E-04	7.054E-01	4.739E-05
2111	1.516E-03	1.214E+00	8.159E-05	4.050E-04	6.071E-01	4.079E-05
2112	1.305E-03	1.045E+00	7.022E-05	3.486E-04	5.226E-01	3.511E-05
2113	1.123E-03	8.995E-01	6.044E-05	3.001E-04	4.498E-01	3.022E-05
2114	9.669E-04	7.742E-01	5.202E-05	2.583E-04	3.871E-01	2.601E-05
2115	8.322E-04	6.664E-01	4.478E-05	2.223E-04	3.332E-01	2.239E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
1975	0	0	0	0	0	0
1976	1.720E+02	9.397E+04	6.314E+00	4.042E-01	1.128E+02	7.577E-03
1977	3.201E+02	1.749E+05	1.175E+01	7.521E-01	2.098E+02	1.410E-02
1978	4.475E+02	2.445E+05	1.643E+01	1.052E+00	2.934E+02	1.971E-02
1979	5.572E+02	3.044E+05	2.045E+01	1.309E+00	3.653E+02	2.454E-02
1980	6.516E+02	3.560E+05	2.392E+01	1.531E+00	4.272E+02	2.870E-02
1981	7.328E+02	4.003E+05	2.690E+01	1.722E+00	4.804E+02	3.228E-02
1982	8.028E+02	4.386E+05	2.947E+01	1.886E+00	5.263E+02	3.536E-02
1983	8.630E+02	4.714E+05	3.168E+01	2.028E+00	5.657E+02	3.801E-02
1984	9.148E+02	4.997E+05	3.358E+01	2.150E+00	5.997E+02	4.029E-02
1985	9.594E+02	5.241E+05	3.521E+01	2.254E+00	6.289E+02	4.226E-02
1986	9.978E+02	5.451E+05	3.662E+01	2.345E+00	6.541E+02	4.395E-02
1987	1.031E+03	5.631E+05	3.784E+01	2.422E+00	6.757E+02	4.540E-02
1988	1.059E+03	5.787E+05	3.888E+01	2.489E+00	6.944E+02	4.666E-02
1989	1.084E+03	5.920E+05	3.978E+01	2.546E+00	7.104E+02	4.773E-02
1990	1.105E+03	6.035E+05	4.055E+01	2.596E+00	7.242E+02	4.866E-02
1991	1.189E+03	6.496E+05	4.365E+01	2.794E+00	7.796E+02	5.238E-02
1992	1.262E+03	6.893E+05	4.632E+01	2.965E+00	8.272E+02	5.558E-02
1993	1.324E+03	7.235E+05	4.861E+01	3.112E+00	8.682E+02	5.833E-02
1994	1.378E+03	7.529E+05	5.059E+01	3.238E+00	9.035E+02	6.070E-02
1995	1.424E+03	7.782E+05	5.229E+01	3.347E+00	9.338E+02	6.274E-02
1996	1.464E+03	8.000E+05	5.375E+01	3.441E+00	9.600E+02	6.450E-02
1997	1.499E+03	8.187E+05	5.501E+01	3.522E+00	9.825E+02	6.601E-02
1998	1.647E+03	8.999E+05	6.047E+01	3.871E+00	1.080E+03	7.256E-02
1999	1.894E+03	1.035E+06	6.954E+01	4.452E+00	1.242E+03	8.344E-02
2000	2.107E+03	1.151E+06	7.734E+01	4.951E+00	1.381E+03	9.281E-02
2001	2.457E+03	1.342E+06	9.019E+01	5.774E+00	1.611E+03	1.082E-01
2002	2.758E+03	1.507E+06	1.012E+02	6.481E+00	1.808E+03	1.215E-01
2003	3.017E+03	1.648E+06	1.108E+02	7.090E+00	1.978E+03	1.329E-01
2004	3.048E+03	1.665E+06	1.119E+02	7.162E+00	1.998E+03	1.342E-01
2005	3.258E+03	1.780E+06	1.196E+02	7.656E+00	2.136E+03	1.435E-01
2006	3.585E+03	1.958E+06	1.316E+02	8.424E+00	2.350E+03	1.579E-01
2007	3.765E+03	2.057E+06	1.382E+02	8.846E+00	2.468E+03	1.658E-01
2008	3.927E+03	2.145E+06	1.441E+02	9.228E+00	2.574E+03	1.730E-01
2009	3.956E+03	2.161E+06	1.452E+02	9.297E+00	2.594E+03	1.743E-01
2010	3.751E+03	2.049E+06	1.377E+02	8.813E+00	2.459E+03	1.652E-01
2011	3.446E+03	1.883E+06	1.265E+02	8.098E+00	2.259E+03	1.518E-01
2012	3.127E+03	1.708E+06	1.148E+02	7.348E+00	2.050E+03	1.377E-01
2013	2.691E+03	1.470E+06	9.879E+01	6.324E+00	1.764E+03	1.185E-01
2014	2.317E+03	1.266E+06	8.503E+01	5.443E+00	1.519E+03	1.020E-01
2015	1.994E+03	1.089E+06	7.319E+01	4.685E+00	1.307E+03	8.782E-02
2016	1.716E+03	9.375E+05	6.299E+01	4.033E+00	1.125E+03	7.559E-02
2017	1.477E+03	8.069E+05	5.422E+01	3.471E+00	9.683E+02	6.506E-02
2018	1.271E+03	6.945E+05	4.667E+01	2.987E+00	8.334E+02	5.600E-02
2019	1.094E+03	5.978E+05	4.017E+01	2.571E+00	7.173E+02	4.820E-02
2020	9.418E+02	5.145E+05	3.457E+01	2.213E+00	6.174E+02	4.148E-02
2021	8.106E+02	4.429E+05	2.976E+01	1.905E+00	5.314E+02	3.571E-02
2022	6.977E+02	3.812E+05	2.561E+01	1.640E+00	4.574E+02	3.073E-02
2023	6.005E+02	3.281E+05	2.204E+01	1.411E+00	3.937E+02	2.645E-02
2024	5.169E+02	2.824E+05	1.897E+01	1.215E+00	3.388E+02	2.277E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2025	4.449E+02	2.430E+05	1.633E+01	1.045E+00	2.916E+02	1.960E-02
2026	3.829E+02	2.092E+05	1.406E+01	8.998E-01	2.510E+02	1.687E-02
2027	3.296E+02	1.800E+05	1.210E+01	7.745E-01	2.161E+02	1.452E-02
2028	2.837E+02	1.550E+05	1.041E+01	6.666E-01	1.860E+02	1.249E-02
2029	2.442E+02	1.334E+05	8.962E+00	5.737E-01	1.601E+02	1.075E-02
2030	2.101E+02	1.148E+05	7.714E+00	4.938E-01	1.378E+02	9.256E-03
2031	1.809E+02	9.881E+04	6.639E+00	4.250E-01	1.186E+02	7.967E-03
2032	1.557E+02	8.505E+04	5.714E+00	3.658E-01	1.021E+02	6.857E-03
2033	1.340E+02	7.320E+04	4.918E+00	3.149E-01	8.784E+01	5.902E-03
2034	1.153E+02	6.301E+04	4.233E+00	2.710E-01	7.561E+01	5.080E-03
2035	9.927E+01	5.423E+04	3.644E+00	2.333E-01	6.508E+01	4.372E-03
2036	8.544E+01	4.668E+04	3.136E+00	2.008E-01	5.601E+01	3.763E-03
2037	7.354E+01	4.017E+04	2.699E+00	1.728E-01	4.821E+01	3.239E-03
2038	6.330E+01	3.458E+04	2.323E+00	1.487E-01	4.149E+01	2.788E-03
2039	5.448E+01	2.976E+04	2.000E+00	1.280E-01	3.571E+01	2.400E-03
2040	4.689E+01	2.562E+04	1.721E+00	1.102E-01	3.074E+01	2.065E-03
2041	4.036E+01	2.205E+04	1.481E+00	9.484E-02	2.646E+01	1.778E-03
2042	3.474E+01	1.898E+04	1.275E+00	8.163E-02	2.277E+01	1.530E-03
2043	2.990E+01	1.633E+04	1.097E+00	7.026E-02	1.960E+01	1.317E-03
2044	2.573E+01	1.406E+04	9.446E-01	6.047E-02	1.687E+01	1.134E-03
2045	2.215E+01	1.210E+04	8.130E-01	5.205E-02	1.452E+01	9.756E-04
2046	1.906E+01	1.041E+04	6.998E-01	4.480E-02	1.250E+01	8.397E-04
2047	1.641E+01	8.964E+03	6.023E-01	3.856E-02	1.076E+01	7.228E-04
2048	1.412E+01	7.716E+03	5.184E-01	3.319E-02	9.259E+00	6.221E-04
2049	1.216E+01	6.641E+03	4.462E-01	2.856E-02	7.969E+00	5.354E-04
2050	1.046E+01	5.716E+03	3.840E-01	2.459E-02	6.859E+00	4.609E-04
2051	9.005E+00	4.920E+03	3.305E-01	2.116E-02	5.904E+00	3.967E-04
2052	7.751E+00	4.234E+03	2.845E-01	1.821E-02	5.081E+00	3.414E-04
2053	6.671E+00	3.645E+03	2.449E-01	1.568E-02	4.373E+00	2.939E-04
2054	5.742E+00	3.137E+03	2.108E-01	1.349E-02	3.764E+00	2.529E-04
2055	4.942E+00	2.700E+03	1.814E-01	1.161E-02	3.240E+00	2.177E-04
2056	4.254E+00	2.324E+03	1.561E-01	9.996E-03	2.789E+00	1.874E-04
2057	3.661E+00	2.000E+03	1.344E-01	8.603E-03	2.400E+00	1.613E-04
2058	3.151E+00	1.722E+03	1.157E-01	7.405E-03	2.066E+00	1.388E-04
2059	2.712E+00	1.482E+03	9.956E-02	6.374E-03	1.778E+00	1.195E-04
2060	2.335E+00	1.275E+03	8.569E-02	5.486E-03	1.530E+00	1.028E-04
2061	2.009E+00	1.098E+03	7.376E-02	4.722E-03	1.317E+00	8.851E-05
2062	1.729E+00	9.448E+02	6.348E-02	4.064E-03	1.134E+00	7.618E-05
2063	1.489E+00	8.132E+02	5.464E-02	3.498E-03	9.759E-01	6.557E-05
2064	1.281E+00	6.999E+02	4.703E-02	3.011E-03	8.399E-01	5.643E-05
2065	1.103E+00	6.024E+02	4.048E-02	2.591E-03	7.229E-01	4.857E-05
2066	9.492E-01	5.185E+02	3.484E-02	2.230E-03	6.222E-01	4.181E-05
2067	8.169E-01	4.463E+02	2.999E-02	1.920E-03	5.356E-01	3.598E-05
2068	7.032E-01	3.841E+02	2.581E-02	1.652E-03	4.610E-01	3.097E-05
2069	6.052E-01	3.306E+02	2.221E-02	1.422E-03	3.968E-01	2.666E-05
2070	5.209E-01	2.846E+02	1.912E-02	1.224E-03	3.415E-01	2.294E-05
2071	4.484E-01	2.449E+02	1.646E-02	1.054E-03	2.939E-01	1.975E-05
2072	3.859E-01	2.108E+02	1.416E-02	9.068E-04	2.530E-01	1.700E-05
2073	3.321E-01	1.815E+02	1.219E-02	7.805E-04	2.177E-01	1.463E-05
2074	2.859E-01	1.562E+02	1.049E-02	6.718E-04	1.874E-01	1.259E-05
2075	2.461E-01	1.344E+02	9.032E-03	5.782E-04	1.613E-01	1.084E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2076	2.118E-01	1.157E+02	7.774E-03	4.977E-04	1.388E-01	9.329E-06
2077	1.823E-01	9.958E+01	6.691E-03	4.283E-04	1.195E-01	8.029E-06
2078	1.569E-01	8.571E+01	5.759E-03	3.687E-04	1.029E-01	6.911E-06
2079	1.350E-01	7.377E+01	4.957E-03	3.173E-04	8.853E-02	5.948E-06
2080	1.162E-01	6.350E+01	4.266E-03	2.731E-04	7.620E-02	5.120E-06
2081	1.000E-01	5.465E+01	3.672E-03	2.351E-04	6.558E-02	4.406E-06
2082	8.611E-02	4.704E+01	3.161E-03	2.023E-04	5.645E-02	3.793E-06
2083	7.411E-02	4.049E+01	2.720E-03	1.742E-04	4.858E-02	3.264E-06
2084	6.379E-02	3.485E+01	2.341E-03	1.499E-04	4.182E-02	2.810E-06
2085	5.490E-02	2.999E+01	2.015E-03	1.290E-04	3.599E-02	2.418E-06
2086	4.726E-02	2.582E+01	1.735E-03	1.110E-04	3.098E-02	2.081E-06
2087	4.067E-02	2.222E+01	1.493E-03	9.558E-05	2.666E-02	1.792E-06
2088	3.501E-02	1.912E+01	1.285E-03	8.226E-05	2.295E-02	1.542E-06
2089	3.013E-02	1.646E+01	1.106E-03	7.080E-05	1.975E-02	1.327E-06
2090	2.593E-02	1.417E+01	9.519E-04	6.094E-05	1.700E-02	1.142E-06
2091	2.232E-02	1.219E+01	8.193E-04	5.245E-05	1.463E-02	9.832E-07
2092	1.921E-02	1.050E+01	7.052E-04	4.515E-05	1.260E-02	8.463E-07
2093	1.654E-02	9.034E+00	6.070E-04	3.886E-05	1.084E-02	7.284E-07
2094	1.423E-02	7.776E+00	5.224E-04	3.345E-05	9.331E-03	6.269E-07
2095	1.225E-02	6.693E+00	4.497E-04	2.879E-05	8.031E-03	5.396E-07
2096	1.054E-02	5.760E+00	3.870E-04	2.478E-05	6.912E-03	4.644E-07
2097	9.075E-03	4.958E+00	3.331E-04	2.133E-05	5.950E-03	3.997E-07
2098	7.811E-03	4.267E+00	2.867E-04	1.836E-05	5.121E-03	3.441E-07
2099	6.723E-03	3.673E+00	2.468E-04	1.580E-05	4.408E-03	2.961E-07
2100	5.787E-03	3.161E+00	2.124E-04	1.360E-05	3.794E-03	2.549E-07
2101	4.981E-03	2.721E+00	1.828E-04	1.170E-05	3.265E-03	2.194E-07
2102	4.287E-03	2.342E+00	1.574E-04	1.007E-05	2.810E-03	1.888E-07
2103	3.690E-03	2.016E+00	1.354E-04	8.670E-06	2.419E-03	1.625E-07
2104	3.176E-03	1.735E+00	1.166E-04	7.463E-06	2.082E-03	1.399E-07
2105	2.733E-03	1.493E+00	1.003E-04	6.423E-06	1.792E-03	1.204E-07
2106	2.353E-03	1.285E+00	8.636E-05	5.529E-06	1.542E-03	1.036E-07
2107	2.025E-03	1.106E+00	7.433E-05	4.758E-06	1.328E-03	8.920E-08
2108	1.743E-03	9.522E-01	6.398E-05	4.096E-06	1.143E-03	7.677E-08
2109	1.500E-03	8.195E-01	5.506E-05	3.525E-06	9.834E-04	6.608E-08
2110	1.291E-03	7.054E-01	4.739E-05	3.034E-06	8.465E-04	5.687E-08
2111	1.111E-03	6.071E-01	4.079E-05	2.611E-06	7.286E-04	4.895E-08
2112	9.565E-04	5.226E-01	3.511E-05	2.248E-06	6.271E-04	4.213E-08
2113	8.233E-04	4.498E-01	3.022E-05	1.935E-06	5.397E-04	3.626E-08
2114	7.086E-04	3.871E-01	2.601E-05	1.665E-06	4.645E-04	3.121E-08
2115	6.099E-04	3.332E-01	2.239E-05	1.433E-06	3.998E-04	2.687E-08

Summary Report

Landfill Name or Identifier: Powerstown Landfill Calibrated

Date: 11 November 2011

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where,

Q_{CH_4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1975**	
Landfill Closure Year (with 80-year limit)	**2014**	
Actual Closure Year (without limit)	***2014***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.150**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**62**	*m^3/Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1975	10,800	11,880	0	0
1976	10,800	11,880	10,800	11,880
1977	10,800	11,880	21,600	23,760
1978	10,800	11,880	32,400	35,640
1979	10,800	11,880	43,200	47,520
1980	10,800	11,880	54,000	59,400
1981	10,800	11,880	64,800	71,280
1982	10,800	11,880	75,600	83,160
1983	10,800	11,880	86,400	95,040
1984	10,800	11,880	97,200	106,920
1985	10,800	11,880	108,000	118,800
1986	10,800	11,880	118,800	130,680
1987	10,800	11,880	129,600	142,560
1988	10,800	11,880	140,400	154,440
1989	10,800	11,880	151,200	166,320
1990	14,961	16,457	162,000	178,200
1991	14,961	16,457	176,961	194,657
1992	14,961	16,457	191,922	211,114
1993	14,961	16,457	206,883	227,571
1994	14,961	16,457	221,844	244,028
1995	14,961	16,457	236,805	260,486
1996	14,961	16,457	251,766	276,943
1997	22,441	24,685	266,727	293,400
1998	29,922	32,914	289,168	318,085
1999	29,922	32,914	319,090	350,999
2000	40,394	44,433	349,012	383,913
2001	40,394	44,433	389,406	428,347
2002	40,394	44,433	429,800	472,780
2003	28,307	31,138	470,194	517,213
2004	39,853	43,838	498,501	548,351
2005	49,010	53,911	538,354	592,189
2006	42,638	46,902	587,364	646,100
2007	43,130	47,443	630,002	693,002
2008	40,000	44,000	673,132	740,445
2009	40,000	44,000	713,132	784,445
2010	40,000	44,000	753,132	828,445
2011	40,000	44,000	793,132	872,445
2012	40,000	44,000	833,132	916,445
2013	8,689	9,558	873,132	960,445
2014	0	0	881,821	970,003

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2015	0	0	881,821	970,003
2016	0	0	881,821	970,003
2017	0	0	881,821	970,003
2018	0	0	881,821	970,003
2019	0	0	881,821	970,003
2020	0	0	881,821	970,003
2021	0	0	881,821	970,003
2022	0	0	881,821	970,003
2023	0	0	881,821	970,003
2024	0	0	881,821	970,003
2025	0	0	881,821	970,003
2026	0	0	881,821	970,003
2027	0	0	881,821	970,003
2028	0	0	881,821	970,003
2029	0	0	881,821	970,003
2030	0	0	881,821	970,003
2031	0	0	881,821	970,003
2032	0	0	881,821	970,003
2033	0	0	881,821	970,003
2034	0	0	881,821	970,003
2035	0	0	881,821	970,003
2036	0	0	881,821	970,003
2037	0	0	881,821	970,003
2038	0	0	881,821	970,003
2039	0	0	881,821	970,003
2040	0	0	881,821	970,003
2041	0	0	881,821	970,003
2042	0	0	881,821	970,003
2043	0	0	881,821	970,003
2044	0	0	881,821	970,003
2045	0	0	881,821	970,003
2046	0	0	881,821	970,003
2047	0	0	881,821	970,003
2048	0	0	881,821	970,003
2049	0	0	881,821	970,003
2050	0	0	881,821	970,003
2051	0	0	881,821	970,003
2052	0	0	881,821	970,003
2053	0	0	881,821	970,003
2054	0	0	881,821	970,003

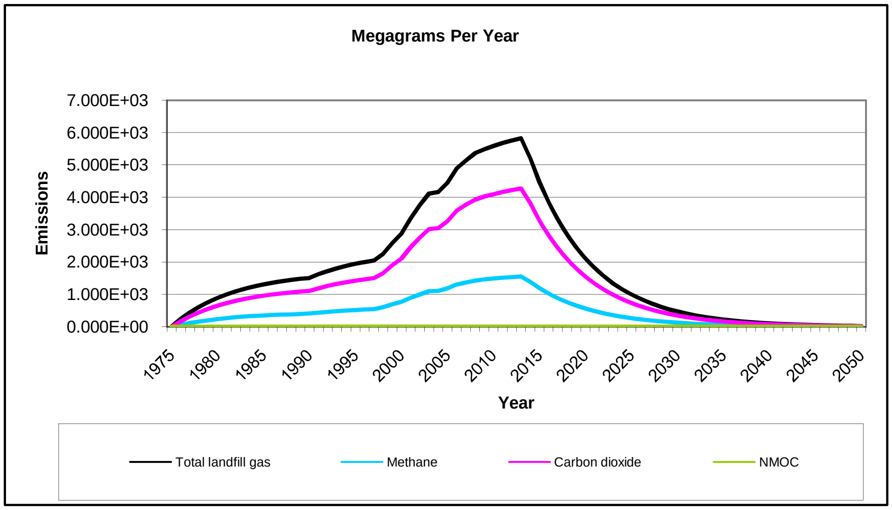
Pollutant Parameters

	Compound	Gas / Pollutant Default Parameters: Concentration (*ppmv*)	Molecular Weight	User-specified Pollutant Parameters: Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
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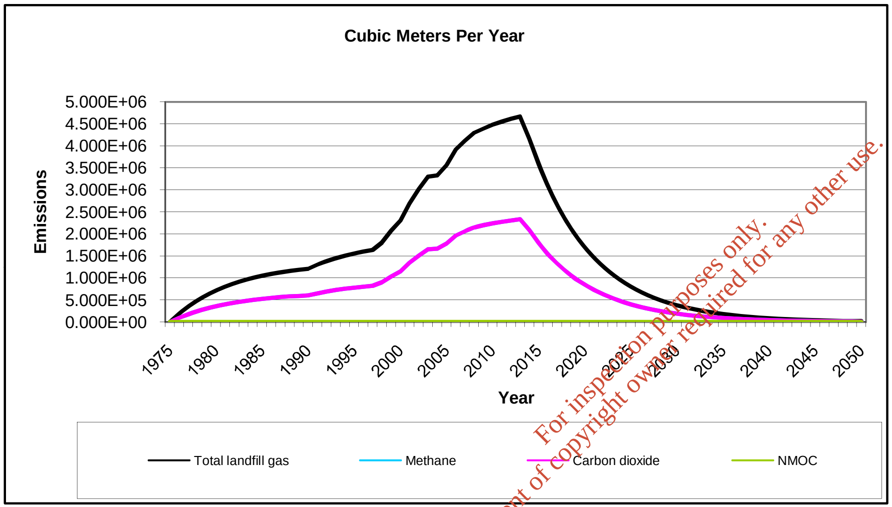
6.000E+03
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
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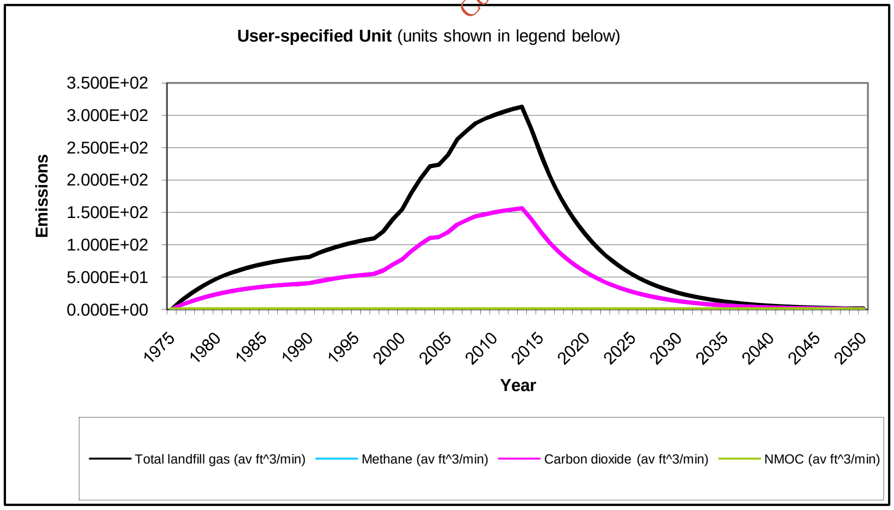
4.500E+06
4.000E+06
3.500E+06
3.000E+06
2.500E+06
2.000E+06
1.500E+06
1.000E+06
5.000E+05
0.000E+00
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
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3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
1975	0	0	0	0	0	0
1976	2.347E+02	1.879E+05	1.263E+01	6.269E+01	9.397E+04	6.314E+00
1977	4.367E+02	3.497E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1978	6.106E+02	4.889E+05	3.285E+01	1.631E+02	2.445E+05	1.643E+01
1979	7.603E+02	6.088E+05	4.090E+01	2.031E+02	3.044E+05	2.045E+01
1980	8.891E+02	7.119E+05	4.783E+01	2.375E+02	3.560E+05	2.392E+01
1981	9.999E+02	8.007E+05	5.380E+01	2.671E+02	4.003E+05	2.690E+01
1982	1.095E+03	8.771E+05	5.893E+01	2.926E+02	4.386E+05	2.947E+01
1983	1.177E+03	9.429E+05	6.335E+01	3.145E+02	4.714E+05	3.168E+01
1984	1.248E+03	9.995E+05	6.716E+01	3.334E+02	4.997E+05	3.358E+01
1985	1.309E+03	1.048E+06	7.043E+01	3.497E+02	5.241E+05	3.521E+01
1986	1.361E+03	1.090E+06	7.325E+01	3.636E+02	5.451E+05	3.662E+01
1987	1.406E+03	1.126E+06	7.567E+01	3.757E+02	5.631E+05	3.784E+01
1988	1.445E+03	1.157E+06	7.776E+01	3.860E+02	5.787E+05	3.888E+01
1989	1.479E+03	1.184E+06	7.956E+01	3.950E+02	5.920E+05	3.978E+01
1990	1.507E+03	1.207E+06	8.110E+01	4.026E+02	6.035E+05	4.055E+01
1991	1.623E+03	1.299E+06	8.730E+01	4.334E+02	6.496E+05	4.365E+01
1992	1.722E+03	1.379E+06	9.263E+01	4.599E+02	6.893E+05	4.632E+01
1993	1.807E+03	1.447E+06	9.722E+01	4.827E+02	7.235E+05	4.861E+01
1994	1.880E+03	1.506E+06	1.012E+02	5.023E+02	7.529E+05	5.059E+01
1995	1.944E+03	1.556E+06	1.046E+02	5.192E+02	7.782E+05	5.229E+01
1996	1.998E+03	1.600E+06	1.075E+02	5.337E+02	8.000E+05	5.375E+01
1997	2.045E+03	1.637E+06	1.100E+02	5.462E+02	8.187E+05	5.501E+01
1998	2.248E+03	1.800E+06	1.209E+02	6.004E+02	8.999E+05	6.047E+01
1999	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2000	2.875E+03	2.302E+06	1.547E+02	7.680E+02	1.151E+06	7.734E+01
2001	3.352E+03	2.685E+06	1.804E+02	8.955E+02	1.342E+06	9.019E+01
2002	3.763E+03	3.014E+06	2.025E+02	1.005E+03	1.507E+06	1.012E+02
2003	4.117E+03	3.297E+06	2.215E+02	1.100E+03	1.648E+06	1.108E+02
2004	4.159E+03	3.330E+06	2.237E+02	1.111E+03	1.665E+06	1.119E+02
2005	4.446E+03	3.560E+06	2.392E+02	1.187E+03	1.780E+06	1.196E+02
2006	4.891E+03	3.917E+06	2.632E+02	1.307E+03	1.958E+06	1.316E+02
2007	5.137E+03	4.113E+06	2.764E+02	1.372E+03	2.057E+06	1.382E+02
2008	5.358E+03	4.291E+06	2.883E+02	1.431E+03	2.145E+06	1.441E+02
2009	5.481E+03	4.389E+06	2.949E+02	1.464E+03	2.195E+06	1.475E+02
2010	5.587E+03	4.474E+06	3.006E+02	1.492E+03	2.237E+06	1.503E+02
2011	5.678E+03	4.547E+06	3.055E+02	1.517E+03	2.273E+06	1.528E+02
2012	5.757E+03	4.610E+06	3.097E+02	1.538E+03	2.305E+06	1.549E+02
2013	5.824E+03	4.664E+06	3.133E+02	1.556E+03	2.332E+06	1.567E+02
2014	5.202E+03	4.165E+06	2.799E+02	1.389E+03	2.083E+06	1.399E+02
2015	4.477E+03	3.585E+06	2.409E+02	1.196E+03	1.793E+06	1.204E+02
2016	3.853E+03	3.086E+06	2.073E+02	1.029E+03	1.543E+06	1.037E+02
2017	3.317E+03	2.656E+06	1.784E+02	8.859E+02	1.328E+06	8.922E+01
2018	2.855E+03	2.286E+06	1.536E+02	7.625E+02	1.143E+06	7.679E+01
2019	2.457E+03	1.967E+06	1.322E+02	6.563E+02	9.837E+05	6.610E+01
2020	2.115E+03	1.693E+06	1.138E+02	5.649E+02	8.467E+05	5.689E+01
2021	1.820E+03	1.458E+06	9.793E+01	4.862E+02	7.288E+05	4.897E+01
2022	1.567E+03	1.255E+06	8.429E+01	4.185E+02	6.273E+05	4.215E+01
2023	1.348E+03	1.080E+06	7.255E+01	3.602E+02	5.399E+05	3.628E+01
2024	1.161E+03	9.294E+05	6.244E+01	3.100E+02	4.647E+05	3.122E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2025	9.990E+02	7.999E+05	5.375E+01	2.668E+02	4.000E+05	2.687E+01
2026	8.598E+02	6.885E+05	4.626E+01	2.297E+02	3.443E+05	2.313E+01
2027	7.401E+02	5.926E+05	3.982E+01	1.977E+02	2.963E+05	1.991E+01
2028	6.370E+02	5.101E+05	3.427E+01	1.701E+02	2.550E+05	1.714E+01
2029	5.482E+02	4.390E+05	2.950E+01	1.464E+02	2.195E+05	1.475E+01
2030	4.719E+02	3.779E+05	2.539E+01	1.260E+02	1.889E+05	1.269E+01
2031	4.061E+02	3.252E+05	2.185E+01	1.085E+02	1.626E+05	1.093E+01
2032	3.496E+02	2.799E+05	1.881E+01	9.338E+01	1.400E+05	9.404E+00
2033	3.009E+02	2.409E+05	1.619E+01	8.037E+01	1.205E+05	8.094E+00
2034	2.590E+02	2.074E+05	1.393E+01	6.917E+01	1.037E+05	6.967E+00
2035	2.229E+02	1.785E+05	1.199E+01	5.954E+01	8.924E+04	5.996E+00
2036	1.919E+02	1.536E+05	1.032E+01	5.125E+01	7.681E+04	5.161E+00
2037	1.651E+02	1.322E+05	8.884E+00	4.411E+01	6.611E+04	4.442E+00
2038	1.421E+02	1.138E+05	7.647E+00	3.796E+01	5.690E+04	3.823E+00
2039	1.223E+02	9.796E+04	6.582E+00	3.268E+01	4.898E+04	3.291E+00
2040	1.053E+02	8.431E+04	5.665E+00	2.812E+01	4.216E+04	2.832E+00
2041	9.062E+01	7.257E+04	4.876E+00	2.421E+01	3.628E+04	2.438E+00
2042	7.800E+01	6.246E+04	4.197E+00	2.083E+01	3.123E+04	2.098E+00
2043	6.714E+01	5.376E+04	3.612E+00	1.793E+01	2.688E+04	1.806E+00
2044	5.778E+01	4.627E+04	3.109E+00	1.543E+01	2.314E+04	1.554E+00
2045	4.974E+01	3.983E+04	2.676E+00	1.328E+01	1.991E+04	1.338E+00
2046	4.281E+01	3.428E+04	2.303E+00	1.143E+01	1.714E+04	1.152E+00
2047	3.684E+01	2.950E+04	1.982E+00	9.842E+00	1.475E+04	9.912E-01
2048	3.171E+01	2.539E+04	1.706E+00	8.471E+00	1.270E+04	8.531E-01
2049	2.730E+01	2.186E+04	1.469E+00	7.291E+00	1.093E+04	7.343E-01
2050	2.349E+01	1.881E+04	1.264E+00	6.275E+00	9.406E+03	6.320E-01
2051	2.022E+01	1.619E+04	1.088E+00	5.401E+00	8.096E+03	5.440E-01
2052	1.740E+01	1.394E+04	9.364E-01	4.649E+00	6.968E+03	4.682E-01
2053	1.498E+01	1.200E+04	8.060E-01	4.001E+00	5.998E+03	4.030E-01
2054	1.289E+01	1.032E+04	6.937E-01	3.444E+00	5.162E+03	3.468E-01
2055	1.110E+01	8.886E+03	5.971E-01	2.964E+00	4.443E+03	2.985E-01
2056	9.552E+00	7.649E+03	5.139E-01	2.551E+00	3.824E+03	2.570E-01
2057	8.221E+00	6.583E+03	4.423E-01	2.196E+00	3.292E+03	2.212E-01
2058	7.076E+00	5.666E+03	3.807E-01	1.890E+00	2.833E+03	1.904E-01
2059	6.090E+00	4.877E+03	3.277E-01	1.627E+00	2.438E+03	1.638E-01
2060	5.242E+00	4.198E+03	2.820E-01	1.400E+00	2.099E+03	1.410E-01
2061	4.512E+00	3.613E+03	2.428E-01	1.205E+00	1.806E+03	1.214E-01
2062	3.883E+00	3.110E+03	2.089E-01	1.037E+00	1.555E+03	1.045E-01
2063	3.342E+00	2.677E+03	1.798E-01	8.928E-01	1.338E+03	8.992E-02
2064	2.877E+00	2.304E+03	1.548E-01	7.685E-01	1.152E+03	7.739E-02
2065	2.476E+00	1.983E+03	1.332E-01	6.614E-01	9.914E+02	6.661E-02
2066	2.131E+00	1.707E+03	1.147E-01	5.693E-01	8.533E+02	5.733E-02
2067	1.834E+00	1.469E+03	9.870E-02	4.900E-01	7.345E+02	4.935E-02
2068	1.579E+00	1.264E+03	8.495E-02	4.217E-01	6.321E+02	4.247E-02
2069	1.359E+00	1.088E+03	7.312E-02	3.630E-01	5.441E+02	3.656E-02
2070	1.170E+00	9.366E+02	6.293E-02	3.124E-01	4.683E+02	3.147E-02
2071	1.007E+00	8.062E+02	5.417E-02	2.689E-01	4.031E+02	2.708E-02
2072	8.665E-01	6.939E+02	4.662E-02	2.315E-01	3.469E+02	2.331E-02
2073	7.458E-01	5.972E+02	4.013E-02	1.992E-01	2.986E+02	2.006E-02
2074	6.419E-01	5.140E+02	3.454E-02	1.715E-01	2.570E+02	1.727E-02
2075	5.525E-01	4.424E+02	2.973E-02	1.476E-01	2.212E+02	1.486E-02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	4.756E-01	3.808E+02	2.559E-02	1.270E-01	1.904E+02	1.279E-02
2077	4.093E-01	3.278E+02	2.202E-02	1.093E-01	1.639E+02	1.101E-02
2078	3.523E-01	2.821E+02	1.895E-02	9.410E-02	1.411E+02	9.477E-03
2079	3.032E-01	2.428E+02	1.631E-02	8.099E-02	1.214E+02	8.157E-03
2080	2.610E-01	2.090E+02	1.404E-02	6.971E-02	1.045E+02	7.021E-03
2081	2.246E-01	1.799E+02	1.209E-02	6.000E-02	8.994E+01	6.043E-03
2082	1.933E-01	1.548E+02	1.040E-02	5.164E-02	7.741E+01	5.201E-03
2083	1.664E-01	1.333E+02	8.953E-03	4.445E-02	6.663E+01	4.477E-03
2084	1.432E-01	1.147E+02	7.706E-03	3.826E-02	5.735E+01	3.853E-03
2085	1.233E-01	9.872E+01	6.633E-03	3.293E-02	4.936E+01	3.316E-03
2086	1.061E-01	8.497E+01	5.709E-03	2.834E-02	4.248E+01	2.854E-03
2087	9.133E-02	7.313E+01	4.914E-03	2.440E-02	3.657E+01	2.457E-03
2088	7.861E-02	6.295E+01	4.229E-03	2.100E-02	3.147E+01	2.115E-03
2089	6.766E-02	5.418E+01	3.640E-03	1.807E-02	2.709E+01	1.820E-03
2090	5.823E-02	4.663E+01	3.133E-03	1.555E-02	2.332E+01	1.567E-03
2091	5.012E-02	4.014E+01	2.697E-03	1.339E-02	2.007E+01	1.348E-03
2092	4.314E-02	3.455E+01	2.321E-03	1.152E-02	1.727E+01	1.161E-03
2093	3.713E-02	2.973E+01	1.998E-03	9.918E-03	1.487E+01	9.989E-04
2094	3.196E-02	2.559E+01	1.720E-03	8.537E-03	1.280E+01	8.598E-04
2095	2.751E-02	2.203E+01	1.480E-03	7.348E-03	1.101E+01	7.400E-04
2096	2.368E-02	1.896E+01	1.274E-03	6.324E-03	9.479E+00	6.369E-04
2097	2.038E-02	1.632E+01	1.096E-03	5.443E-03	8.159E+00	5.482E-04
2098	1.754E-02	1.405E+01	9.437E-04	4.685E-03	7.023E+00	4.718E-04
2099	1.510E-02	1.209E+01	8.122E-04	4.032E-03	6.044E+00	4.061E-04
2100	1.299E-02	1.040E+01	6.991E-04	3.471E-03	5.202E+00	3.496E-04
2101	1.118E-02	8.956E+00	6.017E-04	2.987E-03	4.478E+00	3.009E-04
2102	9.626E-03	7.708E+00	5.179E-04	2.571E-03	3.854E+00	2.590E-04
2103	8.285E-03	6.634E+00	4.458E-04	2.213E-03	3.317E+00	2.229E-04
2104	7.131E-03	5.710E+00	3.837E-04	1.905E-03	2.855E+00	1.918E-04
2105	6.138E-03	4.915E+00	3.302E-04	1.639E-03	2.457E+00	1.651E-04
2106	5.283E-03	4.230E+00	2.842E-04	1.411E-03	2.115E+00	1.421E-04
2107	4.547E-03	3.641E+00	2.446E-04	1.215E-03	1.821E+00	1.223E-04
2108	3.914E-03	3.134E+00	2.106E-04	1.045E-03	1.567E+00	1.053E-04
2109	3.369E-03	2.697E+00	1.812E-04	8.998E-04	1.349E+00	9.062E-05
2110	2.899E-03	2.322E+00	1.560E-04	7.744E-04	1.161E+00	7.800E-05
2111	2.495E-03	1.998E+00	1.343E-04	6.666E-04	9.991E-01	6.713E-05
2112	2.148E-03	1.720E+00	1.156E-04	5.737E-04	8.600E-01	5.778E-05
2113	1.849E-03	1.480E+00	9.946E-05	4.938E-04	7.402E-01	4.973E-05
2114	1.591E-03	1.274E+00	8.561E-05	4.250E-04	6.371E-01	4.280E-05
2115	1.370E-03	1.097E+00	7.368E-05	3.658E-04	5.483E-01	3.684E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1975	0	0	0	0	0	0
1976	1.720E+02	9.397E+04	6.314E+00	4.042E-01	1.128E+02	7.577E-03
1977	3.201E+02	1.749E+05	1.175E+01	7.521E-01	2.098E+02	1.410E-02
1978	4.475E+02	2.445E+05	1.643E+01	1.052E+00	2.934E+02	1.971E-02
1979	5.572E+02	3.044E+05	2.045E+01	1.309E+00	3.653E+02	2.454E-02
1980	6.516E+02	3.560E+05	2.392E+01	1.531E+00	4.272E+02	2.870E-02
1981	7.328E+02	4.003E+05	2.690E+01	1.722E+00	4.804E+02	3.228E-02
1982	8.028E+02	4.386E+05	2.947E+01	1.886E+00	5.263E+02	3.536E-02
1983	8.630E+02	4.714E+05	3.168E+01	2.028E+00	5.657E+02	3.801E-02
1984	9.148E+02	4.997E+05	3.358E+01	2.150E+00	5.997E+02	4.029E-02
1985	9.594E+02	5.241E+05	3.521E+01	2.254E+00	6.289E+02	4.226E-02
1986	9.978E+02	5.451E+05	3.662E+01	2.345E+00	6.541E+02	4.395E-02
1987	1.031E+03	5.631E+05	3.784E+01	2.422E+00	6.757E+02	4.540E-02
1988	1.059E+03	5.787E+05	3.888E+01	2.489E+00	6.944E+02	4.666E-02
1989	1.084E+03	5.920E+05	3.978E+01	2.546E+00	7.104E+02	4.773E-02
1990	1.105E+03	6.035E+05	4.055E+01	2.596E+00	7.242E+02	4.866E-02
1991	1.189E+03	6.496E+05	4.365E+01	2.794E+00	7.796E+02	5.238E-02
1992	1.262E+03	6.893E+05	4.632E+01	2.965E+00	8.272E+02	5.558E-02
1993	1.324E+03	7.235E+05	4.861E+01	3.112E+00	8.682E+02	5.833E-02
1994	1.378E+03	7.529E+05	5.059E+01	3.238E+00	9.035E+02	6.070E-02
1995	1.424E+03	7.782E+05	5.229E+01	3.347E+00	9.338E+02	6.274E-02
1996	1.464E+03	8.000E+05	5.375E+01	3.441E+00	9.600E+02	6.450E-02
1997	1.499E+03	8.187E+05	5.501E+01	3.522E+00	9.825E+02	6.601E-02
1998	1.647E+03	8.999E+05	6.047E+01	3.871E+00	1.080E+03	7.256E-02
1999	1.894E+03	1.035E+06	6.954E+01	4.452E+00	1.242E+03	8.344E-02
2000	2.107E+03	1.151E+06	7.734E+01	4.951E+00	1.381E+03	9.281E-02
2001	2.457E+03	1.342E+06	9.019E+01	5.774E+00	1.611E+03	1.082E-01
2002	2.758E+03	1.507E+06	1.012E+02	6.481E+00	1.808E+03	1.215E-01
2003	3.017E+03	1.648E+06	1.108E+02	7.090E+00	1.978E+03	1.329E-01
2004	3.048E+03	1.665E+06	1.119E+02	7.162E+00	1.998E+03	1.342E-01
2005	3.258E+03	1.780E+06	1.196E+02	7.656E+00	2.136E+03	1.435E-01
2006	3.585E+03	1.958E+06	1.316E+02	8.424E+00	2.350E+03	1.579E-01
2007	3.765E+03	2.057E+06	1.382E+02	8.846E+00	2.468E+03	1.658E-01
2008	3.927E+03	2.145E+06	1.441E+02	9.228E+00	2.574E+03	1.730E-01
2009	4.017E+03	2.195E+06	1.475E+02	9.440E+00	2.634E+03	1.769E-01
2010	4.095E+03	2.237E+06	1.503E+02	9.622E+00	2.684E+03	1.804E-01
2011	4.161E+03	2.273E+06	1.528E+02	9.779E+00	2.728E+03	1.833E-01
2012	4.219E+03	2.305E+06	1.549E+02	9.914E+00	2.766E+03	1.858E-01
2013	4.268E+03	2.332E+06	1.567E+02	1.003E+01	2.798E+03	1.880E-01
2014	3.812E+03	2.083E+06	1.399E+02	8.958E+00	2.499E+03	1.679E-01
2015	3.281E+03	1.793E+06	1.204E+02	7.710E+00	2.151E+03	1.445E-01
2016	2.824E+03	1.543E+06	1.037E+02	6.636E+00	1.851E+03	1.244E-01
2017	2.431E+03	1.328E+06	8.922E+01	5.712E+00	1.594E+03	1.071E-01
2018	2.092E+03	1.143E+06	7.679E+01	4.916E+00	1.372E+03	9.215E-02
2019	1.801E+03	9.837E+05	6.610E+01	4.231E+00	1.180E+03	7.932E-02
2020	1.550E+03	8.467E+05	5.689E+01	3.642E+00	1.016E+03	6.827E-02
2021	1.334E+03	7.288E+05	4.897E+01	3.135E+00	8.745E+02	5.876E-02
2022	1.148E+03	6.273E+05	4.215E+01	2.698E+00	7.527E+02	5.058E-02
2023	9.883E+02	5.399E+05	3.628E+01	2.322E+00	6.479E+02	4.353E-02
2024	8.506E+02	4.647E+05	3.122E+01	1.999E+00	5.576E+02	3.747E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2025	7.321E+02	4.000E+05	2.687E+01	1.720E+00	4.800E+02	3.225E-02
2026	6.301E+02	3.443E+05	2.313E+01	1.481E+00	4.131E+02	2.776E-02
2027	5.424E+02	2.963E+05	1.991E+01	1.274E+00	3.556E+02	2.389E-02
2028	4.668E+02	2.550E+05	1.714E+01	1.097E+00	3.060E+02	2.056E-02
2029	4.018E+02	2.195E+05	1.475E+01	9.442E-01	2.634E+02	1.770E-02
2030	3.458E+02	1.889E+05	1.269E+01	8.126E-01	2.267E+02	1.523E-02
2031	2.977E+02	1.626E+05	1.093E+01	6.995E-01	1.951E+02	1.311E-02
2032	2.562E+02	1.400E+05	9.404E+00	6.020E-01	1.680E+02	1.128E-02
2033	2.205E+02	1.205E+05	8.094E+00	5.182E-01	1.446E+02	9.713E-03
2034	1.898E+02	1.037E+05	6.967E+00	4.460E-01	1.244E+02	8.360E-03
2035	1.634E+02	8.924E+04	5.996E+00	3.839E-01	1.071E+02	7.196E-03
2036	1.406E+02	7.681E+04	5.161E+00	3.304E-01	9.218E+01	6.193E-03
2037	1.210E+02	6.611E+04	4.442E+00	2.844E-01	7.934E+01	5.331E-03
2038	1.042E+02	5.690E+04	3.823E+00	2.448E-01	6.829E+01	4.588E-03
2039	8.965E+01	4.898E+04	3.291E+00	2.107E-01	5.877E+01	3.949E-03
2040	7.717E+01	4.216E+04	2.832E+00	1.813E-01	5.059E+01	3.399E-03
2041	6.642E+01	3.628E+04	2.438E+00	1.561E-01	4.354E+01	2.925E-03
2042	5.717E+01	3.123E+04	2.098E+00	1.343E-01	3.748E+01	2.518E-03
2043	4.920E+01	2.688E+04	1.806E+00	1.156E-01	3.226E+01	2.167E-03
2044	4.235E+01	2.314E+04	1.554E+00	9.951E-02	2.776E+01	1.865E-03
2045	3.645E+01	1.991E+04	1.338E+00	8.565E-02	2.390E+01	1.606E-03
2046	3.137E+01	1.714E+04	1.152E+00	7.372E-02	2.057E+01	1.382E-03
2047	2.700E+01	1.475E+04	9.912E-01	6.345E-02	1.770E+01	1.189E-03
2048	2.324E+01	1.270E+04	8.531E-01	5.461E-02	1.524E+01	1.024E-03
2049	2.000E+01	1.093E+04	7.343E-01	4.701E-02	1.311E+01	8.811E-04
2050	1.722E+01	9.406E+03	6.320E-01	4.046E-02	1.129E+01	7.584E-04
2051	1.482E+01	8.096E+03	5.440E-01	3.482E-02	9.715E+00	6.528E-04
2052	1.276E+01	6.968E+03	4.682E-01	2.997E-02	8.362E+00	5.618E-04
2053	1.098E+01	5.998E+03	4.030E-01	2.580E-02	7.197E+00	4.836E-04
2054	9.449E+00	5.162E+03	3.468E-01	2.220E-02	6.195E+00	4.162E-04
2055	8.133E+00	4.443E+03	2.985E-01	1.911E-02	5.332E+00	3.582E-04
2056	7.000E+00	3.824E+03	2.570E-01	1.645E-02	4.589E+00	3.083E-04
2057	6.025E+00	3.292E+03	2.212E-01	1.416E-02	3.950E+00	2.654E-04
2058	5.186E+00	2.833E+03	1.904E-01	1.219E-02	3.400E+00	2.284E-04
2059	4.464E+00	2.438E+03	1.638E-01	1.049E-02	2.926E+00	1.966E-04
2060	3.842E+00	2.099E+03	1.410E-01	9.028E-03	2.519E+00	1.692E-04
2061	3.307E+00	1.806E+03	1.214E-01	7.770E-03	2.168E+00	1.457E-04
2062	2.846E+00	1.555E+03	1.045E-01	6.688E-03	1.866E+00	1.254E-04
2063	2.450E+00	1.338E+03	8.992E-02	5.756E-03	1.606E+00	1.079E-04
2064	2.108E+00	1.152E+03	7.739E-02	4.955E-03	1.382E+00	9.287E-05
2065	1.815E+00	9.914E+02	6.661E-02	4.264E-03	1.190E+00	7.993E-05
2066	1.562E+00	8.533E+02	5.733E-02	3.670E-03	1.024E+00	6.880E-05
2067	1.344E+00	7.345E+02	4.935E-02	3.159E-03	8.813E-01	5.922E-05
2068	1.157E+00	6.321E+02	4.247E-02	2.719E-03	7.586E-01	5.097E-05
2069	9.960E-01	5.441E+02	3.656E-02	2.340E-03	6.529E-01	4.387E-05
2070	8.572E-01	4.683E+02	3.147E-02	2.014E-03	5.620E-01	3.776E-05
2071	7.378E-01	4.031E+02	2.708E-02	1.734E-03	4.837E-01	3.250E-05
2072	6.351E-01	3.469E+02	2.331E-02	1.492E-03	4.163E-01	2.797E-05
2073	5.466E-01	2.986E+02	2.006E-02	1.284E-03	3.583E-01	2.408E-05
2074	4.705E-01	2.570E+02	1.727E-02	1.106E-03	3.084E-01	2.072E-05
2075	4.049E-01	2.212E+02	1.486E-02	9.515E-04	2.655E-01	1.784E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2076	3.485E-01	1.904E+02	1.279E-02	8.190E-04	2.285E-01	1.535E-05
2077	3.000E-01	1.639E+02	1.101E-02	7.049E-04	1.967E-01	1.321E-05
2078	2.582E-01	1.411E+02	9.477E-03	6.067E-04	1.693E-01	1.137E-05
2079	2.222E-01	1.214E+02	8.157E-03	5.222E-04	1.457E-01	9.789E-06
2080	1.913E-01	1.045E+02	7.021E-03	4.495E-04	1.254E-01	8.425E-06
2081	1.646E-01	8.994E+01	6.043E-03	3.869E-04	1.079E-01	7.252E-06
2082	1.417E-01	7.741E+01	5.201E-03	3.330E-04	9.289E-02	6.241E-06
2083	1.220E-01	6.663E+01	4.477E-03	2.866E-04	7.995E-02	5.372E-06
2084	1.050E-01	5.735E+01	3.853E-03	2.467E-04	6.882E-02	4.624E-06
2085	9.035E-02	4.936E+01	3.316E-03	2.123E-04	5.923E-02	3.980E-06
2086	7.777E-02	4.248E+01	2.854E-03	1.827E-04	5.098E-02	3.425E-06
2087	6.693E-02	3.657E+01	2.457E-03	1.573E-04	4.388E-02	2.948E-06
2088	5.761E-02	3.147E+01	2.115E-03	1.354E-04	3.777E-02	2.538E-06
2089	4.959E-02	2.709E+01	1.820E-03	1.165E-04	3.251E-02	2.184E-06
2090	4.268E-02	2.332E+01	1.567E-03	1.003E-04	2.798E-02	1.880E-06
2091	3.673E-02	2.007E+01	1.348E-03	8.632E-05	2.408E-02	1.618E-06
2092	3.162E-02	1.727E+01	1.161E-03	7.430E-05	2.073E-02	1.393E-06
2093	2.721E-02	1.487E+01	9.989E-04	6.395E-05	1.784E-02	1.199E-06
2094	2.342E-02	1.280E+01	8.598E-04	5.504E-05	1.536E-02	1.032E-06
2095	2.016E-02	1.101E+01	7.400E-04	4.737E-05	1.322E-02	8.880E-07
2096	1.735E-02	9.479E+00	6.369E-04	4.077E-05	1.138E-02	7.643E-07
2097	1.494E-02	8.159E+00	5.482E-04	3.509E-05	9.791E-03	6.578E-07
2098	1.285E-02	7.023E+00	4.718E-04	3.021E-05	8.427E-03	5.662E-07
2099	1.106E-02	6.044E+00	4.061E-04	2.600E-05	7.253E-03	4.873E-07
2100	9.523E-03	5.202E+00	3.496E-04	2.238E-05	6.243E-03	4.195E-07
2101	8.197E-03	4.478E+00	3.009E-04	1.926E-05	5.373E-03	3.610E-07
2102	7.055E-03	3.854E+00	2.590E-04	1.658E-05	4.625E-03	3.107E-07
2103	6.072E-03	3.317E+00	2.229E-04	1.427E-05	3.981E-03	2.675E-07
2104	5.226E-03	2.855E+00	1.918E-04	1.228E-05	3.426E-03	2.302E-07
2105	4.498E-03	2.457E+00	1.651E-04	1.057E-05	2.949E-03	1.981E-07
2106	3.872E-03	2.115E+00	1.421E-04	9.098E-06	2.538E-03	1.705E-07
2107	3.332E-03	1.821E+00	1.223E-04	7.831E-06	2.185E-03	1.468E-07
2108	2.868E-03	1.567E+00	1.053E-04	6.740E-06	1.880E-03	1.263E-07
2109	2.469E-03	1.349E+00	9.062E-05	5.801E-06	1.618E-03	1.087E-07
2110	2.125E-03	1.161E+00	7.800E-05	4.993E-06	1.393E-03	9.359E-08
2111	1.829E-03	9.991E-01	6.713E-05	4.298E-06	1.199E-03	8.056E-08
2112	1.574E-03	8.600E-01	5.778E-05	3.699E-06	1.032E-03	6.934E-08
2113	1.355E-03	7.402E-01	4.973E-05	3.184E-06	8.882E-04	5.968E-08
2114	1.166E-03	6.371E-01	4.280E-05	2.740E-06	7.645E-04	5.137E-08
2115	1.004E-03	5.483E-01	3.684E-05	2.359E-06	6.580E-04	4.421E-08

Summary Report

Landfill Name or Identifier: Powerstown Landfill Calibrated

Date: 11 November 2011

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where,

Q_{CH_4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1975**	
Landfill Closure Year (with 80-year limit)	**2016**	
Actual Closure Year (without limit)	***2016***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.150**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**62**	*m^3/Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1975	10,800	11,880	0	0
1976	10,800	11,880	10,800	11,880
1977	10,800	11,880	21,600	23,760
1978	10,800	11,880	32,400	35,640
1979	10,800	11,880	43,200	47,520
1980	10,800	11,880	54,000	59,400
1981	10,800	11,880	64,800	71,280
1982	10,800	11,880	75,600	83,160
1983	10,800	11,880	86,400	95,040
1984	10,800	11,880	97,200	106,920
1985	10,800	11,880	108,000	118,800
1986	10,800	11,880	118,800	130,680
1987	10,800	11,880	129,600	142,560
1988	10,800	11,880	140,400	154,440
1989	10,800	11,880	151,200	166,320
1990	14,961	16,457	162,000	178,200
1991	14,961	16,457	176,961	194,657
1992	14,961	16,457	191,922	211,114
1993	14,961	16,457	206,883	227,571
1994	14,961	16,457	221,844	244,028
1995	14,961	16,457	236,805	260,486
1996	14,961	16,457	251,766	276,943
1997	22,441	24,685	266,727	293,400
1998	29,922	32,914	289,168	318,085
1999	29,922	32,914	319,090	350,999
2000	40,394	44,433	349,012	383,913
2001	40,394	44,433	389,406	428,347
2002	40,394	44,433	429,800	472,780
2003	28,307	31,138	470,194	517,213
2004	39,853	43,838	498,501	548,351
2005	49,010	53,911	538,354	592,189
2006	42,638	46,902	587,364	646,100
2007	43,130	47,443	630,002	693,002
2008	36,177	39,795	673,132	740,445
2009	21,684	23,852	709,309	780,240
2010	13,697	15,067	730,993	804,092
2011	10,088	11,097	744,690	819,159
2012	40,000	44,000	754,778	830,256
2013	40,000	44,000	794,778	874,256
2014	40,000	44,000	834,778	918,256

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2015	7,043	7,747	874,778	962,256
2016	0	0	881,821	970,003
2017	0	0	881,821	970,003
2018	0	0	881,821	970,003
2019	0	0	881,821	970,003
2020	0	0	881,821	970,003
2021	0	0	881,821	970,003
2022	0	0	881,821	970,003
2023	0	0	881,821	970,003
2024	0	0	881,821	970,003
2025	0	0	881,821	970,003
2026	0	0	881,821	970,003
2027	0	0	881,821	970,003
2028	0	0	881,821	970,003
2029	0	0	881,821	970,003
2030	0	0	881,821	970,003
2031	0	0	881,821	970,003
2032	0	0	881,821	970,003
2033	0	0	881,821	970,003
2034	0	0	881,821	970,003
2035	0	0	881,821	970,003
2036	0	0	881,821	970,003
2037	0	0	881,821	970,003
2038	0	0	881,821	970,003
2039	0	0	881,821	970,003
2040	0	0	881,821	970,003
2041	0	0	881,821	970,003
2042	0	0	881,821	970,003
2043	0	0	881,821	970,003
2044	0	0	881,821	970,003
2045	0	0	881,821	970,003
2046	0	0	881,821	970,003
2047	0	0	881,821	970,003
2048	0	0	881,821	970,003
2049	0	0	881,821	970,003
2050	0	0	881,821	970,003
2051	0	0	881,821	970,003
2052	0	0	881,821	970,003
2053	0	0	881,821	970,003
2054	0	0	881,821	970,003

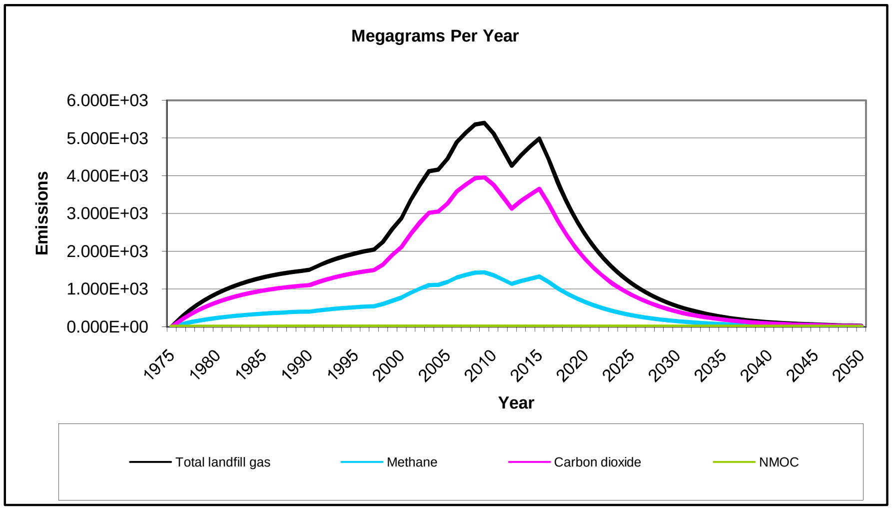
Pollutant Parameters

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
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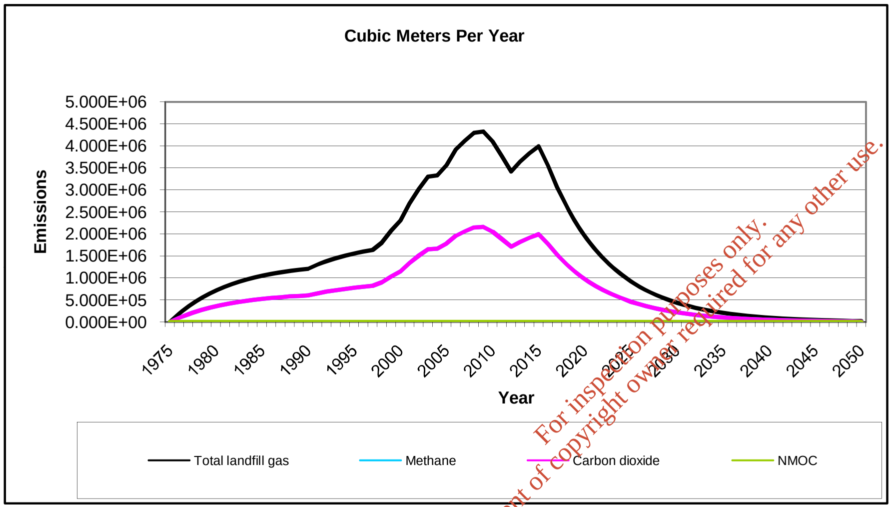
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
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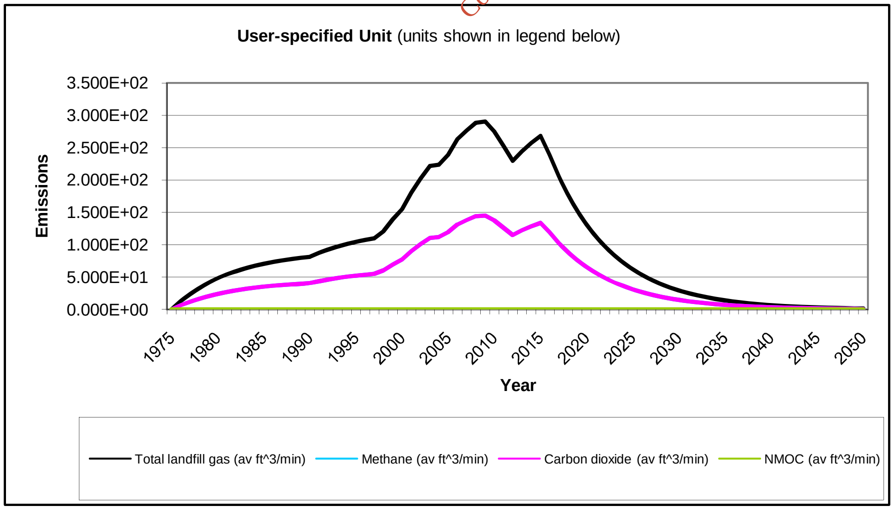
4.500E+06
4.000E+06
3.500E+06
3.000E+06
2.500E+06
2.000E+06
1.500E+06
1.000E+06
5.000E+05
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
3.500E+02
3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1975	0	0	0	0	0	0
1976	2.347E+02	1.879E+05	1.263E+01	6.269E+01	9.397E+04	6.314E+00
1977	4.367E+02	3.497E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1978	6.106E+02	4.889E+05	3.285E+01	1.631E+02	2.445E+05	1.643E+01
1979	7.603E+02	6.088E+05	4.090E+01	2.031E+02	3.044E+05	2.045E+01
1980	8.891E+02	7.119E+05	4.783E+01	2.375E+02	3.560E+05	2.392E+01
1981	9.999E+02	8.007E+05	5.380E+01	2.671E+02	4.003E+05	2.690E+01
1982	1.095E+03	8.771E+05	5.893E+01	2.926E+02	4.386E+05	2.947E+01
1983	1.177E+03	9.429E+05	6.335E+01	3.145E+02	4.714E+05	3.168E+01
1984	1.248E+03	9.995E+05	6.716E+01	3.334E+02	4.997E+05	3.358E+01
1985	1.309E+03	1.048E+06	7.043E+01	3.497E+02	5.241E+05	3.521E+01
1986	1.361E+03	1.090E+06	7.325E+01	3.636E+02	5.451E+05	3.662E+01
1987	1.406E+03	1.126E+06	7.567E+01	3.757E+02	5.631E+05	3.784E+01
1988	1.445E+03	1.157E+06	7.776E+01	3.860E+02	5.787E+05	3.888E+01
1989	1.479E+03	1.184E+06	7.956E+01	3.950E+02	5.920E+05	3.978E+01
1990	1.507E+03	1.207E+06	8.110E+01	4.026E+02	6.035E+05	4.055E+01
1991	1.623E+03	1.299E+06	8.730E+01	4.334E+02	6.496E+05	4.365E+01
1992	1.722E+03	1.379E+06	9.263E+01	4.599E+02	6.893E+05	4.632E+01
1993	1.807E+03	1.447E+06	9.722E+01	4.827E+02	7.235E+05	4.861E+01
1994	1.880E+03	1.506E+06	1.012E+02	5.023E+02	7.529E+05	5.059E+01
1995	1.944E+03	1.556E+06	1.046E+02	5.192E+02	7.782E+05	5.229E+01
1996	1.998E+03	1.600E+06	1.075E+02	5.337E+02	8.000E+05	5.375E+01
1997	2.045E+03	1.637E+06	1.100E+02	5.462E+02	8.187E+05	5.501E+01
1998	2.248E+03	1.800E+06	1.209E+02	6.004E+02	8.999E+05	6.047E+01
1999	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2000	2.875E+03	2.302E+06	1.547E+02	7.680E+02	1.151E+06	7.734E+01
2001	3.352E+03	2.685E+06	1.804E+02	8.955E+02	1.342E+06	9.019E+01
2002	3.763E+03	3.014E+06	2.025E+02	1.005E+03	1.507E+06	1.012E+02
2003	4.117E+03	3.297E+06	2.215E+02	1.100E+03	1.648E+06	1.108E+02
2004	4.159E+03	3.330E+06	2.237E+02	1.111E+03	1.665E+06	1.119E+02
2005	4.446E+03	3.560E+06	2.392E+02	1.187E+03	1.780E+06	1.196E+02
2006	4.891E+03	3.917E+06	2.632E+02	1.307E+03	1.958E+06	1.316E+02
2007	5.137E+03	4.113E+06	2.764E+02	1.372E+03	2.057E+06	1.382E+02
2008	5.358E+03	4.291E+06	2.883E+02	1.431E+03	2.145E+06	1.441E+02
2009	5.398E+03	4.323E+06	2.904E+02	1.442E+03	2.161E+06	1.452E+02
2010	5.118E+03	4.098E+06	2.753E+02	1.367E+03	2.049E+06	1.377E+02
2011	4.702E+03	3.765E+06	2.530E+02	1.256E+03	1.883E+06	1.265E+02
2012	4.267E+03	3.417E+06	2.296E+02	1.140E+03	1.708E+06	1.148E+02
2013	4.542E+03	3.637E+06	2.444E+02	1.213E+03	1.818E+06	1.222E+02
2014	4.778E+03	3.826E+06	2.571E+02	1.276E+03	1.913E+06	1.285E+02
2015	4.982E+03	3.989E+06	2.680E+02	1.331E+03	1.995E+06	1.340E+02
2016	4.441E+03	3.556E+06	2.389E+02	1.186E+03	1.778E+06	1.195E+02
2017	3.822E+03	3.061E+06	2.057E+02	1.021E+03	1.530E+06	1.028E+02
2018	3.290E+03	2.635E+06	1.770E+02	8.788E+02	1.317E+06	8.851E+01
2019	2.832E+03	2.268E+06	1.524E+02	7.564E+02	1.134E+06	7.618E+01
2020	2.437E+03	1.952E+06	1.311E+02	6.510E+02	9.759E+05	6.557E+01
2021	2.098E+03	1.680E+06	1.129E+02	5.604E+02	8.399E+05	5.643E+01
2022	1.806E+03	1.446E+06	9.715E+01	4.823E+02	7.229E+05	4.857E+01
2023	1.554E+03	1.244E+06	8.362E+01	4.151E+02	6.222E+05	4.181E+01
2024	1.338E+03	1.071E+06	7.197E+01	3.573E+02	5.356E+05	3.598E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2025	1.151E+03	9.219E+05	6.194E+01	3.075E+02	4.610E+05	3.097E+01
2026	9.909E+02	7.935E+05	5.332E+01	2.647E+02	3.968E+05	2.666E+01
2027	8.529E+02	6.830E+05	4.589E+01	2.278E+02	3.415E+05	2.294E+01
2028	7.341E+02	5.878E+05	3.950E+01	1.961E+02	2.939E+05	1.975E+01
2029	6.319E+02	5.060E+05	3.400E+01	1.688E+02	2.530E+05	1.700E+01
2030	5.438E+02	4.355E+05	2.926E+01	1.453E+02	2.177E+05	1.463E+01
2031	4.681E+02	3.748E+05	2.518E+01	1.250E+02	1.874E+05	1.259E+01
2032	4.029E+02	3.226E+05	2.168E+01	1.076E+02	1.613E+05	1.084E+01
2033	3.468E+02	2.777E+05	1.866E+01	9.263E+01	1.388E+05	9.329E+00
2034	2.985E+02	2.390E+05	1.606E+01	7.972E+01	1.195E+05	8.029E+00
2035	2.569E+02	2.057E+05	1.382E+01	6.862E+01	1.029E+05	6.911E+00
2036	2.211E+02	1.771E+05	1.190E+01	5.906E+01	8.853E+04	5.948E+00
2037	1.903E+02	1.524E+05	1.024E+01	5.083E+01	7.620E+04	5.120E+00
2038	1.638E+02	1.312E+05	8.813E+00	4.375E+01	6.558E+04	4.406E+00
2039	1.410E+02	1.129E+05	7.585E+00	3.766E+01	5.645E+04	3.793E+00
2040	1.213E+02	9.717E+04	6.529E+00	3.241E+01	4.858E+04	3.264E+00
2041	1.044E+02	8.363E+04	5.619E+00	2.790E+01	4.182E+04	2.810E+00
2042	8.990E+01	7.198E+04	4.837E+00	2.401E+01	3.599E+04	2.418E+00
2043	7.737E+01	6.196E+04	4.163E+00	2.067E+01	3.098E+04	2.081E+00
2044	6.660E+01	5.333E+04	3.583E+00	1.779E+01	2.666E+04	1.792E+00
2045	5.732E+01	4.590E+04	3.084E+00	1.531E+01	2.295E+04	1.542E+00
2046	4.934E+01	3.951E+04	2.654E+00	1.318E+01	1.975E+04	1.327E+00
2047	4.246E+01	3.400E+04	2.285E+00	1.134E+01	1.700E+04	1.142E+00
2048	3.655E+01	2.927E+04	1.966E+00	9.763E+00	1.463E+04	9.832E-01
2049	3.146E+01	2.519E+04	1.693E+00	8.403E+00	1.260E+04	8.463E-01
2050	2.708E+01	2.168E+04	1.457E+00	7.232E+00	1.084E+04	7.284E-01
2051	2.330E+01	1.866E+04	1.254E+00	6.225E+00	9.331E+03	6.269E-01
2052	2.006E+01	1.606E+04	1.079E+00	5.358E+00	8.031E+03	5.396E-01
2053	1.726E+01	1.382E+04	9.289E-01	4.612E+00	6.912E+03	4.644E-01
2054	1.486E+01	1.190E+04	7.995E-01	3.969E+00	5.950E+03	3.997E-01
2055	1.279E+01	1.024E+04	6.881E-01	3.416E+00	5.121E+03	3.441E-01
2056	1.101E+01	8.815E+03	5.923E-01	2.940E+00	4.408E+03	2.961E-01
2057	9.475E+00	7.587E+03	5.098E-01	2.531E+00	3.794E+03	2.549E-01
2058	8.155E+00	6.530E+03	4.388E-01	2.178E+00	3.265E+03	2.194E-01
2059	7.019E+00	5.621E+03	3.777E-01	1.875E+00	2.810E+03	1.888E-01
2060	6.042E+00	4.838E+03	3.250E-01	1.614E+00	2.419E+03	1.625E-01
2061	5.200E+00	4.164E+03	2.798E-01	1.389E+00	2.082E+03	1.399E-01
2062	4.476E+00	3.584E+03	2.408E-01	1.196E+00	1.792E+03	1.204E-01
2063	3.852E+00	3.085E+03	2.073E-01	1.029E+00	1.542E+03	1.036E-01
2064	3.316E+00	2.655E+03	1.784E-01	8.856E-01	1.328E+03	8.920E-02
2065	2.854E+00	2.285E+03	1.535E-01	7.623E-01	1.143E+03	7.677E-02
2066	2.456E+00	1.967E+03	1.322E-01	6.561E-01	9.834E+02	6.608E-02
2067	2.114E+00	1.693E+03	1.137E-01	5.647E-01	8.465E+02	5.687E-02
2068	1.820E+00	1.457E+03	9.790E-02	4.861E-01	7.286E+02	4.895E-02
2069	1.566E+00	1.254E+03	8.427E-02	4.184E-01	6.271E+02	4.213E-02
2070	1.348E+00	1.079E+03	7.253E-02	3.601E-01	5.397E+02	3.626E-02
2071	1.160E+00	9.291E+02	6.243E-02	3.099E-01	4.645E+02	3.121E-02
2072	9.987E-01	7.997E+02	5.373E-02	2.668E-01	3.998E+02	2.687E-02
2073	8.596E-01	6.883E+02	4.625E-02	2.296E-01	3.441E+02	2.312E-02
2074	7.398E-01	5.924E+02	3.980E-02	1.976E-01	2.962E+02	1.990E-02
2075	6.368E-01	5.099E+02	3.426E-02	1.701E-01	2.549E+02	1.713E-02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	5.481E-01	4.389E+02	2.949E-02	1.464E-01	2.194E+02	1.474E-02
2077	4.717E-01	3.777E+02	2.538E-02	1.260E-01	1.889E+02	1.269E-02
2078	4.060E-01	3.251E+02	2.185E-02	1.085E-01	1.626E+02	1.092E-02
2079	3.495E-01	2.798E+02	1.880E-02	9.335E-02	1.399E+02	9.401E-03
2080	3.008E-01	2.409E+02	1.618E-02	8.034E-02	1.204E+02	8.092E-03
2081	2.589E-01	2.073E+02	1.393E-02	6.915E-02	1.037E+02	6.965E-03
2082	2.228E-01	1.784E+02	1.199E-02	5.952E-02	8.922E+01	5.994E-03
2083	1.918E-01	1.536E+02	1.032E-02	5.123E-02	7.679E+01	5.159E-03
2084	1.651E-01	1.322E+02	8.882E-03	4.409E-02	6.609E+01	4.441E-03
2085	1.421E-01	1.138E+02	7.644E-03	3.795E-02	5.689E+01	3.822E-03
2086	1.223E-01	9.793E+01	6.580E-03	3.267E-02	4.896E+01	3.290E-03
2087	1.053E-01	8.429E+01	5.663E-03	2.812E-02	4.214E+01	2.832E-03
2088	9.060E-02	7.255E+01	4.874E-03	2.420E-02	3.627E+01	2.437E-03
2089	7.798E-02	6.244E+01	4.195E-03	2.083E-02	3.122E+01	2.098E-03
2090	6.712E-02	5.374E+01	3.611E-03	1.793E-02	2.687E+01	1.805E-03
2091	5.777E-02	4.626E+01	3.108E-03	1.543E-02	2.313E+01	1.554E-03
2092	4.972E-02	3.981E+01	2.675E-03	1.328E-02	1.991E+01	1.338E-03
2093	4.279E-02	3.427E+01	2.302E-03	1.143E-02	1.713E+01	1.151E-03
2094	3.683E-02	2.949E+01	1.982E-03	9.839E-03	1.475E+01	9.909E-04
2095	3.170E-02	2.539E+01	1.706E-03	8.468E-03	1.269E+01	8.529E-04
2096	2.729E-02	2.185E+01	1.468E-03	7.289E-03	1.093E+01	7.341E-04
2097	2.349E-02	1.881E+01	1.264E-03	6.273E-03	9.403E+00	6.318E-04
2098	2.021E-02	1.619E+01	1.088E-03	5.400E-03	8.094E+00	5.438E-04
2099	1.740E-02	1.393E+01	9.361E-04	4.647E-03	6.966E+00	4.681E-04
2100	1.498E-02	1.199E+01	8.057E-04	4.000E-03	5.996E+00	4.029E-04
2101	1.289E-02	1.032E+01	6.935E-04	3.443E-03	5.161E+00	3.467E-04
2102	1.109E-02	8.884E+00	5.969E-04	2.963E-03	4.442E+00	2.984E-04
2103	9.549E-03	7.646E+00	5.137E-04	2.551E-03	3.823E+00	2.569E-04
2104	8.219E-03	6.581E+00	4.422E-04	2.195E-03	3.291E+00	2.211E-04
2105	7.074E-03	5.664E+00	3.806E-04	1.890E-03	2.832E+00	1.903E-04
2106	6.089E-03	4.875E+00	3.276E-04	1.626E-03	2.438E+00	1.638E-04
2107	5.240E-03	4.196E+00	2.820E-04	1.400E-03	2.098E+00	1.410E-04
2108	4.511E-03	3.612E+00	2.427E-04	1.205E-03	1.806E+00	1.213E-04
2109	3.882E-03	3.109E+00	2.089E-04	1.037E-03	1.554E+00	1.044E-04
2110	3.341E-03	2.676E+00	1.798E-04	8.925E-04	1.338E+00	8.989E-05
2111	2.876E-03	2.303E+00	1.547E-04	7.682E-04	1.151E+00	7.737E-05
2112	2.475E-03	1.982E+00	1.332E-04	6.612E-04	9.911E-01	6.659E-05
2113	2.131E-03	1.706E+00	1.146E-04	5.691E-04	8.531E-01	5.732E-05
2114	1.834E-03	1.468E+00	9.867E-05	4.898E-04	7.342E-01	4.933E-05
2115	1.578E-03	1.264E+00	8.492E-05	4.216E-04	6.320E-01	4.246E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
1975	0	0	0	0	0	0
1976	1.720E+02	9.397E+04	6.314E+00	4.042E-01	1.128E+02	7.577E-03
1977	3.201E+02	1.749E+05	1.175E+01	7.521E-01	2.098E+02	1.410E-02
1978	4.475E+02	2.445E+05	1.643E+01	1.052E+00	2.934E+02	1.971E-02
1979	5.572E+02	3.044E+05	2.045E+01	1.309E+00	3.653E+02	2.454E-02
1980	6.516E+02	3.560E+05	2.392E+01	1.531E+00	4.272E+02	2.870E-02
1981	7.328E+02	4.003E+05	2.690E+01	1.722E+00	4.804E+02	3.228E-02
1982	8.028E+02	4.386E+05	2.947E+01	1.886E+00	5.263E+02	3.536E-02
1983	8.630E+02	4.714E+05	3.168E+01	2.028E+00	5.657E+02	3.801E-02
1984	9.148E+02	4.997E+05	3.358E+01	2.150E+00	5.997E+02	4.029E-02
1985	9.594E+02	5.241E+05	3.521E+01	2.254E+00	6.289E+02	4.226E-02
1986	9.978E+02	5.451E+05	3.662E+01	2.345E+00	6.541E+02	4.395E-02
1987	1.031E+03	5.631E+05	3.784E+01	2.422E+00	6.757E+02	4.540E-02
1988	1.059E+03	5.787E+05	3.888E+01	2.489E+00	6.944E+02	4.666E-02
1989	1.084E+03	5.920E+05	3.978E+01	2.546E+00	7.104E+02	4.773E-02
1990	1.105E+03	6.035E+05	4.055E+01	2.596E+00	7.242E+02	4.866E-02
1991	1.189E+03	6.496E+05	4.365E+01	2.794E+00	7.796E+02	5.238E-02
1992	1.262E+03	6.893E+05	4.632E+01	2.965E+00	8.272E+02	5.558E-02
1993	1.324E+03	7.235E+05	4.861E+01	3.112E+00	8.682E+02	5.833E-02
1994	1.378E+03	7.529E+05	5.059E+01	3.238E+00	9.035E+02	6.070E-02
1995	1.424E+03	7.782E+05	5.229E+01	3.347E+00	9.338E+02	6.274E-02
1996	1.464E+03	8.000E+05	5.375E+01	3.441E+00	9.600E+02	6.450E-02
1997	1.499E+03	8.187E+05	5.501E+01	3.522E+00	9.825E+02	6.601E-02
1998	1.647E+03	8.999E+05	6.047E+01	3.871E+00	1.080E+03	7.256E-02
1999	1.894E+03	1.035E+06	6.954E+01	4.452E+00	1.242E+03	8.344E-02
2000	2.107E+03	1.151E+06	7.734E+01	4.951E+00	1.381E+03	9.281E-02
2001	2.457E+03	1.342E+06	9.019E+01	5.774E+00	1.611E+03	1.082E-01
2002	2.758E+03	1.507E+06	1.012E+02	6.481E+00	1.808E+03	1.215E-01
2003	3.017E+03	1.648E+06	1.108E+02	7.090E+00	1.978E+03	1.329E-01
2004	3.048E+03	1.665E+06	1.119E+02	7.162E+00	1.998E+03	1.342E-01
2005	3.258E+03	1.780E+06	1.196E+02	7.656E+00	2.136E+03	1.435E-01
2006	3.585E+03	1.958E+06	1.316E+02	8.424E+00	2.350E+03	1.579E-01
2007	3.765E+03	2.057E+06	1.382E+02	8.846E+00	2.468E+03	1.658E-01
2008	3.927E+03	2.145E+06	1.441E+02	9.228E+00	2.574E+03	1.730E-01
2009	3.956E+03	2.161E+06	1.452E+02	9.297E+00	2.594E+03	1.743E-01
2010	3.751E+03	2.049E+06	1.377E+02	8.813E+00	2.459E+03	1.652E-01
2011	3.446E+03	1.883E+06	1.265E+02	8.098E+00	2.259E+03	1.518E-01
2012	3.127E+03	1.708E+06	1.148E+02	7.348E+00	2.050E+03	1.377E-01
2013	3.329E+03	1.818E+06	1.222E+02	7.821E+00	2.182E+03	1.466E-01
2014	3.502E+03	1.913E+06	1.285E+02	8.229E+00	2.296E+03	1.543E-01
2015	3.651E+03	1.995E+06	1.340E+02	8.580E+00	2.394E+03	1.608E-01
2016	3.255E+03	1.778E+06	1.195E+02	7.648E+00	2.134E+03	1.434E-01
2017	2.801E+03	1.530E+06	1.028E+02	6.583E+00	1.837E+03	1.234E-01
2018	2.411E+03	1.317E+06	8.851E+01	5.666E+00	1.581E+03	1.062E-01
2019	2.075E+03	1.134E+06	7.618E+01	4.877E+00	1.361E+03	9.141E-02
2020	1.786E+03	9.759E+05	6.557E+01	4.197E+00	1.171E+03	7.868E-02
2021	1.537E+03	8.399E+05	5.643E+01	3.613E+00	1.008E+03	6.772E-02
2022	1.323E+03	7.229E+05	4.857E+01	3.110E+00	8.675E+02	5.829E-02
2023	1.139E+03	6.222E+05	4.181E+01	2.676E+00	7.467E+02	5.017E-02
2024	9.803E+02	5.356E+05	3.598E+01	2.304E+00	6.427E+02	4.318E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2025	8.438E+02	4.610E+05	3.097E+01	1.983E+00	5.532E+02	3.717E-02
2026	7.263E+02	3.968E+05	2.666E+01	1.707E+00	4.761E+02	3.199E-02
2027	6.251E+02	3.415E+05	2.294E+01	1.469E+00	4.098E+02	2.753E-02
2028	5.380E+02	2.939E+05	1.975E+01	1.264E+00	3.527E+02	2.370E-02
2029	4.631E+02	2.530E+05	1.700E+01	1.088E+00	3.036E+02	2.040E-02
2030	3.986E+02	2.177E+05	1.463E+01	9.366E-01	2.613E+02	1.756E-02
2031	3.431E+02	1.874E+05	1.259E+01	8.061E-01	2.249E+02	1.511E-02
2032	2.953E+02	1.613E+05	1.084E+01	6.938E-01	1.936E+02	1.301E-02
2033	2.541E+02	1.388E+05	9.329E+00	5.972E-01	1.666E+02	1.119E-02
2034	2.187E+02	1.195E+05	8.029E+00	5.140E-01	1.434E+02	9.635E-03
2035	1.883E+02	1.029E+05	6.911E+00	4.424E-01	1.234E+02	8.293E-03
2036	1.620E+02	8.853E+04	5.948E+00	3.808E-01	1.062E+02	7.138E-03
2037	1.395E+02	7.620E+04	5.120E+00	3.277E-01	9.144E+01	6.144E-03
2038	1.200E+02	6.558E+04	4.406E+00	2.821E-01	7.870E+01	5.288E-03
2039	1.033E+02	5.645E+04	3.793E+00	2.428E-01	6.774E+01	4.551E-03
2040	8.893E+01	4.858E+04	3.264E+00	2.090E-01	5.830E+01	3.917E-03
2041	7.655E+01	4.182E+04	2.810E+00	1.799E-01	5.018E+01	3.372E-03
2042	6.588E+01	3.599E+04	2.418E+00	1.548E-01	4.319E+01	2.902E-03
2043	5.671E+01	3.098E+04	2.081E+00	1.333E-01	3.717E+01	2.498E-03
2044	4.881E+01	2.666E+04	1.792E+00	1.147E-01	3.200E+01	2.150E-03
2045	4.201E+01	2.295E+04	1.542E+00	9.872E-02	2.754E+01	1.850E-03
2046	3.616E+01	1.975E+04	1.327E+00	8.497E-02	2.370E+01	1.593E-03
2047	3.112E+01	1.700E+04	1.142E+00	7.313E-02	2.040E+01	1.371E-03
2048	2.679E+01	1.463E+04	9.832E-01	6.294E-02	1.756E+01	1.180E-03
2049	2.306E+01	1.260E+04	8.463E-01	5.418E-02	1.511E+01	1.016E-03
2050	1.984E+01	1.084E+04	7.284E-01	4.663E-02	1.301E+01	8.741E-04
2051	1.708E+01	9.331E+03	6.269E-01	4.013E-02	1.120E+01	7.523E-04
2052	1.470E+01	8.031E+03	5.396E-01	3.454E-02	9.637E+00	6.475E-04
2053	1.265E+01	6.912E+03	4.644E-01	2.973E-02	8.295E+00	5.573E-04
2054	1.089E+01	5.950E+03	3.997E-01	2.559E-02	7.139E+00	4.797E-04
2055	9.374E+00	5.121E+03	3.441E-01	2.203E-02	6.145E+00	4.129E-04
2056	8.068E+00	4.408E+03	2.961E-01	1.896E-02	5.289E+00	3.554E-04
2057	6.944E+00	3.794E+03	2.549E-01	1.632E-02	4.552E+00	3.059E-04
2058	5.977E+00	3.265E+03	2.194E-01	1.404E-02	3.918E+00	2.633E-04
2059	5.144E+00	2.810E+03	1.888E-01	1.209E-02	3.372E+00	2.266E-04
2060	4.428E+00	2.419E+03	1.625E-01	1.040E-02	2.903E+00	1.950E-04
2061	3.811E+00	2.082E+03	1.399E-01	8.955E-03	2.498E+00	1.679E-04
2062	3.280E+00	1.792E+03	1.204E-01	7.708E-03	2.150E+00	1.445E-04
2063	2.823E+00	1.542E+03	1.036E-01	6.634E-03	1.851E+00	1.244E-04
2064	2.430E+00	1.328E+03	8.920E-02	5.710E-03	1.593E+00	1.070E-04
2065	2.092E+00	1.143E+03	7.677E-02	4.915E-03	1.371E+00	9.213E-05
2066	1.800E+00	9.834E+02	6.608E-02	4.230E-03	1.180E+00	7.929E-05
2067	1.549E+00	8.465E+02	5.687E-02	3.641E-03	1.016E+00	6.825E-05
2068	1.334E+00	7.286E+02	4.895E-02	3.134E-03	8.743E-01	5.874E-05
2069	1.148E+00	6.271E+02	4.213E-02	2.697E-03	7.525E-01	5.056E-05
2070	9.880E-01	5.397E+02	3.626E-02	2.322E-03	6.477E-01	4.352E-05
2071	8.504E-01	4.645E+02	3.121E-02	1.998E-03	5.575E-01	3.746E-05
2072	7.319E-01	3.998E+02	2.687E-02	1.720E-03	4.798E-01	3.224E-05
2073	6.300E-01	3.441E+02	2.312E-02	1.480E-03	4.130E-01	2.775E-05
2074	5.422E-01	2.962E+02	1.990E-02	1.274E-03	3.555E-01	2.388E-05
2075	4.667E-01	2.549E+02	1.713E-02	1.097E-03	3.059E-01	2.056E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2076	4.017E-01	2.194E+02	1.474E-02	9.439E-04	2.633E-01	1.769E-05
2077	3.457E-01	1.889E+02	1.269E-02	8.124E-04	2.266E-01	1.523E-05
2078	2.976E-01	1.626E+02	1.092E-02	6.992E-04	1.951E-01	1.311E-05
2079	2.561E-01	1.399E+02	9.401E-03	6.018E-04	1.679E-01	1.128E-05
2080	2.204E-01	1.204E+02	8.092E-03	5.180E-04	1.445E-01	9.710E-06
2081	1.897E-01	1.037E+02	6.965E-03	4.459E-04	1.244E-01	8.357E-06
2082	1.633E-01	8.922E+01	5.994E-03	3.838E-04	1.071E-01	7.193E-06
2083	1.406E-01	7.679E+01	5.159E-03	3.303E-04	9.215E-02	6.191E-06
2084	1.210E-01	6.609E+01	4.441E-03	2.843E-04	7.931E-02	5.329E-06
2085	1.041E-01	5.689E+01	3.822E-03	2.447E-04	6.826E-02	4.587E-06
2086	8.963E-02	4.896E+01	3.290E-03	2.106E-04	5.876E-02	3.948E-06
2087	7.714E-02	4.214E+01	2.832E-03	1.813E-04	5.057E-02	3.398E-06
2088	6.640E-02	3.627E+01	2.437E-03	1.560E-04	4.353E-02	2.925E-06
2089	5.715E-02	3.122E+01	2.098E-03	1.343E-04	3.746E-02	2.517E-06
2090	4.919E-02	2.687E+01	1.805E-03	1.156E-04	3.225E-02	2.167E-06
2091	4.234E-02	2.313E+01	1.554E-03	9.948E-05	2.775E-02	1.865E-06
2092	3.644E-02	1.991E+01	1.338E-03	8.563E-05	2.389E-02	1.605E-06
2093	3.136E-02	1.713E+01	1.151E-03	7.370E-05	2.056E-02	1.381E-06
2094	2.700E-02	1.475E+01	9.909E-04	6.343E-05	1.770E-02	1.189E-06
2095	2.323E-02	1.269E+01	8.529E-04	5.460E-05	1.523E-02	1.023E-06
2096	2.000E-02	1.093E+01	7.341E-04	4.699E-05	1.311E-02	8.809E-07
2097	1.721E-02	9.403E+00	6.318E-04	4.045E-05	1.128E-02	7.582E-07
2098	1.482E-02	8.094E+00	5.438E-04	3.481E-05	9.712E-03	6.526E-07
2099	1.275E-02	6.966E+00	4.681E-04	2.996E-05	8.359E-03	5.617E-07
2100	1.098E-02	5.996E+00	4.029E-04	2.579E-05	7.195E-03	4.834E-07
2101	9.447E-03	5.161E+00	3.467E-04	2.220E-05	6.193E-03	4.161E-07
2102	8.131E-03	4.442E+00	2.984E-04	1.911E-05	5.330E-03	3.581E-07
2103	6.998E-03	3.823E+00	2.569E-04	1.644E-05	4.588E-03	3.082E-07
2104	6.023E-03	3.291E+00	2.211E-04	1.415E-05	3.949E-03	2.653E-07
2105	5.184E-03	2.832E+00	1.903E-04	1.218E-05	3.399E-03	2.284E-07
2106	4.462E-03	2.438E+00	1.638E-04	1.049E-05	2.925E-03	1.965E-07
2107	3.841E-03	2.098E+00	1.410E-04	9.025E-06	2.518E-03	1.692E-07
2108	3.306E-03	1.806E+00	1.213E-04	7.768E-06	2.167E-03	1.456E-07
2109	2.845E-03	1.554E+00	1.044E-04	6.686E-06	1.865E-03	1.253E-07
2110	2.449E-03	1.338E+00	8.989E-05	5.755E-06	1.605E-03	1.079E-07
2111	2.108E-03	1.151E+00	7.737E-05	4.953E-06	1.382E-03	9.284E-08
2112	1.814E-03	9.911E-01	6.659E-05	4.263E-06	1.189E-03	7.991E-08
2113	1.562E-03	8.531E-01	5.732E-05	3.669E-06	1.024E-03	6.878E-08
2114	1.344E-03	7.342E-01	4.933E-05	3.158E-06	8.811E-04	5.920E-08
2115	1.157E-03	6.320E-01	4.246E-05	2.718E-06	7.583E-04	5.095E-08

Summary Report

Landfill Name or Identifier: Powerstown Landfill Calibrated

Date: 11 November 2011

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n}\sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10}\right) e^{-kt_{ij}}$$

Where,

Q_{CH_4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1975**	
Landfill Closure Year (with 80-year limit)	**2014**	
Actual Closure Year (without limit)	***2014***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.150**	*year* $^{-1}$
Potential Methane Generation Capacity, L_o	**62**	*m^3/Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1975	10,800	11,880	0	0
1976	10,800	11,880	10,800	11,880
1977	10,800	11,880	21,600	23,760
1978	10,800	11,880	32,400	35,640
1979	10,800	11,880	43,200	47,520
1980	10,800	11,880	54,000	59,400
1981	10,800	11,880	64,800	71,280
1982	10,800	11,880	75,600	83,160
1983	10,800	11,880	86,400	95,040
1984	10,800	11,880	97,200	106,920
1985	10,800	11,880	108,000	118,800
1986	10,800	11,880	118,800	130,680
1987	10,800	11,880	129,600	142,560
1988	10,800	11,880	140,400	154,440
1989	10,800	11,880	151,200	166,320
1990	14,961	16,457	162,000	178,200
1991	14,961	16,457	176,961	194,657
1992	14,961	16,457	191,922	211,114
1993	14,961	16,457	206,883	227,571
1994	14,961	16,457	221,844	244,028
1995	14,961	16,457	236,805	260,486
1996	14,961	16,457	251,766	276,943
1997	22,441	24,685	266,727	293,400
1998	29,922	32,914	289,168	318,085
1999	29,922	32,914	319,090	350,999
2000	40,394	44,433	349,012	383,913
2001	40,394	44,433	389,406	428,347
2002	40,394	44,433	429,800	472,780
2003	28,307	31,138	470,194	517,213
2004	39,853	43,838	498,501	548,351
2005	49,010	53,911	538,354	592,189
2006	42,638	46,902	587,364	646,100
2007	43,130	47,443	630,002	693,002
2008	36,177	39,795	673,132	740,445
2009	21,684	23,852	709,309	780,240
2010	13,697	15,067	730,993	804,092
2011	10,088	11,097	744,690	819,159
2012	50,000	55,000	754,778	830,256
2013	50,000	55,000	804,778	885,256
2014	27,043	29,747	854,778	940,256

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2015	0	0	881,821	970,003
2016	0	0	881,821	970,003
2017	0	0	881,821	970,003
2018	0	0	881,821	970,003
2019	0	0	881,821	970,003
2020	0	0	881,821	970,003
2021	0	0	881,821	970,003
2022	0	0	881,821	970,003
2023	0	0	881,821	970,003
2024	0	0	881,821	970,003
2025	0	0	881,821	970,003
2026	0	0	881,821	970,003
2027	0	0	881,821	970,003
2028	0	0	881,821	970,003
2029	0	0	881,821	970,003
2030	0	0	881,821	970,003
2031	0	0	881,821	970,003
2032	0	0	881,821	970,003
2033	0	0	881,821	970,003
2034	0	0	881,821	970,003
2035	0	0	881,821	970,003
2036	0	0	881,821	970,003
2037	0	0	881,821	970,003
2038	0	0	881,821	970,003
2039	0	0	881,821	970,003
2040	0	0	881,821	970,003
2041	0	0	881,821	970,003
2042	0	0	881,821	970,003
2043	0	0	881,821	970,003
2044	0	0	881,821	970,003
2045	0	0	881,821	970,003
2046	0	0	881,821	970,003
2047	0	0	881,821	970,003
2048	0	0	881,821	970,003
2049	0	0	881,821	970,003
2050	0	0	881,821	970,003
2051	0	0	881,821	970,003
2052	0	0	881,821	970,003
2053	0	0	881,821	970,003
2054	0	0	881,821	970,003

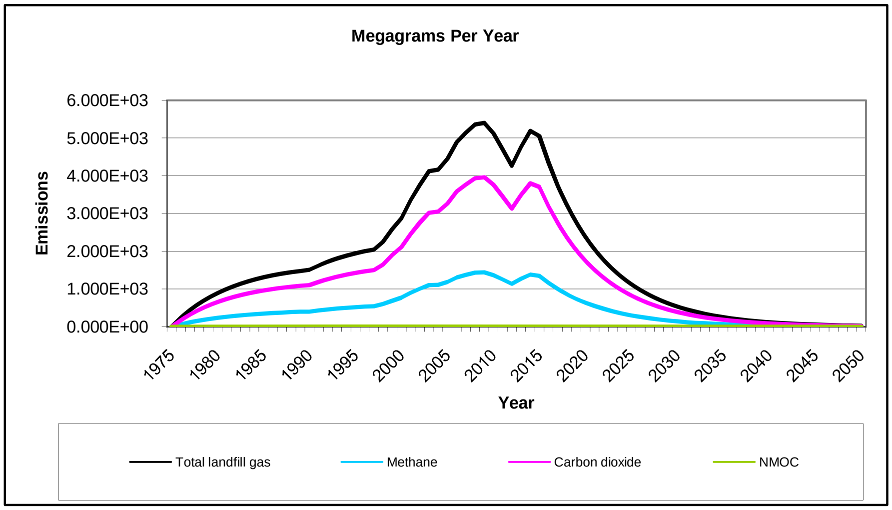
Pollutant Parameters

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs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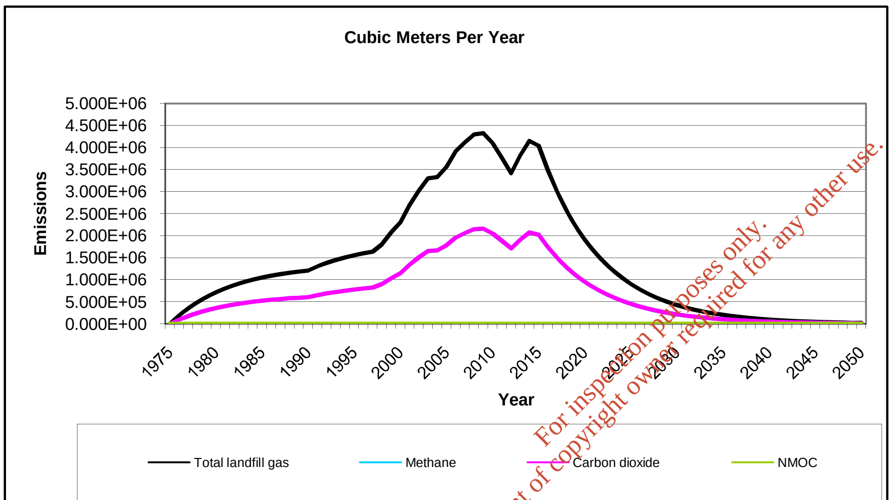
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC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4.000E+06
3.500E+06
3.000E+06
2.500E+06
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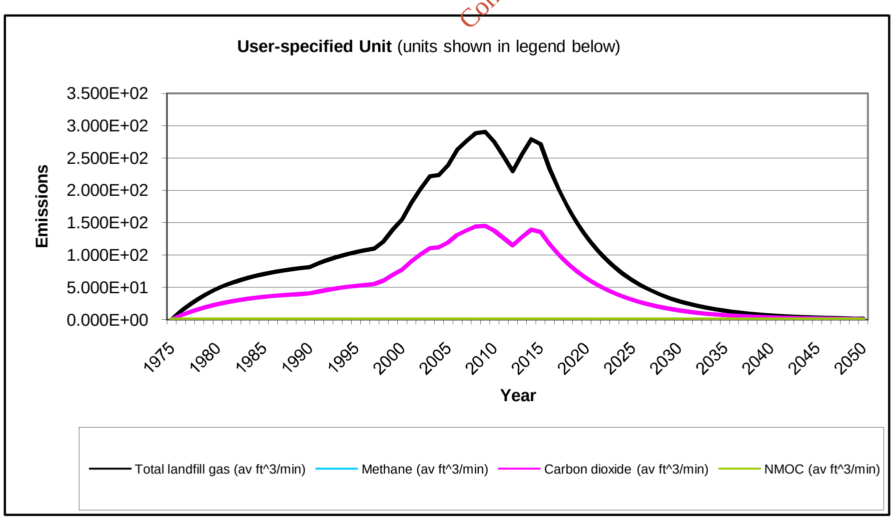
1.500E+06
1.000E+06
5.000E+05
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
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3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
1975	0	0	0	0	0	0
1976	2.347E+02	1.879E+05	1.263E+01	6.269E+01	9.397E+04	6.314E+00
1977	4.367E+02	3.497E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1978	6.106E+02	4.889E+05	3.285E+01	1.631E+02	2.445E+05	1.643E+01
1979	7.603E+02	6.088E+05	4.090E+01	2.031E+02	3.044E+05	2.045E+01
1980	8.891E+02	7.119E+05	4.783E+01	2.375E+02	3.560E+05	2.392E+01
1981	9.999E+02	8.007E+05	5.380E+01	2.671E+02	4.003E+05	2.690E+01
1982	1.095E+03	8.771E+05	5.893E+01	2.926E+02	4.386E+05	2.947E+01
1983	1.177E+03	9.429E+05	6.335E+01	3.145E+02	4.714E+05	3.168E+01
1984	1.248E+03	9.995E+05	6.716E+01	3.334E+02	4.997E+05	3.358E+01
1985	1.309E+03	1.048E+06	7.043E+01	3.497E+02	5.241E+05	3.521E+01
1986	1.361E+03	1.090E+06	7.325E+01	3.636E+02	5.451E+05	3.662E+01
1987	1.406E+03	1.126E+06	7.567E+01	3.757E+02	5.631E+05	3.784E+01
1988	1.445E+03	1.157E+06	7.776E+01	3.860E+02	5.787E+05	3.888E+01
1989	1.479E+03	1.184E+06	7.956E+01	3.950E+02	5.920E+05	3.978E+01
1990	1.507E+03	1.207E+06	8.110E+01	4.026E+02	6.035E+05	4.055E+01
1991	1.623E+03	1.299E+06	8.730E+01	4.334E+02	6.496E+05	4.365E+01
1992	1.722E+03	1.379E+06	9.263E+01	4.599E+02	6.893E+05	4.632E+01
1993	1.807E+03	1.447E+06	9.722E+01	4.827E+02	7.235E+05	4.861E+01
1994	1.880E+03	1.506E+06	1.012E+02	5.023E+02	7.529E+05	5.059E+01
1995	1.944E+03	1.556E+06	1.046E+02	5.192E+02	7.782E+05	5.229E+01
1996	1.998E+03	1.600E+06	1.075E+02	5.337E+02	8.000E+05	5.375E+01
1997	2.045E+03	1.637E+06	1.100E+02	5.462E+02	8.187E+05	5.501E+01
1998	2.248E+03	1.800E+06	1.209E+02	6.004E+02	8.999E+05	6.047E+01
1999	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2000	2.875E+03	2.302E+06	1.547E+02	7.680E+02	1.151E+06	7.734E+01
2001	3.352E+03	2.685E+06	1.804E+02	8.955E+02	1.342E+06	9.019E+01
2002	3.763E+03	3.014E+06	2.025E+02	1.005E+03	1.507E+06	1.012E+02
2003	4.117E+03	3.297E+06	2.215E+02	1.100E+03	1.648E+06	1.108E+02
2004	4.159E+03	3.330E+06	2.237E+02	1.111E+03	1.665E+06	1.119E+02
2005	4.446E+03	3.560E+06	2.392E+02	1.187E+03	1.780E+06	1.196E+02
2006	4.891E+03	3.917E+06	2.632E+02	1.307E+03	1.958E+06	1.316E+02
2007	5.137E+03	4.113E+06	2.764E+02	1.372E+03	2.057E+06	1.382E+02
2008	5.358E+03	4.291E+06	2.883E+02	1.431E+03	2.145E+06	1.441E+02
2009	5.398E+03	4.323E+06	2.904E+02	1.442E+03	2.161E+06	1.452E+02
2010	5.118E+03	4.098E+06	2.753E+02	1.367E+03	2.049E+06	1.377E+02
2011	4.702E+03	3.765E+06	2.530E+02	1.256E+03	1.883E+06	1.265E+02
2012	4.267E+03	3.417E+06	2.296E+02	1.140E+03	1.708E+06	1.148E+02
2013	4.759E+03	3.811E+06	2.560E+02	1.271E+03	1.905E+06	1.280E+02
2014	5.183E+03	4.150E+06	2.788E+02	1.384E+03	2.075E+06	1.394E+02
2015	5.048E+03	4.043E+06	2.716E+02	1.348E+03	2.021E+06	1.358E+02
2016	4.345E+03	3.479E+06	2.338E+02	1.161E+03	1.740E+06	1.169E+02
2017	3.740E+03	2.995E+06	2.012E+02	9.990E+02	1.497E+06	1.006E+02
2018	3.219E+03	2.578E+06	1.732E+02	8.598E+02	1.289E+06	8.660E+01
2019	2.771E+03	2.219E+06	1.491E+02	7.401E+02	1.109E+06	7.453E+01
2020	2.385E+03	1.910E+06	1.283E+02	6.370E+02	9.548E+05	6.415E+01
2021	2.053E+03	1.644E+06	1.104E+02	5.483E+02	8.218E+05	5.522E+01
2022	1.767E+03	1.415E+06	9.505E+01	4.719E+02	7.073E+05	4.753E+01
2023	1.521E+03	1.218E+06	8.181E+01	4.062E+02	6.088E+05	4.091E+01
2024	1.309E+03	1.048E+06	7.041E+01	3.496E+02	5.240E+05	3.521E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2025	1.126E+03	9.020E+05	6.061E+01	3.009E+02	4.510E+05	3.030E+01
2026	9.696E+02	7.764E+05	5.216E+01	2.590E+02	3.882E+05	2.608E+01
2027	8.345E+02	6.682E+05	4.490E+01	2.229E+02	3.341E+05	2.245E+01
2028	7.183E+02	5.752E+05	3.864E+01	1.919E+02	2.876E+05	1.932E+01
2029	6.182E+02	4.950E+05	3.326E+01	1.651E+02	2.475E+05	1.663E+01
2030	5.321E+02	4.261E+05	2.863E+01	1.421E+02	2.130E+05	1.431E+01
2031	4.580E+02	3.667E+05	2.464E+01	1.223E+02	1.834E+05	1.232E+01
2032	3.942E+02	3.157E+05	2.121E+01	1.053E+02	1.578E+05	1.060E+01
2033	3.393E+02	2.717E+05	1.825E+01	9.063E+01	1.358E+05	9.127E+00
2034	2.920E+02	2.338E+05	1.571E+01	7.800E+01	1.169E+05	7.856E+00
2035	2.513E+02	2.013E+05	1.352E+01	6.714E+01	1.006E+05	6.762E+00
2036	2.163E+02	1.732E+05	1.164E+01	5.779E+01	8.662E+04	5.820E+00
2037	1.862E+02	1.491E+05	1.002E+01	4.974E+01	7.455E+04	5.009E+00
2038	1.603E+02	1.283E+05	8.623E+00	4.281E+01	6.417E+04	4.311E+00
2039	1.379E+02	1.105E+05	7.422E+00	3.685E+01	5.523E+04	3.711E+00
2040	1.187E+02	9.507E+04	6.388E+00	3.171E+01	4.754E+04	3.194E+00
2041	1.022E+02	8.183E+04	5.498E+00	2.730E+01	4.091E+04	2.749E+00
2042	8.796E+01	7.043E+04	4.732E+00	2.349E+01	3.522E+04	2.366E+00
2043	7.570E+01	6.062E+04	4.073E+00	2.022E+01	3.031E+04	2.037E+00
2044	6.516E+01	5.218E+04	3.506E+00	1.740E+01	2.609E+04	1.753E+00
2045	5.608E+01	4.491E+04	3.017E+00	1.498E+01	2.245E+04	1.509E+00
2046	4.827E+01	3.865E+04	2.597E+00	1.289E+01	1.933E+04	1.299E+00
2047	4.155E+01	3.327E+04	2.235E+00	1.110E+01	1.663E+04	1.118E+00
2048	3.576E+01	2.864E+04	1.924E+00	9.552E+00	1.432E+04	9.620E-01
2049	3.078E+01	2.465E+04	1.656E+00	8.221E+00	1.232E+04	8.280E-01
2050	2.649E+01	2.121E+04	1.425E+00	7.076E+00	1.061E+04	7.127E-01
2051	2.280E+01	1.826E+04	1.227E+00	6.091E+00	9.129E+03	6.134E-01
2052	1.963E+01	1.572E+04	1.056E+00	5.242E+00	7.858E+03	5.280E-01
2053	1.689E+01	1.353E+04	9.088E-01	4.512E+00	6.763E+03	4.544E-01
2054	1.454E+01	1.164E+04	7.822E-01	3.884E+00	5.821E+03	3.911E-01
2055	1.251E+01	1.002E+04	6.733E-01	3.343E+00	5.010E+03	3.366E-01
2056	1.077E+01	8.625E+03	5.795E-01	2.877E+00	4.312E+03	2.897E-01
2057	9.271E+00	7.423E+03	4.988E-01	2.476E+00	3.712E+03	2.494E-01
2058	7.979E+00	6.389E+03	4.293E-01	2.131E+00	3.195E+03	2.147E-01
2059	6.868E+00	5.499E+03	3.695E-01	1.834E+00	2.750E+03	1.848E-01
2060	5.911E+00	4.733E+03	3.180E-01	1.579E+00	2.367E+03	1.590E-01
2061	5.088E+00	4.074E+03	2.737E-01	1.359E+00	2.037E+03	1.369E-01
2062	4.379E+00	3.507E+03	2.356E-01	1.170E+00	1.753E+03	1.178E-01
2063	3.769E+00	3.018E+03	2.028E-01	1.007E+00	1.509E+03	1.014E-01
2064	3.244E+00	2.598E+03	1.745E-01	8.665E-01	1.299E+03	8.727E-02
2065	2.792E+00	2.236E+03	1.502E-01	7.458E-01	1.118E+03	7.511E-02
2066	2.403E+00	1.924E+03	1.293E-01	6.419E-01	9.622E+02	6.465E-02
2067	2.069E+00	1.656E+03	1.113E-01	5.525E-01	8.282E+02	5.565E-02
2068	1.780E+00	1.426E+03	9.579E-02	4.756E-01	7.128E+02	4.790E-02
2069	1.532E+00	1.227E+03	8.245E-02	4.093E-01	6.135E+02	4.122E-02
2070	1.319E+00	1.056E+03	7.096E-02	3.523E-01	5.281E+02	3.548E-02
2071	1.135E+00	9.090E+02	6.108E-02	3.032E-01	4.545E+02	3.054E-02
2072	9.771E-01	7.824E+02	5.257E-02	2.610E-01	3.912E+02	2.629E-02
2073	8.410E-01	6.734E+02	4.525E-02	2.246E-01	3.367E+02	2.262E-02
2074	7.239E-01	5.796E+02	3.895E-02	1.933E-01	2.898E+02	1.947E-02
2075	6.230E-01	4.989E+02	3.352E-02	1.664E-01	2.494E+02	1.676E-02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	5.362E-01	4.294E+02	2.885E-02	1.432E-01	2.147E+02	1.443E-02
2077	4.616E-01	3.696E+02	2.483E-02	1.233E-01	1.848E+02	1.242E-02
2078	3.973E-01	3.181E+02	2.137E-02	1.061E-01	1.591E+02	1.069E-02
2079	3.419E-01	2.738E+02	1.840E-02	9.133E-02	1.369E+02	9.198E-03
2080	2.943E-01	2.357E+02	1.583E-02	7.861E-02	1.178E+02	7.917E-03
2081	2.533E-01	2.028E+02	1.363E-02	6.766E-02	1.014E+02	6.814E-03
2082	2.180E-01	1.746E+02	1.173E-02	5.824E-02	8.729E+01	5.865E-03
2083	1.877E-01	1.503E+02	1.010E-02	5.012E-02	7.513E+01	5.048E-03
2084	1.615E-01	1.293E+02	8.690E-03	4.314E-02	6.467E+01	4.345E-03
2085	1.390E-01	1.113E+02	7.479E-03	3.713E-02	5.566E+01	3.740E-03
2086	1.197E-01	9.581E+01	6.438E-03	3.196E-02	4.791E+01	3.219E-03
2087	1.030E-01	8.247E+01	5.541E-03	2.751E-02	4.123E+01	2.770E-03
2088	8.864E-02	7.098E+01	4.769E-03	2.368E-02	3.549E+01	2.385E-03
2089	7.629E-02	6.109E+01	4.105E-03	2.038E-02	3.055E+01	2.052E-03
2090	6.567E-02	5.258E+01	3.533E-03	1.754E-02	2.629E+01	1.767E-03
2091	5.652E-02	4.526E+01	3.041E-03	1.510E-02	2.263E+01	1.520E-03
2092	4.865E-02	3.895E+01	2.617E-03	1.299E-02	1.948E+01	1.309E-03
2093	4.187E-02	3.353E+01	2.253E-03	1.118E-02	1.676E+01	1.126E-03
2094	3.604E-02	2.886E+01	1.939E-03	9.626E-03	1.443E+01	9.695E-04
2095	3.102E-02	2.484E+01	1.669E-03	8.285E-03	1.242E+01	8.344E-04
2096	2.670E-02	2.138E+01	1.436E-03	7.131E-03	1.069E+01	7.182E-04
2097	2.298E-02	1.840E+01	1.236E-03	6.138E-03	9.200E+00	6.182E-04
2098	1.978E-02	1.584E+01	1.064E-03	5.283E-03	7.919E+00	5.321E-04
2099	1.702E-02	1.363E+01	9.159E-04	4.547E-03	6.816E+00	4.580E-04
2100	1.465E-02	1.173E+01	7.883E-04	3.914E-03	5.866E+00	3.942E-04
2101	1.261E-02	1.010E+01	6.785E-04	3.369E-03	5.049E+00	3.393E-04
2102	1.085E-02	8.692E+00	5.840E-04	2.899E-03	4.346E+00	2.920E-04
2103	9.343E-03	7.481E+00	5.027E-04	2.496E-03	3.741E+00	2.513E-04
2104	8.041E-03	6.439E+00	4.326E-04	2.148E-03	3.220E+00	2.163E-04
2105	6.921E-03	5.542E+00	3.724E-04	1.849E-03	2.771E+00	1.862E-04
2106	5.957E-03	4.770E+00	3.205E-04	1.591E-03	2.385E+00	1.603E-04
2107	5.127E-03	4.106E+00	2.759E-04	1.370E-03	2.053E+00	1.379E-04
2108	4.413E-03	3.534E+00	2.374E-04	1.179E-03	1.767E+00	1.187E-04
2109	3.798E-03	3.042E+00	2.044E-04	1.015E-03	1.521E+00	1.022E-04
2110	3.269E-03	2.618E+00	1.759E-04	8.733E-04	1.309E+00	8.795E-05
2111	2.814E-03	2.253E+00	1.514E-04	7.516E-04	1.127E+00	7.570E-05
2112	2.422E-03	1.939E+00	1.303E-04	6.469E-04	9.697E-01	6.515E-05
2113	2.085E-03	1.669E+00	1.122E-04	5.568E-04	8.346E-01	5.608E-05
2114	1.794E-03	1.437E+00	9.654E-05	4.793E-04	7.184E-01	4.827E-05
2115	1.544E-03	1.237E+00	8.309E-05	4.125E-04	6.183E-01	4.154E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1975	0	0	0	0	0	0
1976	1.720E+02	9.397E+04	6.314E+00	4.042E-01	1.128E+02	7.577E-03
1977	3.201E+02	1.749E+05	1.175E+01	7.521E-01	2.098E+02	1.410E-02
1978	4.475E+02	2.445E+05	1.643E+01	1.052E+00	2.934E+02	1.971E-02
1979	5.572E+02	3.044E+05	2.045E+01	1.309E+00	3.653E+02	2.454E-02
1980	6.516E+02	3.560E+05	2.392E+01	1.531E+00	4.272E+02	2.870E-02
1981	7.328E+02	4.003E+05	2.690E+01	1.722E+00	4.804E+02	3.228E-02
1982	8.028E+02	4.386E+05	2.947E+01	1.886E+00	5.263E+02	3.536E-02
1983	8.630E+02	4.714E+05	3.168E+01	2.028E+00	5.657E+02	3.801E-02
1984	9.148E+02	4.997E+05	3.358E+01	2.150E+00	5.997E+02	4.029E-02
1985	9.594E+02	5.241E+05	3.521E+01	2.254E+00	6.289E+02	4.226E-02
1986	9.978E+02	5.451E+05	3.662E+01	2.345E+00	6.541E+02	4.395E-02
1987	1.031E+03	5.631E+05	3.784E+01	2.422E+00	6.757E+02	4.540E-02
1988	1.059E+03	5.787E+05	3.888E+01	2.489E+00	6.944E+02	4.666E-02
1989	1.084E+03	5.920E+05	3.978E+01	2.546E+00	7.104E+02	4.773E-02
1990	1.105E+03	6.035E+05	4.055E+01	2.596E+00	7.242E+02	4.866E-02
1991	1.189E+03	6.496E+05	4.365E+01	2.794E+00	7.796E+02	5.238E-02
1992	1.262E+03	6.893E+05	4.632E+01	2.965E+00	8.272E+02	5.558E-02
1993	1.324E+03	7.235E+05	4.861E+01	3.112E+00	8.682E+02	5.833E-02
1994	1.378E+03	7.529E+05	5.059E+01	3.238E+00	9.035E+02	6.070E-02
1995	1.424E+03	7.782E+05	5.229E+01	3.347E+00	9.338E+02	6.274E-02
1996	1.464E+03	8.000E+05	5.375E+01	3.441E+00	9.600E+02	6.450E-02
1997	1.499E+03	8.187E+05	5.501E+01	3.522E+00	9.825E+02	6.601E-02
1998	1.647E+03	8.999E+05	6.047E+01	3.871E+00	1.080E+03	7.256E-02
1999	1.894E+03	1.035E+06	6.954E+01	4.452E+00	1.242E+03	8.344E-02
2000	2.107E+03	1.151E+06	7.734E+01	4.951E+00	1.381E+03	9.281E-02
2001	2.457E+03	1.342E+06	9.019E+01	5.774E+00	1.611E+03	1.082E-01
2002	2.758E+03	1.507E+06	1.012E+02	6.481E+00	1.808E+03	1.215E-01
2003	3.017E+03	1.648E+06	1.108E+02	7.090E+00	1.978E+03	1.329E-01
2004	3.048E+03	1.665E+06	1.119E+02	7.162E+00	1.998E+03	1.342E-01
2005	3.258E+03	1.780E+06	1.196E+02	7.656E+00	2.136E+03	1.435E-01
2006	3.585E+03	1.958E+06	1.316E+02	8.424E+00	2.350E+03	1.579E-01
2007	3.765E+03	2.057E+06	1.382E+02	8.846E+00	2.468E+03	1.658E-01
2008	3.927E+03	2.145E+06	1.441E+02	9.228E+00	2.574E+03	1.730E-01
2009	3.956E+03	2.161E+06	1.452E+02	9.297E+00	2.594E+03	1.743E-01
2010	3.751E+03	2.049E+06	1.377E+02	8.813E+00	2.459E+03	1.652E-01
2011	3.446E+03	1.883E+06	1.265E+02	8.098E+00	2.259E+03	1.518E-01
2012	3.127E+03	1.708E+06	1.148E+02	7.348E+00	2.050E+03	1.377E-01
2013	3.488E+03	1.905E+06	1.280E+02	8.196E+00	2.286E+03	1.536E-01
2014	3.798E+03	2.075E+06	1.394E+02	8.925E+00	2.490E+03	1.673E-01
2015	3.700E+03	2.021E+06	1.358E+02	8.694E+00	2.426E+03	1.630E-01
2016	3.185E+03	1.740E+06	1.169E+02	7.483E+00	2.088E+03	1.403E-01
2017	2.741E+03	1.497E+06	1.006E+02	6.441E+00	1.797E+03	1.207E-01
2018	2.359E+03	1.289E+06	8.660E+01	5.544E+00	1.547E+03	1.039E-01
2019	2.031E+03	1.109E+06	7.453E+01	4.772E+00	1.331E+03	8.944E-02
2020	1.748E+03	9.548E+05	6.415E+01	4.107E+00	1.146E+03	7.698E-02
2021	1.504E+03	8.218E+05	5.522E+01	3.535E+00	9.862E+02	6.626E-02
2022	1.295E+03	7.073E+05	4.753E+01	3.042E+00	8.488E+02	5.703E-02
2023	1.114E+03	6.088E+05	4.091E+01	2.619E+00	7.306E+02	4.909E-02
2024	9.592E+02	5.240E+05	3.521E+01	2.254E+00	6.288E+02	4.225E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m³/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m³/year)*	*(av ft^3/min)*
2025	8.256E+02	4.510E+05	3.030E+01	1.940E+00	5.412E+02	3.636E-02
2026	7.106E+02	3.882E+05	2.608E+01	1.670E+00	4.658E+02	3.130E-02
2027	6.116E+02	3.341E+05	2.245E+01	1.437E+00	4.009E+02	2.694E-02
2028	5.264E+02	2.876E+05	1.932E+01	1.237E+00	3.451E+02	2.319E-02
2029	4.531E+02	2.475E+05	1.663E+01	1.065E+00	2.970E+02	1.996E-02
2030	3.900E+02	2.130E+05	1.431E+01	9.164E-01	2.557E+02	1.718E-02
2031	3.357E+02	1.834E+05	1.232E+01	7.887E-01	2.200E+02	1.478E-02
2032	2.889E+02	1.578E+05	1.060E+01	6.789E-01	1.894E+02	1.273E-02
2033	2.487E+02	1.358E+05	9.127E+00	5.843E-01	1.630E+02	1.095E-02
2034	2.140E+02	1.169E+05	7.856E+00	5.029E-01	1.403E+02	9.427E-03
2035	1.842E+02	1.006E+05	6.762E+00	4.329E-01	1.208E+02	8.114E-03
2036	1.586E+02	8.662E+04	5.820E+00	3.726E-01	1.039E+02	6.984E-03
2037	1.365E+02	7.455E+04	5.009E+00	3.207E-01	8.946E+01	6.011E-03
2038	1.175E+02	6.417E+04	4.311E+00	2.760E-01	7.700E+01	5.174E-03
2039	1.011E+02	5.523E+04	3.711E+00	2.376E-01	6.627E+01	4.453E-03
2040	8.701E+01	4.754E+04	3.194E+00	2.045E-01	5.704E+01	3.833E-03
2041	7.489E+01	4.091E+04	2.749E+00	1.760E-01	4.910E+01	3.299E-03
2042	6.446E+01	3.522E+04	2.366E+00	1.515E-01	4.226E+01	2.839E-03
2043	5.548E+01	3.031E+04	2.037E+00	1.304E-01	3.637E+01	2.444E-03
2044	4.775E+01	2.609E+04	1.753E+00	1.122E-01	3.131E+01	2.103E-03
2045	4.110E+01	2.245E+04	1.509E+00	9.658E-02	2.695E+01	1.810E-03
2046	3.538E+01	1.933E+04	1.299E+00	8.313E-02	2.319E+01	1.558E-03
2047	3.045E+01	1.663E+04	1.118E+00	7.155E-02	1.996E+01	1.341E-03
2048	2.621E+01	1.432E+04	9.620E-01	6.159E-02	1.718E+01	1.154E-03
2049	2.256E+01	1.232E+04	8.280E-01	5.301E-02	1.479E+01	9.936E-04
2050	1.942E+01	1.061E+04	7.127E-01	4.562E-02	1.273E+01	8.552E-04
2051	1.671E+01	9.129E+03	6.134E-01	3.927E-02	1.096E+01	7.361E-04
2052	1.438E+01	7.858E+03	5.280E-01	3.380E-02	9.429E+00	6.335E-04
2053	1.238E+01	6.763E+03	4.544E-01	2.909E-02	8.116E+00	5.453E-04
2054	1.066E+01	5.821E+03	3.911E-01	2.504E-02	6.985E+00	4.693E-04
2055	9.171E+00	5.010E+03	3.366E-01	2.155E-02	6.012E+00	4.040E-04
2056	7.894E+00	4.312E+03	2.897E-01	1.855E-02	5.175E+00	3.477E-04
2057	6.794E+00	3.712E+03	2.494E-01	1.597E-02	4.454E+00	2.993E-04
2058	5.848E+00	3.195E+03	2.147E-01	1.374E-02	3.834E+00	2.576E-04
2059	5.033E+00	2.750E+03	1.848E-01	1.183E-02	3.300E+00	2.217E-04
2060	4.332E+00	2.367E+03	1.590E-01	1.018E-02	2.840E+00	1.908E-04
2061	3.729E+00	2.037E+03	1.369E-01	8.762E-03	2.444E+00	1.642E-04
2062	3.209E+00	1.753E+03	1.178E-01	7.541E-03	2.104E+00	1.414E-04
2063	2.762E+00	1.509E+03	1.014E-01	6.491E-03	1.811E+00	1.217E-04
2064	2.378E+00	1.299E+03	8.727E-02	5.587E-03	1.559E+00	1.047E-04
2065	2.046E+00	1.118E+03	7.511E-02	4.809E-03	1.342E+00	9.014E-05
2066	1.761E+00	9.622E+02	6.465E-02	4.139E-03	1.155E+00	7.758E-05
2067	1.516E+00	8.282E+02	5.565E-02	3.562E-03	9.938E-01	6.678E-05
2068	1.305E+00	7.128E+02	4.790E-02	3.066E-03	8.554E-01	5.747E-05
2069	1.123E+00	6.135E+02	4.122E-02	2.639E-03	7.362E-01	4.947E-05
2070	9.666E-01	5.281E+02	3.548E-02	2.271E-03	6.337E-01	4.258E-05
2071	8.320E-01	4.545E+02	3.054E-02	1.955E-03	5.454E-01	3.665E-05
2072	7.161E-01	3.912E+02	2.629E-02	1.683E-03	4.695E-01	3.154E-05
2073	6.164E-01	3.367E+02	2.262E-02	1.448E-03	4.041E-01	2.715E-05
2074	5.305E-01	2.898E+02	1.947E-02	1.247E-03	3.478E-01	2.337E-05
2075	4.566E-01	2.494E+02	1.676E-02	1.073E-03	2.993E-01	2.011E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2076	3.930E-01	2.147E+02	1.443E-02	9.235E-04	2.576E-01	1.731E-05
2077	3.383E-01	1.848E+02	1.242E-02	7.949E-04	2.218E-01	1.490E-05
2078	2.911E-01	1.591E+02	1.069E-02	6.841E-04	1.909E-01	1.282E-05
2079	2.506E-01	1.369E+02	9.198E-03	5.889E-04	1.643E-01	1.104E-05
2080	2.157E-01	1.178E+02	7.917E-03	5.068E-04	1.414E-01	9.500E-06
2081	1.856E-01	1.014E+02	6.814E-03	4.362E-04	1.217E-01	8.177E-06
2082	1.598E-01	8.729E+01	5.865E-03	3.755E-04	1.047E-01	7.038E-06
2083	1.375E-01	7.513E+01	5.048E-03	3.232E-04	9.016E-02	6.058E-06
2084	1.184E-01	6.467E+01	4.345E-03	2.782E-04	7.760E-02	5.214E-06
2085	1.019E-01	5.566E+01	3.740E-03	2.394E-04	6.679E-02	4.488E-06
2086	8.769E-02	4.791E+01	3.219E-03	2.061E-04	5.749E-02	3.863E-06
2087	7.548E-02	4.123E+01	2.770E-03	1.774E-04	4.948E-02	3.325E-06
2088	6.496E-02	3.549E+01	2.385E-03	1.527E-04	4.259E-02	2.861E-06
2089	5.592E-02	3.055E+01	2.052E-03	1.314E-04	3.666E-02	2.463E-06
2090	4.813E-02	2.629E+01	1.767E-03	1.131E-04	3.155E-02	2.120E-06
2091	4.142E-02	2.263E+01	1.520E-03	9.734E-05	2.716E-02	1.825E-06
2092	3.565E-02	1.948E+01	1.309E-03	8.378E-05	2.337E-02	1.570E-06
2093	3.069E-02	1.676E+01	1.126E-03	7.211E-05	2.012E-02	1.352E-06
2094	2.641E-02	1.443E+01	9.695E-04	6.206E-05	1.731E-02	1.163E-06
2095	2.273E-02	1.242E+01	8.344E-04	5.342E-05	1.490E-02	1.001E-06
2096	1.957E-02	1.069E+01	7.182E-04	4.598E-05	1.283E-02	8.619E-07
2097	1.684E-02	9.200E+00	6.182E-04	3.957E-05	1.104E-02	7.418E-07
2098	1.450E-02	7.919E+00	5.321E-04	3.406E-05	9.503E-03	6.385E-07
2099	1.248E-02	6.816E+00	4.580E-04	2.932E-05	8.179E-03	5.495E-07
2100	1.074E-02	5.866E+00	3.942E-04	2.523E-05	7.040E-03	4.730E-07
2101	9.243E-03	5.049E+00	3.393E-04	2.172E-05	6.059E-03	4.071E-07
2102	7.955E-03	4.346E+00	2.920E-04	1.869E-05	5.215E-03	3.504E-07
2103	6.847E-03	3.741E+00	2.513E-04	1.609E-05	4.489E-03	3.016E-07
2104	5.893E-03	3.220E+00	2.163E-04	1.385E-05	3.863E-03	2.596E-07
2105	5.072E-03	2.771E+00	1.862E-04	1.192E-05	3.325E-03	2.234E-07
2106	4.366E-03	2.385E+00	1.603E-04	1.026E-05	2.862E-03	1.923E-07
2107	3.758E-03	2.053E+00	1.379E-04	8.830E-06	2.463E-03	1.655E-07
2108	3.234E-03	1.767E+00	1.187E-04	7.600E-06	2.120E-03	1.425E-07
2109	2.784E-03	1.521E+00	1.022E-04	6.542E-06	1.825E-03	1.226E-07
2110	2.396E-03	1.309E+00	8.795E-05	5.630E-06	1.571E-03	1.055E-07
2111	2.062E-03	1.127E+00	7.570E-05	4.846E-06	1.352E-03	9.084E-08
2112	1.775E-03	9.697E-01	6.515E-05	4.171E-06	1.164E-03	7.819E-08
2113	1.528E-03	8.346E-01	5.608E-05	3.590E-06	1.002E-03	6.730E-08
2114	1.315E-03	7.184E-01	4.827E-05	3.090E-06	8.621E-04	5.792E-08
2115	1.132E-03	6.183E-01	4.154E-05	2.660E-06	7.420E-04	4.985E-08

Summary Report

Landfill Name or Identifier: Powerstown Landfill Calibrated

Date: 11 November 2011

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,

Q_{CH_4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1975**	
Landfill Closure Year (with 80-year limit)	**2025**	
Actual Closure Year (without limit)	***2025***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.150**	*year* $^{-1}$
Potential Methane Generation Capacity, L_o	**62**	m^3 */Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1975	10,800	11,880	0	0
1976	10,800	11,880	10,800	11,880
1977	10,800	11,880	21,600	23,760
1978	10,800	11,880	32,400	35,640
1979	10,800	11,880	43,200	47,520
1980	10,800	11,880	54,000	59,400
1981	10,800	11,880	64,800	71,280
1982	10,800	11,880	75,600	83,160
1983	10,800	11,880	86,400	95,040
1984	10,800	11,880	97,200	106,920
1985	10,800	11,880	108,000	118,800
1986	10,800	11,880	118,800	130,680
1987	10,800	11,880	129,600	142,560
1988	10,800	11,880	140,400	154,440
1989	10,800	11,880	151,200	166,320
1990	14,961	16,457	162,000	178,200
1991	14,961	16,457	176,961	194,657
1992	14,961	16,457	191,922	211,114
1993	14,961	16,457	206,883	227,571
1994	14,961	16,457	221,844	244,028
1995	14,961	16,457	236,805	260,486
1996	14,961	16,457	251,766	276,943
1997	22,441	24,685	266,727	293,400
1998	29,922	32,914	289,168	318,085
1999	29,922	32,914	319,090	350,999
2000	40,394	44,433	349,012	383,913
2001	40,394	44,433	389,406	428,347
2002	40,394	44,433	429,800	472,780
2003	28,307	31,138	470,194	517,213
2004	39,853	43,838	498,501	548,351
2005	49,010	53,911	538,354	592,189
2006	42,638	46,902	587,364	646,100
2007	43,130	47,443	630,002	693,002
2008	36,177	39,795	673,132	740,445
2009	21,684	23,852	709,309	780,240
2010	13,697	15,067	730,993	804,092
2011	10,088	11,097	744,690	819,159
2012	10,000	11,000	754,778	830,256
2013	10,000	11,000	764,778	841,256
2014	10,000	11,000	774,778	852,256

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2015	10,000	11,000	784,778	863,256
2016	10,000	11,000	794,778	874,256
2017	10,000	11,000	804,778	885,256
2018	10,000	11,000	814,778	896,256
2019	10,000	11,000	824,778	907,256
2020	10,000	11,000	834,778	918,256
2021	10,000	11,000	844,778	929,256
2022	10,000	11,000	854,778	940,256
2023	10,000	11,000	864,778	951,256
2024	7,043	7,747	874,778	962,256
2025	0	0	881,821	970,003
2026	0	0	881,821	970,003
2027	0	0	881,821	970,003
2028	0	0	881,821	970,003
2029	0	0	881,821	970,003
2030	0	0	881,821	970,003
2031	0	0	881,821	970,003
2032	0	0	881,821	970,003
2033	0	0	881,821	970,003
2034	0	0	881,821	970,003
2035	0	0	881,821	970,003
2036	0	0	881,821	970,003
2037	0	0	881,821	970,003
2038	0	0	881,821	970,003
2039	0	0	881,821	970,003
2040	0	0	881,821	970,003
2041	0	0	881,821	970,003
2042	0	0	881,821	970,003
2043	0	0	881,821	970,003
2044	0	0	881,821	970,003
2045	0	0	881,821	970,003
2046	0	0	881,821	970,003
2047	0	0	881,821	970,003
2048	0	0	881,821	970,003
2049	0	0	881,821	970,003
2050	0	0	881,821	970,003
2051	0	0	881,821	970,003
2052	0	0	881,821	970,003
2053	0	0	881,821	970,003
2054	0	0	881,821	970,003

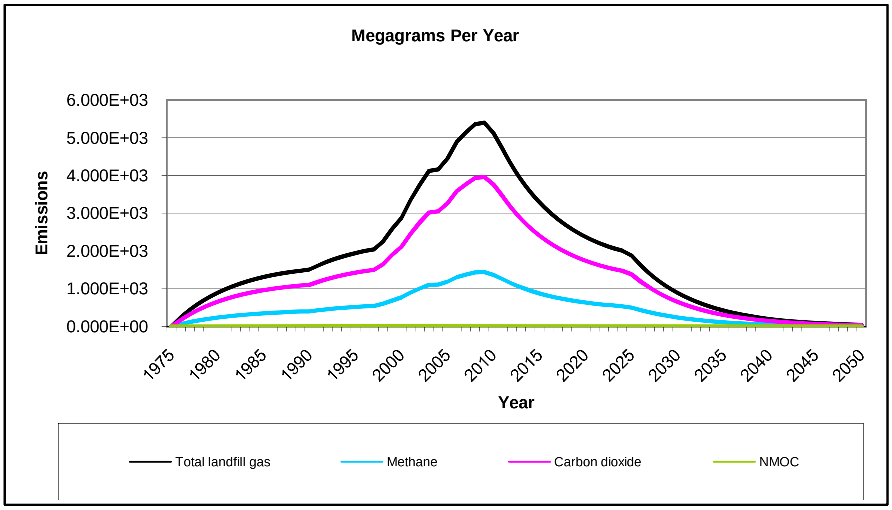
Pollutant Parameters

	Compound	Gas / Pollutant Default Parameters: Concentration (*ppmv*)	Molecular Weight	User-specified Pollutant Parameters: Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
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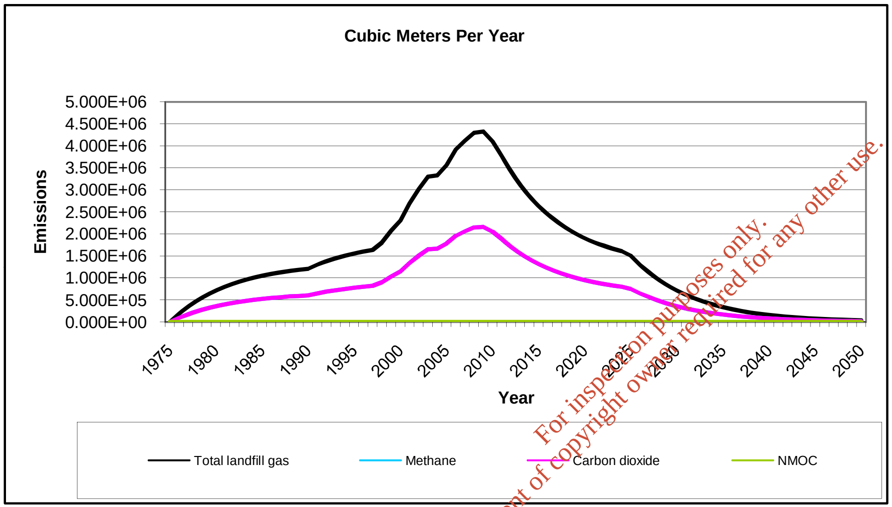
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
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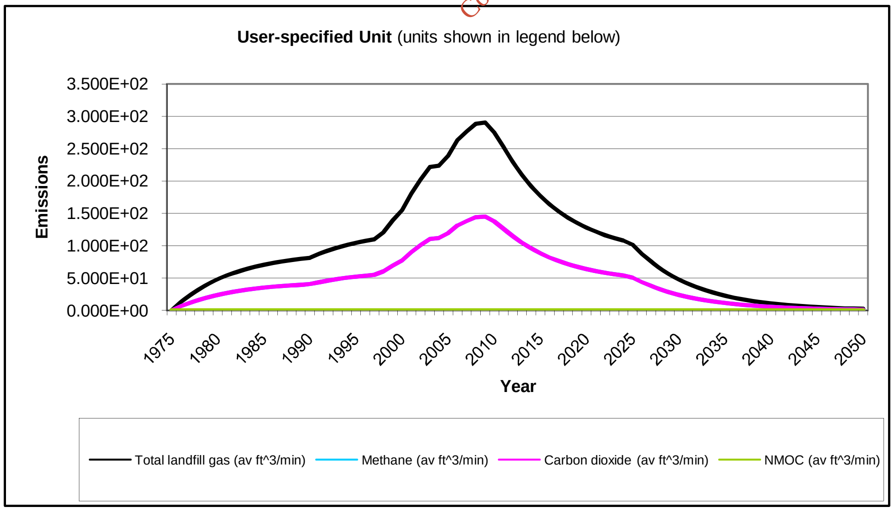
4.500E+06
4.000E+06
3.500E+06
3.000E+06
2.500E+06
2.000E+06
1.500E+06
1.000E+06
5.000E+05
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
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3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
Emissions
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas (Mg/year)	Total landfill gas (m^3/year)	Total landfill gas (av ft^3/min)	Methane (Mg/year)	Methane (m^3/year)	Methane (av ft^3/min)
1975	0	0	0	0	0	0
1976	2.347E+02	1.879E+05	1.263E+01	6.269E+01	9.397E+04	6.314E+00
1977	4.367E+02	3.497E+05	2.350E+01	1.167E+02	1.749E+05	1.175E+01
1978	6.106E+02	4.889E+05	3.285E+01	1.631E+02	2.445E+05	1.643E+01
1979	7.603E+02	6.088E+05	4.090E+01	2.031E+02	3.044E+05	2.045E+01
1980	8.891E+02	7.119E+05	4.783E+01	2.375E+02	3.560E+05	2.392E+01
1981	9.999E+02	8.007E+05	5.380E+01	2.671E+02	4.003E+05	2.690E+01
1982	1.095E+03	8.771E+05	5.893E+01	2.926E+02	4.386E+05	2.947E+01
1983	1.177E+03	9.429E+05	6.335E+01	3.145E+02	4.714E+05	3.168E+01
1984	1.248E+03	9.995E+05	6.716E+01	3.334E+02	4.997E+05	3.358E+01
1985	1.309E+03	1.048E+06	7.043E+01	3.497E+02	5.241E+05	3.521E+01
1986	1.361E+03	1.090E+06	7.325E+01	3.636E+02	5.451E+05	3.662E+01
1987	1.406E+03	1.126E+06	7.567E+01	3.757E+02	5.631E+05	3.784E+01
1988	1.445E+03	1.157E+06	7.776E+01	3.860E+02	5.787E+05	3.888E+01
1989	1.479E+03	1.184E+06	7.956E+01	3.950E+02	5.920E+05	3.978E+01
1990	1.507E+03	1.207E+06	8.110E+01	4.026E+02	6.035E+05	4.055E+01
1991	1.623E+03	1.299E+06	8.730E+01	4.334E+02	6.496E+05	4.365E+01
1992	1.722E+03	1.379E+06	9.263E+01	4.599E+02	6.893E+05	4.632E+01
1993	1.807E+03	1.447E+06	9.722E+01	4.827E+02	7.235E+05	4.861E+01
1994	1.880E+03	1.506E+06	1.012E+02	5.023E+02	7.529E+05	5.059E+01
1995	1.944E+03	1.556E+06	1.046E+02	5.192E+02	7.782E+05	5.229E+01
1996	1.998E+03	1.600E+06	1.075E+02	5.337E+02	8.000E+05	5.375E+01
1997	2.045E+03	1.637E+06	1.100E+02	5.462E+02	8.187E+05	5.501E+01
1998	2.248E+03	1.800E+06	1.209E+02	6.004E+02	8.999E+05	6.047E+01
1999	2.585E+03	2.070E+06	1.391E+02	6.905E+02	1.035E+06	6.954E+01
2000	2.875E+03	2.302E+06	1.547E+02	7.680E+02	1.151E+06	7.734E+01
2001	3.352E+03	2.685E+06	1.804E+02	8.955E+02	1.342E+06	9.019E+01
2002	3.763E+03	3.014E+06	2.025E+02	1.005E+03	1.507E+06	1.012E+02
2003	4.117E+03	3.297E+06	2.215E+02	1.100E+03	1.648E+06	1.108E+02
2004	4.159E+03	3.330E+06	2.237E+02	1.111E+03	1.665E+06	1.119E+02
2005	4.446E+03	3.560E+06	2.392E+02	1.187E+03	1.780E+06	1.196E+02
2006	4.891E+03	3.917E+06	2.632E+02	1.307E+03	1.958E+06	1.316E+02
2007	5.137E+03	4.113E+06	2.764E+02	1.372E+03	2.057E+06	1.382E+02
2008	5.358E+03	4.291E+06	2.883E+02	1.431E+03	2.145E+06	1.441E+02
2009	5.398E+03	4.323E+06	2.904E+02	1.442E+03	2.161E+06	1.452E+02
2010	5.118E+03	4.098E+06	2.753E+02	1.367E+03	2.049E+06	1.377E+02
2011	4.702E+03	3.765E+06	2.530E+02	1.256E+03	1.883E+06	1.265E+02
2012	4.267E+03	3.417E+06	2.296E+02	1.140E+03	1.708E+06	1.148E+02
2013	3.890E+03	3.115E+06	2.093E+02	1.039E+03	1.557E+06	1.046E+02
2014	3.565E+03	2.855E+06	1.918E+02	9.523E+02	1.427E+06	9.591E+01
2015	3.286E+03	2.631E+06	1.768E+02	8.777E+02	1.316E+06	8.839E+01
2016	3.046E+03	2.439E+06	1.639E+02	8.135E+02	1.219E+06	8.193E+01
2017	2.839E+03	2.273E+06	1.527E+02	7.582E+02	1.137E+06	7.636E+01
2018	2.661E+03	2.130E+06	1.431E+02	7.107E+02	1.065E+06	7.157E+01
2019	2.507E+03	2.008E+06	1.349E+02	6.697E+02	1.004E+06	6.745E+01
2020	2.375E+03	1.902E+06	1.278E+02	6.345E+02	9.510E+05	6.390E+01
2021	2.262E+03	1.811E+06	1.217E+02	6.042E+02	9.056E+05	6.085E+01
2022	2.164E+03	1.733E+06	1.164E+02	5.780E+02	8.664E+05	5.822E+01
2023	2.080E+03	1.666E+06	1.119E+02	5.556E+02	8.328E+05	5.595E+01
2024	2.008E+03	1.608E+06	1.080E+02	5.362E+02	8.038E+05	5.401E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2025	1.881E+03	1.506E+06	1.012E+02	5.024E+02	7.531E+05	5.060E+01
2026	1.619E+03	1.296E+06	8.710E+01	4.324E+02	6.482E+05	4.355E+01
2027	1.393E+03	1.116E+06	7.497E+01	3.722E+02	5.579E+05	3.749E+01
2028	1.199E+03	9.604E+05	6.453E+01	3.204E+02	4.802E+05	3.226E+01
2029	1.032E+03	8.266E+05	5.554E+01	2.757E+02	4.133E+05	2.777E+01
2030	8.885E+02	7.115E+05	4.780E+01	2.373E+02	3.557E+05	2.390E+01
2031	7.647E+02	6.124E+05	4.115E+01	2.043E+02	3.062E+05	2.057E+01
2032	6.582E+02	5.271E+05	3.541E+01	1.758E+02	2.635E+05	1.771E+01
2033	5.665E+02	4.537E+05	3.048E+01	1.513E+02	2.268E+05	1.524E+01
2034	4.876E+02	3.905E+05	2.624E+01	1.303E+02	1.952E+05	1.312E+01
2035	4.197E+02	3.361E+05	2.258E+01	1.121E+02	1.680E+05	1.129E+01
2036	3.612E+02	2.893E+05	1.944E+01	9.649E+01	1.446E+05	9.718E+00
2037	3.109E+02	2.490E+05	1.673E+01	8.305E+01	1.245E+05	8.364E+00
2038	2.676E+02	2.143E+05	1.440E+01	7.148E+01	1.071E+05	7.199E+00
2039	2.303E+02	1.844E+05	1.239E+01	6.153E+01	9.222E+04	6.196E+00
2040	1.983E+02	1.588E+05	1.067E+01	5.296E+01	7.938E+04	5.333E+00
2041	1.706E+02	1.366E+05	9.181E+00	4.558E+01	6.832E+04	4.590E+00
2042	1.469E+02	1.176E+05	7.902E+00	3.923E+01	5.880E+04	3.951E+00
2043	1.264E+02	1.012E+05	6.801E+00	3.377E+01	5.061E+04	3.401E+00
2044	1.088E+02	8.713E+04	5.854E+00	2.906E+01	4.356E+04	2.927E+00
2045	9.365E+01	7.499E+04	5.039E+00	2.501E+01	3.749E+04	2.519E+00
2046	8.060E+01	6.454E+04	4.337E+00	2.153E+01	3.227E+04	2.168E+00
2047	6.938E+01	5.555E+04	3.733E+00	1.853E+01	2.778E+04	1.866E+00
2048	5.971E+01	4.782E+04	3.213E+00	1.595E+01	2.391E+04	1.606E+00
2049	5.140E+01	4.116E+04	2.765E+00	1.373E+01	2.058E+04	1.383E+00
2050	4.424E+01	3.542E+04	2.380E+00	1.182E+01	1.771E+04	1.190E+00
2051	3.807E+01	3.049E+04	2.049E+00	1.017E+01	1.524E+04	1.024E+00
2052	3.277E+01	2.624E+04	1.763E+00	8.754E+00	1.312E+04	8.816E-01
2053	2.821E+01	2.259E+04	1.518E+00	7.534E+00	1.129E+04	7.588E-01
2054	2.428E+01	1.944E+04	1.306E+00	6.485E+00	9.720E+03	6.531E-01
2055	2.090E+01	1.673E+04	1.124E+00	5.581E+00	8.366E+03	5.621E-01
2056	1.799E+01	1.440E+04	9.676E-01	4.804E+00	7.201E+03	4.838E-01
2057	1.548E+01	1.240E+04	8.329E-01	4.135E+00	6.198E+03	4.164E-01
2058	1.332E+01	1.067E+04	7.169E-01	3.559E+00	5.335E+03	3.584E-01
2059	1.147E+01	9.183E+03	6.170E-01	3.063E+00	4.591E+03	3.085E-01
2060	9.870E+00	7.904E+03	5.311E-01	2.637E+00	3.952E+03	2.655E-01
2061	8.496E+00	6.803E+03	4.571E-01	2.269E+00	3.401E+03	2.285E-01
2062	7.312E+00	5.855E+03	3.934E-01	1.953E+00	2.928E+03	1.967E-01
2063	6.294E+00	5.040E+03	3.386E-01	1.681E+00	2.520E+03	1.693E-01
2064	5.417E+00	4.338E+03	2.915E-01	1.447E+00	2.169E+03	1.457E-01
2065	4.662E+00	3.734E+03	2.509E-01	1.245E+00	1.867E+03	1.254E-01
2066	4.013E+00	3.213E+03	2.159E-01	1.072E+00	1.607E+03	1.080E-01
2067	3.454E+00	2.766E+03	1.858E-01	9.226E-01	1.383E+03	9.292E-02
2068	2.973E+00	2.381E+03	1.600E-01	7.941E-01	1.190E+03	7.998E-02
2069	2.559E+00	2.049E+03	1.377E-01	6.835E-01	1.024E+03	6.884E-02
2070	2.202E+00	1.764E+03	1.185E-01	5.883E-01	8.818E+02	5.925E-02
2071	1.896E+00	1.518E+03	1.020E-01	5.063E-01	7.590E+02	5.099E-02
2072	1.632E+00	1.306E+03	8.778E-02	4.358E-01	6.532E+02	4.389E-02
2073	1.404E+00	1.125E+03	7.556E-02	3.751E-01	5.623E+02	3.778E-02
2074	1.209E+00	9.679E+02	6.503E-02	3.229E-01	4.839E+02	3.252E-02
2075	1.040E+00	8.331E+02	5.597E-02	2.779E-01	4.165E+02	2.799E-02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	8.954E-01	7.170E+02	4.818E-02	2.392E-01	3.585E+02	2.409E-02
2077	7.707E-01	6.171E+02	4.147E-02	2.059E-01	3.086E+02	2.073E-02
2078	6.634E-01	5.312E+02	3.569E-02	1.772E-01	2.656E+02	1.784E-02
2079	5.710E-01	4.572E+02	3.072E-02	1.525E-01	2.286E+02	1.536E-02
2080	4.914E-01	3.935E+02	2.644E-02	1.313E-01	1.968E+02	1.322E-02
2081	4.230E-01	3.387E+02	2.276E-02	1.130E-01	1.693E+02	1.138E-02
2082	3.641E-01	2.915E+02	1.959E-02	9.724E-02	1.458E+02	9.794E-03
2083	3.133E-01	2.509E+02	1.686E-02	8.370E-02	1.255E+02	8.429E-03
2084	2.697E-01	2.160E+02	1.451E-02	7.204E-02	1.080E+02	7.255E-03
2085	2.321E-01	1.859E+02	1.249E-02	6.200E-02	9.294E+01	6.245E-03
2086	1.998E-01	1.600E+02	1.075E-02	5.337E-02	7.999E+01	5.375E-03
2087	1.720E-01	1.377E+02	9.252E-03	4.593E-02	6.885E+01	4.626E-03
2088	1.480E-01	1.185E+02	7.964E-03	3.954E-02	5.926E+01	3.982E-03
2089	1.274E-01	1.020E+02	6.854E-03	3.403E-02	5.101E+01	3.427E-03
2090	1.097E-01	8.780E+01	5.900E-03	2.929E-02	4.390E+01	2.950E-03
2091	9.438E-02	7.557E+01	5.078E-03	2.521E-02	3.779E+01	2.539E-03
2092	8.123E-02	6.505E+01	4.370E-03	2.170E-02	3.252E+01	2.185E-03
2093	6.992E-02	5.599E+01	3.762E-03	1.868E-02	2.799E+01	1.881E-03
2094	6.018E-02	4.819E+01	3.238E-03	1.607E-02	2.409E+01	1.619E-03
2095	5.180E-02	4.148E+01	2.787E-03	1.384E-02	2.074E+01	1.393E-03
2096	4.458E-02	3.570E+01	2.399E-03	1.191E-02	1.785E+01	1.199E-03
2097	3.837E-02	3.073E+01	2.064E-03	1.025E-02	1.536E+01	1.032E-03
2098	3.303E-02	2.645E+01	1.777E-03	8.822E-03	1.322E+01	8.884E-04
2099	2.843E-02	2.276E+01	1.529E-03	7.593E-03	1.138E+01	7.647E-04
2100	2.447E-02	1.959E+01	1.316E-03	6.535E-03	9.796E+00	6.582E-04
2101	2.106E-02	1.686E+01	1.133E-03	5.625E-03	8.431E+00	5.665E-04
2102	1.813E-02	1.451E+01	9.752E-04	4.841E-03	7.257E+00	4.876E-04
2103	1.560E-02	1.249E+01	8.393E-04	4.167E-03	6.246E+00	4.197E-04
2104	1.343E-02	1.075E+01	7.224E-04	3.587E-03	5.376E+00	3.612E-04
2105	1.156E-02	9.254E+00	6.218E-04	3.087E-03	4.627E+00	3.109E-04
2106	9.947E-03	7.965E+00	5.352E-04	2.657E-03	3.983E+00	2.676E-04
2107	8.562E-03	6.856E+00	4.606E-04	2.287E-03	3.428E+00	2.303E-04
2108	7.369E-03	5.901E+00	3.965E-04	1.968E-03	2.950E+00	1.982E-04
2109	6.343E-03	5.079E+00	3.413E-04	1.694E-03	2.539E+00	1.706E-04
2110	5.459E-03	4.371E+00	2.937E-04	1.458E-03	2.186E+00	1.469E-04
2111	4.699E-03	3.763E+00	2.528E-04	1.255E-03	1.881E+00	1.264E-04
2112	4.044E-03	3.238E+00	2.176E-04	1.080E-03	1.619E+00	1.088E-04
2113	3.481E-03	2.787E+00	1.873E-04	9.298E-04	1.394E+00	9.364E-05
2114	2.996E-03	2.399E+00	1.612E-04	8.003E-04	1.200E+00	8.060E-05
2115	2.579E-03	2.065E+00	1.387E-04	6.888E-04	1.032E+00	6.937E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1975	0	0	0	0	0	0
1976	1.720E+02	9.397E+04	6.314E+00	4.042E-01	1.128E+02	7.577E-03
1977	3.201E+02	1.749E+05	1.175E+01	7.521E-01	2.098E+02	1.410E-02
1978	4.475E+02	2.445E+05	1.643E+01	1.052E+00	2.934E+02	1.971E-02
1979	5.572E+02	3.044E+05	2.045E+01	1.309E+00	3.653E+02	2.454E-02
1980	6.516E+02	3.560E+05	2.392E+01	1.531E+00	4.272E+02	2.870E-02
1981	7.328E+02	4.003E+05	2.690E+01	1.722E+00	4.804E+02	3.228E-02
1982	8.028E+02	4.386E+05	2.947E+01	1.886E+00	5.263E+02	3.536E-02
1983	8.630E+02	4.714E+05	3.168E+01	2.028E+00	5.657E+02	3.801E-02
1984	9.148E+02	4.997E+05	3.358E+01	2.150E+00	5.997E+02	4.029E-02
1985	9.594E+02	5.241E+05	3.521E+01	2.254E+00	6.289E+02	4.226E-02
1986	9.978E+02	5.451E+05	3.662E+01	2.345E+00	6.541E+02	4.395E-02
1987	1.031E+03	5.631E+05	3.784E+01	2.422E+00	6.757E+02	4.540E-02
1988	1.059E+03	5.787E+05	3.888E+01	2.489E+00	6.944E+02	4.666E-02
1989	1.084E+03	5.920E+05	3.978E+01	2.546E+00	7.104E+02	4.773E-02
1990	1.105E+03	6.035E+05	4.055E+01	2.596E+00	7.242E+02	4.866E-02
1991	1.189E+03	6.496E+05	4.365E+01	2.794E+00	7.796E+02	5.238E-02
1992	1.262E+03	6.893E+05	4.632E+01	2.965E+00	8.272E+02	5.558E-02
1993	1.324E+03	7.235E+05	4.861E+01	3.112E+00	8.682E+02	5.833E-02
1994	1.378E+03	7.529E+05	5.059E+01	3.238E+00	9.035E+02	6.070E-02
1995	1.424E+03	7.782E+05	5.229E+01	3.347E+00	9.338E+02	6.274E-02
1996	1.464E+03	8.000E+05	5.375E+01	3.441E+00	9.600E+02	6.450E-02
1997	1.499E+03	8.187E+05	5.501E+01	3.522E+00	9.825E+02	6.601E-02
1998	1.647E+03	8.999E+05	6.047E+01	3.871E+00	1.080E+03	7.256E-02
1999	1.894E+03	1.035E+06	6.954E+01	4.452E+00	1.242E+03	8.344E-02
2000	2.107E+03	1.151E+06	7.734E+01	4.951E+00	1.381E+03	9.281E-02
2001	2.457E+03	1.342E+06	9.019E+01	5.774E+00	1.611E+03	1.082E-01
2002	2.758E+03	1.507E+06	1.012E+02	6.481E+00	1.808E+03	1.215E-01
2003	3.017E+03	1.648E+06	1.108E+02	7.090E+00	1.978E+03	1.329E-01
2004	3.048E+03	1.665E+06	1.119E+02	7.162E+00	1.998E+03	1.342E-01
2005	3.258E+03	1.780E+06	1.196E+02	7.656E+00	2.136E+03	1.435E-01
2006	3.585E+03	1.958E+06	1.316E+02	8.424E+00	2.350E+03	1.579E-01
2007	3.765E+03	2.057E+06	1.382E+02	8.846E+00	2.468E+03	1.658E-01
2008	3.927E+03	2.145E+06	1.441E+02	9.228E+00	2.574E+03	1.730E-01
2009	3.956E+03	2.161E+06	1.452E+02	9.297E+00	2.594E+03	1.743E-01
2010	3.751E+03	2.049E+06	1.377E+02	8.813E+00	2.459E+03	1.652E-01
2011	3.446E+03	1.883E+06	1.265E+02	8.098E+00	2.259E+03	1.518E-01
2012	3.127E+03	1.708E+06	1.148E+02	7.348E+00	2.050E+03	1.377E-01
2013	2.851E+03	1.557E+06	1.046E+02	6.699E+00	1.869E+03	1.256E-01
2014	2.613E+03	1.427E+06	9.591E+01	6.140E+00	1.713E+03	1.151E-01
2015	2.408E+03	1.316E+06	8.839E+01	5.659E+00	1.579E+03	1.061E-01
2016	2.232E+03	1.219E+06	8.193E+01	5.245E+00	1.463E+03	9.831E-02
2017	2.080E+03	1.137E+06	7.636E+01	4.889E+00	1.364E+03	9.164E-02
2018	1.950E+03	1.065E+06	7.157E+01	4.582E+00	1.278E+03	8.589E-02
2019	1.838E+03	1.004E+06	6.745E+01	4.318E+00	1.205E+03	8.094E-02
2020	1.741E+03	9.510E+05	6.390E+01	4.091E+00	1.141E+03	7.668E-02
2021	1.658E+03	9.056E+05	6.085E+01	3.895E+00	1.087E+03	7.301E-02
2022	1.586E+03	8.664E+05	5.822E+01	3.727E+00	1.040E+03	6.986E-02
2023	1.524E+03	8.328E+05	5.595E+01	3.582E+00	9.993E+02	6.714E-02
2024	1.471E+03	8.038E+05	5.401E+01	3.457E+00	9.645E+02	6.481E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m³/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m³/year)*	*(av ft^3/min)*
2025	1.379E+03	7.531E+05	5.060E+01	3.239E+00	9.037E+02	6.072E-02
2026	1.187E+03	6.482E+05	4.355E+01	2.788E+00	7.778E+02	5.226E-02
2027	1.021E+03	5.579E+05	3.749E+01	2.400E+00	6.695E+02	4.498E-02
2028	8.790E+02	4.802E+05	3.226E+01	2.066E+00	5.762E+02	3.872E-02
2029	7.566E+02	4.133E+05	2.777E+01	1.778E+00	4.960E+02	3.332E-02
2030	6.512E+02	3.557E+05	2.390E+01	1.530E+00	4.269E+02	2.868E-02
2031	5.605E+02	3.062E+05	2.057E+01	1.317E+00	3.674E+02	2.469E-02
2032	4.824E+02	2.635E+05	1.771E+01	1.134E+00	3.162E+02	2.125E-02
2033	4.152E+02	2.268E+05	1.524E+01	9.757E-01	2.722E+02	1.829E-02
2034	3.574E+02	1.952E+05	1.312E+01	8.398E-01	2.343E+02	1.574E-02
2035	3.076E+02	1.680E+05	1.129E+01	7.228E-01	2.016E+02	1.355E-02
2036	2.648E+02	1.446E+05	9.718E+00	6.221E-01	1.736E+02	1.166E-02
2037	2.279E+02	1.245E+05	8.364E+00	5.355E-01	1.494E+02	1.004E-02
2038	1.961E+02	1.071E+05	7.199E+00	4.609E-01	1.286E+02	8.639E-03
2039	1.688E+02	9.222E+04	6.196E+00	3.967E-01	1.107E+02	7.436E-03
2040	1.453E+02	7.938E+04	5.333E+00	3.414E-01	9.525E+01	6.400E-03
2041	1.251E+02	6.832E+04	4.590E+00	2.939E-01	8.198E+01	5.508E-03
2042	1.076E+02	5.880E+04	3.951E+00	2.529E-01	7.056E+01	4.741E-03
2043	9.265E+01	5.061E+04	3.401E+00	2.177E-01	6.074E+01	4.081E-03
2044	7.974E+01	4.356E+04	2.927E+00	1.874E-01	5.228E+01	3.512E-03
2045	6.863E+01	3.749E+04	2.519E+00	1.613E-01	4.499E+01	3.023E-03
2046	5.907E+01	3.227E+04	2.168E+00	1.388E-01	3.873E+01	2.602E-03
2047	5.085E+01	2.778E+04	1.866E+00	1.195E-01	3.333E+01	2.240E-03
2048	4.376E+01	2.391E+04	1.606E+00	1.028E-01	2.869E+01	1.928E-03
2049	3.767E+01	2.058E+04	1.383E+00	8.851E-02	2.469E+01	1.659E-03
2050	3.242E+01	1.771E+04	1.190E+00	7.618E-02	2.125E+01	1.428E-03
2051	2.790E+01	1.524E+04	1.024E+00	6.557E-02	1.829E+01	1.229E-03
2052	2.402E+01	1.312E+04	8.816E-01	5.644E-02	1.574E+01	1.058E-03
2053	2.067E+01	1.129E+04	7.588E-01	4.858E-02	1.355E+01	9.105E-04
2054	1.779E+01	9.720E+03	6.531E-01	4.181E-02	1.166E+01	7.837E-04
2055	1.531E+01	8.366E+03	5.621E-01	3.599E-02	1.004E+01	6.745E-04
2056	1.318E+01	7.201E+03	4.838E-01	3.097E-02	8.641E+00	5.806E-04
2057	1.135E+01	6.198E+03	4.164E-01	2.666E-02	7.437E+00	4.997E-04
2058	9.765E+00	5.335E+03	3.584E-01	2.295E-02	6.401E+00	4.301E-04
2059	8.405E+00	4.591E+03	3.085E-01	1.975E-02	5.510E+00	3.702E-04
2060	7.234E+00	3.952E+03	2.655E-01	1.700E-02	4.742E+00	3.186E-04
2061	6.226E+00	3.401E+03	2.285E-01	1.463E-02	4.082E+00	2.743E-04
2062	5.359E+00	2.928E+03	1.967E-01	1.259E-02	3.513E+00	2.360E-04
2063	4.613E+00	2.520E+03	1.693E-01	1.084E-02	3.024E+00	2.032E-04
2064	3.970E+00	2.169E+03	1.457E-01	9.329E-03	2.603E+00	1.749E-04
2065	3.417E+00	1.867E+03	1.254E-01	8.030E-03	2.240E+00	1.505E-04
2066	2.941E+00	1.607E+03	1.080E-01	6.911E-03	1.928E+00	1.295E-04
2067	2.531E+00	1.383E+03	9.292E-02	5.948E-03	1.660E+00	1.115E-04
2068	2.179E+00	1.190E+03	7.998E-02	5.120E-03	1.428E+00	9.597E-05
2069	1.875E+00	1.024E+03	6.884E-02	4.407E-03	1.229E+00	8.260E-05
2070	1.614E+00	8.818E+02	5.925E-02	3.793E-03	1.058E+00	7.110E-05
2071	1.389E+00	7.590E+02	5.099E-02	3.265E-03	9.108E-01	6.119E-05
2072	1.196E+00	6.532E+02	4.389E-02	2.810E-03	7.839E-01	5.267E-05
2073	1.029E+00	5.623E+02	3.778E-02	2.418E-03	6.747E-01	4.533E-05
2074	8.858E-01	4.839E+02	3.252E-02	2.082E-03	5.807E-01	3.902E-05
2075	7.625E-01	4.165E+02	2.799E-02	1.792E-03	4.998E-01	3.358E-05

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2076	6.563E-01	3.585E+02	2.409E-02	1.542E-03	4.302E-01	2.891E-05
2077	5.648E-01	3.086E+02	2.073E-02	1.327E-03	3.703E-01	2.488E-05
2078	4.862E-01	2.656E+02	1.784E-02	1.142E-03	3.187E-01	2.141E-05
2079	4.184E-01	2.286E+02	1.536E-02	9.833E-04	2.743E-01	1.843E-05
2080	3.602E-01	1.968E+02	1.322E-02	8.463E-04	2.361E-01	1.586E-05
2081	3.100E-01	1.693E+02	1.138E-02	7.284E-04	2.032E-01	1.365E-05
2082	2.668E-01	1.458E+02	9.794E-03	6.270E-04	1.749E-01	1.175E-05
2083	2.296E-01	1.255E+02	8.429E-03	5.396E-04	1.505E-01	1.012E-05
2084	1.977E-01	1.080E+02	7.255E-03	4.645E-04	1.296E-01	8.706E-06
2085	1.701E-01	9.294E+01	6.245E-03	3.998E-04	1.115E-01	7.494E-06
2086	1.464E-01	7.999E+01	5.375E-03	3.441E-04	9.599E-02	6.450E-06
2087	1.260E-01	6.885E+01	4.626E-03	2.962E-04	8.262E-02	5.551E-06
2088	1.085E-01	5.926E+01	3.982E-03	2.549E-04	7.111E-02	4.778E-06
2089	9.337E-02	5.101E+01	3.427E-03	2.194E-04	6.121E-02	4.113E-06
2090	8.036E-02	4.390E+01	2.950E-03	1.888E-04	5.268E-02	3.540E-06
2091	6.917E-02	3.779E+01	2.539E-03	1.625E-04	4.534E-02	3.047E-06
2092	5.953E-02	3.252E+01	2.185E-03	1.399E-04	3.903E-02	2.622E-06
2093	5.124E-02	2.799E+01	1.881E-03	1.204E-04	3.359E-02	2.257E-06
2094	4.410E-02	2.409E+01	1.619E-03	1.036E-04	2.891E-02	1.943E-06
2095	3.796E-02	2.074E+01	1.393E-03	8.920E-05	2.489E-02	1.672E-06
2096	3.267E-02	1.785E+01	1.199E-03	7.678E-05	2.142E-02	1.439E-06
2097	2.812E-02	1.536E+01	1.032E-03	6.608E-05	1.844E-02	1.239E-06
2098	2.420E-02	1.322E+01	8.884E-04	5.688E-05	1.587E-02	1.066E-06
2099	2.083E-02	1.138E+01	7.647E-04	4.895E-05	1.366E-02	9.176E-07
2100	1.793E-02	9.796E+00	6.582E-04	4.214E-05	1.175E-02	7.898E-07
2101	1.543E-02	8.431E+00	5.665E-04	3.627E-05	1.012E-02	6.798E-07
2102	1.328E-02	7.257E+00	4.876E-04	3.121E-05	8.708E-03	5.851E-07
2103	1.143E-02	6.246E+00	4.197E-04	2.687E-05	7.495E-03	5.036E-07
2104	9.841E-03	5.376E+00	3.612E-04	2.312E-05	6.451E-03	4.335E-07
2105	8.470E-03	4.627E+00	3.109E-04	1.990E-05	5.553E-03	3.731E-07
2106	7.290E-03	3.983E+00	2.676E-04	1.713E-05	4.779E-03	3.211E-07
2107	6.275E-03	3.428E+00	2.303E-04	1.474E-05	4.114E-03	2.764E-07
2108	5.401E-03	2.950E+00	1.982E-04	1.269E-05	3.541E-03	2.379E-07
2109	4.648E-03	2.539E+00	1.706E-04	1.092E-05	3.047E-03	2.048E-07
2110	4.001E-03	2.186E+00	1.469E-04	9.402E-06	2.623E-03	1.762E-07
2111	3.444E-03	1.881E+00	1.264E-04	8.092E-06	2.258E-03	1.517E-07
2112	2.964E-03	1.619E+00	1.088E-04	6.965E-06	1.943E-03	1.306E-07
2113	2.551E-03	1.394E+00	9.364E-05	5.995E-06	1.672E-03	1.124E-07
2114	2.196E-03	1.200E+00	8.060E-05	5.160E-06	1.439E-03	9.672E-08
2115	1.890E-03	1.032E+00	6.937E-05	4.441E-06	1.239E-03	8.325E-08

Appendix 6

Air Monitoring Results

Table 1 Traffic Inputs Used in DMRB Model

2010 Baseline									
Road	**Speed (km)**	**AADT**	**No. LGV**	**No. HGV**	**%LGV**	**%HGV**	**Data Sources**		
M9	120	12233	11009.7	1223.3	90	10	As there is no NRA traffic counter between the site and Carlow on the M9. The nearest traffic counter on the M9 is at Castledermot north of Carlow Town. Traffic data is taken from *Table 6.4 of EIS for N9/N10 Kilcullen to Waterford Scheme: Waterford to Powerstown*. The EIS prediction for 2010 is considered fairly accurate as the measured AADT at Castledermot in 2010 was 14600, assuming Carlow town would generate c. 2000 vehicles. As no % HGV is predicted in the EIS. The % HGV is taken from the NRA 2010 traffic counter at Castledermot.		
R448	100	13980	12582	1398	92.4	7.6	Data taken from the NRA traffic counter at former N9 (R448) north of Leighlinbridge. This is representative of traffic that will pass the site on the R448 as there are no major junctions in between this counter and the site.		
Forecasted Traffic Growth									
	All Roads TRL HGV	All Roads TRL Cars and HGV	National Primary HGV	National Primary Cars and HGV	National Secondary HGV	National Secondary Cars and HGV	Non National HGV	Non National Cars and HGV	Sourced from *NRA Future Traffic Forecasts 2002-2040*, August 2003.
2010	123	125	133	136	128	131	114	117	
2011	126	127	137	139	131	134	116	118	
2012	128	129	140	142	134	136	117	119	
Road		**AADT**	**No. LGV**	**No. HGV**	**%LGV**	**%HGV**			
M9		12773	11485	1288	89.9	10.1			
R448		14514	13050	1464	89.9	10.1			

2012 Proposed Development + Forecasted Traffic Growth							
Note: this is a conservative calculation as traffic associated with the landfill is already included in 2010 baseline traffic figures							
		Total No.	**No. LGV**	**No. HGV**	**Comments**		
Proposed to generate		82	46	36	Peak vehicle movements per hour		
Proposed to generate		492	276	216	Vehicle movements per day (assuming 6 hour day). **Note:** this is worse case scenario as peak hourly traffic flows will not occur all day.		
Operational Days		303			days per year		
Calculated AADT		408	229	179			
Road	**Speed (km)**	**AADT**	**No. LGV**	**No. HGV**	**%LGV**	**%HGV**	
M9	120	13181	11714	1467	88.9	11.1	
R448	100	14922	13279	1643	89.0	11.0	

Table 2 Results of DMRB Model

Receptor number	Name	Year	CO	Benzene	1,3-butadiene	NO_x	NO_2	PM_{10}	PM_{10}
			Annual mean mg/m^3	Annual mean mg/m^3	Annual mean mg/m^3	Annual mean mg/m^3	Annual mean mg/m^3	Annual mean mg/m^3	Days >50mg/m^3
1	M9	2010	400.05	0.04	0.06	36.21	14.17	18.25	1.60
2	R448	2010	400.05	0.04	0.04	29.39	12.49	16.99	0.74
1	M9	2012	371.89	0.04	0.07	35.14	13.65	17.78	1.24
2	R448	2012	371.89	0.04	0.05	30.91	12.62	16.65	0.57
	Air Quality Limit Value		**-**	**5**		**-**	**40**	**20**	**35**

Figure 1 DMRB Results from the M9

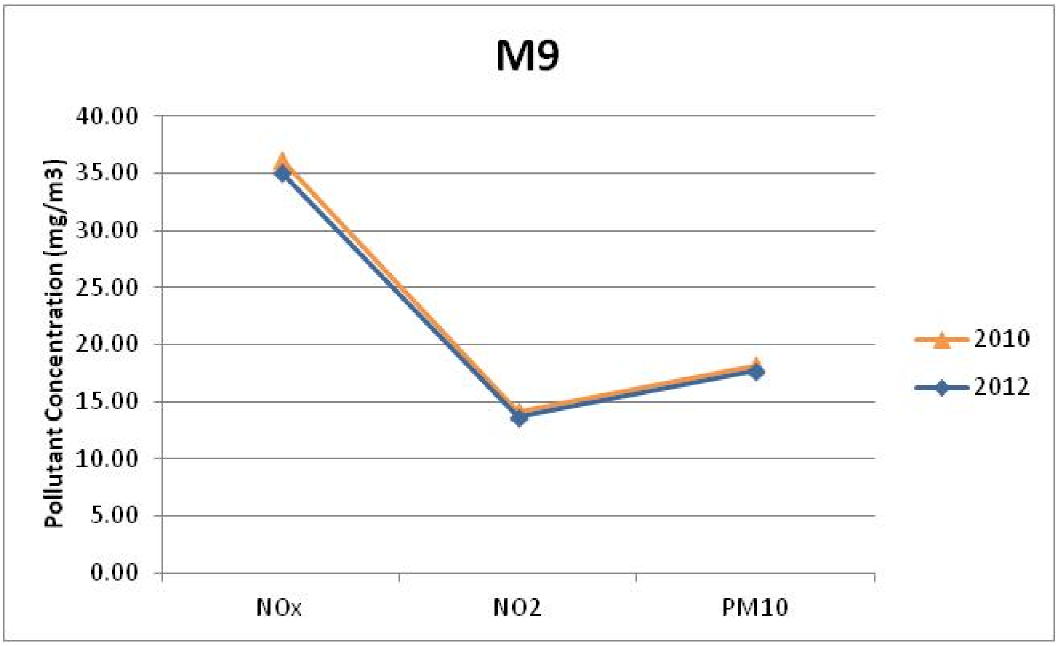


Figure 2 DMRB Results from the R448

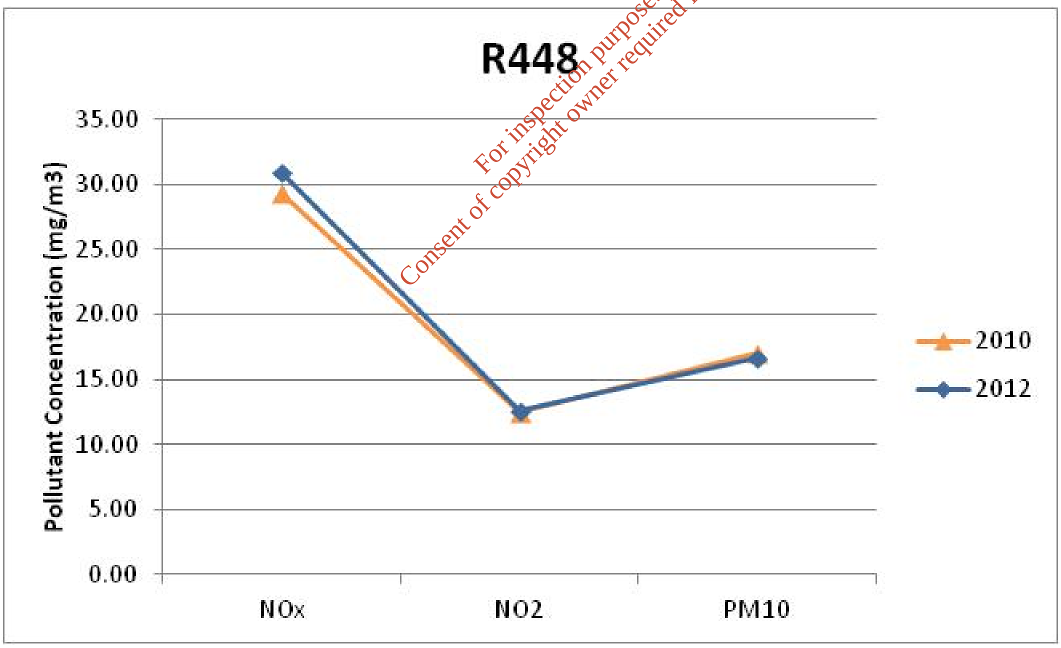


Table 3 Landfill Gas Perimeter Results 2011

Date	Gas	TP 11	TP 12	TP13	TP14	TP15	TP 16	TP17	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9	G 10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21
19/01/2011 & 26/01/2011	CH_4, CO_2, O_2 Air Pressure	0.1 1.5 17.7 1026	0.1 0.8 20.5 1026	0.0 0.4 20.4 1026	0.1 0.2 20.2 1006	0.1 8.0 13.0 1006	0.1 1.3 202. 1026	0.1 0.1 20.2 1006	0.0 1.4 19.0 1026	0.1 1.0 18.8 1026	0.1 1.1 19.2 1026	0.1 0.4 20.0 1026	0.1 0.2 20.8 1026	0.1 1.2 19.3 1026	0.0 0.6 20.1 1026	0.1 1.7 19.4 1026	No access	Well damaged	0.0 0.3 20.2 1006	5.8 19.6 0.4 1006	11.4 14.3 8.5 1006	0.0 4.1 16.6 1006	0.0 5.0 15.2 1006	0.0 0.7 19.7 1006	0.0 0.0 20.3 1006	0.0 0.0 20.3 1006	0.0 0.1 20.4 1006	0.0 0.0 20.4 1006	0.0 0.0 20.4 1006
28/02/2011	CH_4, CO_2, O_2 Air Pressure	0.1 0.5 20.4 1025	0.0 0.9 20.4 1025	0.1 1.5 19.6 1025	0.1 1.1 20.5 1025	0.1 1.3 18.6 1025	0.1 1.3 18.6 1025	0.1 0.0 20.2 1025	0.0 1.2 19.1 1025	0.2 1.3 18.6 1025	0.0 0.3 19.5 1025	0.0 0.2 20.4 1025	0.1 1.2 20.0 1025	0.0 0.4 20.1 1025	0.0 1.9 19.1 1025	0.1 1.3 18.7 1025	No access	Well damaged	0.1 0.3 21.3 1025	0.0 0.3 20.6 1025	0.8 0.8 20.2 1025	0.0 1.4 19.9 1025	0.0 2.8 19.0 1025	0.1 0.2 21.2 1025	0.0 0.2 20.9 1025	0.0 0.0 20.7 1025	0.0 0.0 21.2 1025	0.1 0.0 21.3 1025	0.0 0.0 21.2 1025
22/03/2011 & 25/03/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.1 18.6 1014	0.0 0.7 19.9 1014	0.0 0.9 18.6 1014	0.0 0.1 20.7 1031	0.0 6.5 12.7 1031	0.0 1.0 19.7 1014	0.0 0.2 20.9 1031	0.0 0.0 20.9 1031	0.0 0.0 20.7 1031	0.0 0.0 21.1 1031	0.0 0.0 21.0 1031	0.0 0.5 20.6 1031	0.0 0.1 20.9 1031	0.0 0.2 20.9 1031	0.0 0.1 20.9 1031	No access	Well damaged	0.0 0.0 20.9 1031	0.0 0.0 20.8 1031	0.0 0.0 21.0 1031	0.0 4.8 16.4 1031	0.0 0.0 20.9 1031	0.0 0.0 20.9 1031	0.0 0.0 21.0 1031	0.0 0.0 20.9 1031	0.0 0.0 21.0 1031	0.0 0.0 21.0 1031	0.0 0.0 21.1 1031
27/04/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.0 19.0 1019	0.0 0.7 19.7 1019	0.0 1.4 17.3 1019	0.0 0.2 20.2 1019	0.0 7.8 11.7 1019	0.0 0.9 19.2 1019	0.0 0.2 20.2 1019	0.0 0.2 20.1 1019	0.0 0.1 20.3 1019	0.0 1.3 18.8 1019	0.0 0.9 19.3 1019	0.0 0.5 20.0 1019	0.0 1.7 18.6 1019	0.0 0.9 19.5 1019	0.0 1.1 19.4 1019	No access	Well damaged	0.0 0.0 20.4 1019	0.0 0.0 20.2 1019	0.0 0.0 20.3 1019	0.0 1.2 19.4 1019	0.1 0.0 20.3 1019	0.0 0.1 19.9 1019	22.2 19.3 0.3 1019	0.0 0.0 20.5 1019	0.0 0.1 20.4 1019	0.0 0.0 20.4 1019	0.0 0.0 20.4 1019
13/05/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.1 18.6 1007	0.0 0.4 20.0 1007	0.0 9.5 04.3 1007	0.0 0.1 19.8 1008	0.0 10.0 10.4 1008	0.0 1.0 19.5 1007	0.0 0.9 19.6 1007	0.0 0.1 19.7 1009	0.0 0.4 19.5 1009	0.0 1.8 17.8 1009	0.0 0.5 19.4 1009	0.0 1.5 18.3 1009	0.0 0.2 19.6 1009	0.0 0.1 19.6 1009	0.0 0.4 19.5 1009	No access	Well damaged	0.0 0.0 20.2 1007	0.0 1.7 19.2 1007	0.0 0.0 20.1 1007	0.0 1.1 19.2 1007	0.0 0.1 19.8 1007	0.0 0.1 20.1 1007	23.3 21.4 00.4 1007	0.0 0.8 18.5 1007	0.0 0.2 19.7 1007	0.0 0.0 20.2 1007	0.0 0.0 20.3 1007
03/06/11 08/06/11	CH_4, CO_2, O_2 Air Pressure	0.0 0.8 19.1 1026	0.0 0.4 19.3 1026	0.0 8.3 6.7 994	0.0 0.9 19.5 1026	0.0 6.0 13.9 1026	0.0 0.0 19.4 1026	0.0 0.1 19.9 1026	0.0 0.0 19.6 1026	0.0 0.1 19.4 1026	0.0 0.0 19.5 1026	0.0 0.0 19.4 1026	0.0 0.0 19.3 1026	0.0 0.9 18.8 1026	0.0 0.1 19.8 1026	0.0 0.5 19.7 1026	No access	Well damaged	0.0 0.0 20.1 1026	0.0 0.0 20.0 1026	0.0 0.0 20.0 1026	0.0 0.0 19.2 1026	0.0 0.0 20.0 1026	0.0 0.2 19.9 1026	0.0 0.0 20.0 1026	0.0 0.0 20.0 1026	0.0 0.1 20.0 994	0.0 0.0 20.2 994	0.0 0.3 20.1 994
04/07/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.1 18.6 1007	0.0 1.0 18.8 1007	0.0 1.1 18.0 1007	0.0 0.1 19.8 1008	0.0 7.2 10.6 1008	0.0 0.9 19.1 1007	0.0 0.9 19.0 1008	0.0 0.0 20.1 1008	0.0 0.6 19.2 1008	0.0 0.6 19.5 1008	0.0 0.2 19.9 1008	0.0 1.6 18.3 1008	0.0 0.1 19.8 1008	0.0 0.0 20.1 1008	0.0 0.1 19.9 1008	No access	Well damaged	0.0 0.4 19.6 1008	0.0 0.6 18.7 1008	17.6 20.5 0.6 1008	0.0 2.6 16.5 1008	0.0 0.0 20.0 1008	0.0 1.5 17.9 1008	0.0 13.6 5.3 1008	0.0 0.0 20.2 1008	0.0 0.0 20.1 1008	0.0 0.0 20.1 1008	0.0 0.0 20.1 1008

Note:

All monitoring locations in blue are outside the landfill facility

All exceedances are identified in red text

Wells G11-G21 are within waste mass

Date	Gas	G22	G23	G24	G 25	G 26	G27	G 28	G 29	G 30	G 31	G 32	G 33	G 34	G 35	G 36	G 37	G 38	G 39	G 41	G 43	G 44	G 45	G 46	Main Office	Weigh-bridge office
19/01/2011 & 26/01/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 20.5 1006	0.0 0.3 20.4 1006	0.0 0.9 19.7 1006	0.0 0.4 20.5 1006	0.0 0.5 20.4 1006	0.1 3.3 17.5 1006	0.1 1.3 18.3 1006	0.0 1.8 19.3 1006	0.0 1.2 20.1 1006	0.0 1.3 18.7 1006	0.0 1.2 18.1 1006	0.0 0.1 20.5 1006	0.0 1.1 20.1 1006	0.0 0.3 20.1 1006	0.0 2.0 19.5 1006	0.0 0.1 20.6 1006	0.0 0.1 20.4 1026	0.1 0.9 19.8 1026	0.1 0.3 20.3 1026	0.1 3.1 16.7 1026	0.1 1.0 19.2 1026	0.1 0.5 20.0 1026	0.1 1.4 19.0 1026	0.0 0.0 20.4 1006	0.0 0.0 20.4 1006
28/02/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 20.2 1025	0.1 0.1 21.1 1025	0.0 0.6 20.7 1025	0.0 0.3 21.1 1025	0.0 0.3 21.1 1025	0.1 0.2 20.9 1025	0.2 0.4 20.3 1025	0.0 1.1 19.6 1025	0.0 0.2 20.5 1025	0.0 2.2 18.3 1025	0.0 1.2 19.5 1025	0.1 0.2 21.3 1025	0.0 0.7 20.9 1025	001 0.1 21.3 1025	0.0 0.1 20.8 1025	0.0 0.2 21.3 1025	0.0 0.1 21.3 1025	0.0 0.4 21.1 1025	0.1 0.1 21.2 1025	0.1 0.1 20.4 1025	0.1 0.3 19.6 1025	0.0 0.5 20.8 1025	0.1 1.0 20.4 1025	0.0 0.1 20.4 1025	0.1 0.0 20.5 1025
22/03/2011 & 25/03/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 21.1 1031	0.0 0.1 21.0 1031	0.0 0.5 20.6 1031	0.0 0.3 20.9 1031	0.0 0.2 21.0 1031	0.0 1.0 19.2 1014	0.0 0.9 18.6 1014	0.0 0.1 21.1 1031	0.0 0.4 20.4 1014	0.0 0.6 19.6 1014	0.0 0.7 20.2 1014	0.0 0.1 20.4 1014	0.0 0.4 20.2 1014	0.0 0.2 20.4 1014	0.0 0.7 20.9 1031	0.0 0.2 20.5 1014	0.0 0.0 20.5 1014	0.0 0.3 20.3 1014	0.0 0.1 20.9 1031	0.0 0.0 21.1 1031	0.0 0.1 20.9 1031	0.0 0.5 20.3 1031	0.0 0.1 21.0 1031	0.0 0.0 20.7 1031	0.0 0.0 20.7 1031
27/04/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 20.5 1019	0.0 0.1 20.3 1019	0.0 0.6 20.1 1019	0.0 0.5 20.2 1019	0.0 0.6 20.0 1019	0.0 1.7 18.1 1019	0.0 1.3 17.9 1019	0.0 1.8 17.2 1019	0.0 0.1 20.5 1019	0.0 0.3 20.4 1019	0.0 0.1 20.5 1019	0.0 0.1 20.5 1019	0.0 0.3 20.3 1019	0.0 0.0 20.4 1019	0.0 0.8 19.6 1019	0.0 0.2 20.4 1019	0.0 0.0 20.4 1019	0.0 0.0 20.4 1019	0.1 0.3 20.1 1019	0.0 1.2 19.7 1019	0.0 2.2 17.8 1019	0.0 1.1 19.1 1019	0.0 0.4 19.8 1019	0.0 0.0 20.6 1019	0.0 0.0 20.6 1019
13/05/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.2 20.1 1007	0.0 0.4 20.0 1007	0.0 0.7 19.8 1007	0.0 0.3 20.0 1007	0.0 0.3 19.9 1007	0.0 0.6 19.3 1007	0.0 1.3 18.7 1007	0.0 1.1 18.4 1007	0.0 0.1 20.1 1007	0.0 0.3 20.0 1007	0.0 0.1 20.2 1007	0.0 0.1 20.3 1007	0.0 0.2 20.2 1007	0.0 0.1 20.2 1007	0.0 2.1 19.5 1007	0.0 0.3 20.2 1007	0.0 0.0 20.4 1007	0.0 0.0 20.4 1007	0.2 0.4 20.0 1007	0.2 0.1 20.5 1007	0.0 0.1 20.2 1007	0.0 0.4 20.0 1007	0.0 0.2 20.3 1007	0.0 0.0 20.1 1007	0.0 0.0 20.1 1007
03/06/11 08/06/11	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 20.1 994	0.0 0.1 20.0 994	0.0 0.7 19.7 994	0.0 0.2 20.0 994	0.0 0.4 19.8 994	0.0 0.4 19.3 1026	0.0 0.9 18.7 1026	0.0 1.4 16.2 994	0.0 0.0 20.1 994	0.0 0.4 19.8 994	0.0 0.1 20.2 994	0.0 0.0 20.3 994	0.0 0.1 20.3 994	0.0 0.2 20.3 994	0.0 0.8 18.7 1026	0.0 0.4 20.3 994	0.0 0.0 20.3 994	0.0 0.0 19.8 1026	0.0 0.0 19.7 1026	0.0 0.7 19.1 1026	0.0 2.6 16.8 1026	0.0 0.4 19.6 1026	0.0 0.0 19.9 1026	0.0 0.0 20.5 994	0.0 0.0 20.5 994
04/07/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.9 18.9 1008	0.0 0.2 19.8 1008	0.0 0.5 19.7 1008	0.0 0.2 20.0 1008	0.0 0.0 20.2 1008	0.0 1.9 17.3 1007	0.0 2.0 16.1 1007	0.0 3.1 9.7 1008	0.0 0.0 19.8 1008	0.0 0.4 19.7 1008	0.0 0.0 20.3 1008	0.0 0.0 20.3 1008	0.0 0.1 20.2 1008	0.0 0.3 20.1 1008	0.0 1.0 19.4 1008	0.0 0.1 20.1 1008	0.0 0.0 20.2 1008	0.0 0.0 20.2 1008	0.5 0.6 19.4 1008	0.0 0.4 19.8 1008	0.0 1.3 18.4 1008	0.0 0.9 18.9 1008	0.0 0.3 19.8 1008	0.0 0.0 20.1 1007	0.0 0.0 20.1 1007

Note:

All monitoring locations in blue are outside the landfill facility

All exceedances are identified in red text

Wells G11-G21 are within waste mass

Date	Gas	TP 11	TP 12	TP13	TP14	TP15	TP 16	TP17	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9	G 10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21
25/08/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.2 19.3 998	0.0 1.0 19.7 998	0.0 1.4 19.0 998	0.0 0.1 20.3 997	0.0 7.5 11.7 997	0.0 1.0 19.9 998	0.0 0.5 19.6 998	0.0 0.2 20.2 997	0.0 0.0 20.4 997	0.0 0.9 18.9 997	0.0 0.0 20.2 997	0.0 2.5 17.4 997	0.0 0.0 20.0 997	0.0 0.0 20.2 997	0.0 0.1 20.1 997	No access	Well damaged	8.6 11.2 9.2 998	0.2 4.3 16.7 998	16.9 20.9 10.2 998	0.1 4.7 13.7 998	11.7 13.5 7.1 998	0.0 5.0 12.7 998	19.0 12.2 0.5 998	12.2 19.5 10.3 998	0.0 3.5 11.8 998	0.0 3.6 11.2 998	0.0 1.2 18.6 998
28/09/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.9 20.0 1014	0.0 0.5 20.5 1014	0.0 0.1 20.8 1013	0.0 0.0 20.7 1013	0.0 4.0 16.1 1013	0.0 0.8 20.3 1014	0.0 0.7 20.2 1013	0.0 0.0 20.7 1013	0.0 0.0 20.9 1013	0.0 0.4 20.4 1012	0.0 0.0 20.9 1012	0.0 2.9 18.6 1012	0.0 0.0 20.8 1012	0.0 0.6 20.4 1012	0.0 0.0 21.0 1012	No access	Well damaged	0.0 0.1 21.0 1012	0.0 9.3 12.5 1012	13.3 17.9 5.7 1012	0.0 4.0 15.7 1012	4.8 7.4 13.1 1012	0.0 3.7 16.3 1012	24.3 23.1 0.9 1012	27.7 23.5 0.5 1012	0.0 3.9 11.7 1012	0.0 7.7 7.8 1012	0.1 1.6 18.6 1012
14/10/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.0 20.6 1019	0.0 0.8 20.2 1019	0.0 0.2 20.6 1019	0.0 0.1 20.4 1019	0.0 2.0 18.5 1019	0.0 0.9 20.2 1019	0.0 0.5 20.3 1019	0.0 0.0 20.5 1019	0.0 0.6 20.2 1018	0.0 0.3 20.7 1019	0.0 0.0 21.1 1019	0.0 2.7 18.8 1019	0.0 0.4 20.6 1018	0.0 0.2 20.6 1018	0.0 0.0 21.1 108	No access	Well damaged	0.0 0.0 21.0 1019	0.1 4.1 16.3 1019	0.0 0.0 21.0 1019	0.0 2.7 17.9 1019	3.9 5.3 14.6 1019	0.0 1.3 19.3 1019	27.4 23.6 0.3 1019	31.7 23.7 0.3 1019	0.0 4.2 12.4 1019	0.0 4.5 12.3 1019	0.0 0.0 20.9 1019
10/11/2011 & 15/11/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.9 20.2 1008	0.0 0.6 20.7 1008	0.0 1.1 18.4 1008	0.0 0.1 20.3 1006	0.0 4.6 14.9 1006	0.1 0.8 20.4 1008	0.0 0.5 20.3 1006	0.0 0.0 20.4 1006	0.0 0.0 20.3 1006	0.0 0.1 20.7 1006	0.0 0.0 20.8 1006	0.0 2.3 18.8 1006	0.0 0.2 20.5 1006	0.0 1.4 19.2 1006	0.0 0.0 20.7 1006	No access	Well damaged	0.0 0.0 20.5 1006	0.0 5.4 15.1 1006	0.3 1.8 18.5 1006	0.1 3.5 16.7 1006	0.0 1.1 19.2 1006	0.0 0.3 20.3 1006	0.0 0.1 20.4 1006	0.0 0.0 20.6 1006	0.0 0.5 19.6 1006	0.0 4.2 14.3 1006	0.0 0.0 20.6 1006
05/12/2011	CH_4, CO_2, O_2 Air Pressure	0.1 0.9 20.0 1000	0.1 0.5 19.7 1000	0.1 8.2 8.0 1000	0.1 0.1 20.8 1000	0.1 6.1 14.7 1000	0.1 0.6 19.4 1000	0.1 0.5 19.6 1000	0.1 0.1 20.1 1000	0.1 0.1 20.0 1000	0.1 0.0 20.6 1000	0.1 0.1 20.6 1000	0.1 1.8 19.4 1000	0.1 0.7 19.5 1000	0.1 0.7 19.7 1000	0.1 1.0 19.6 1000	No access	Well damaged	1.6 5.1 16.3 1000	1.5 15.0 5.3 1000	5.6 6.3 15.3 1000	0.1 3.5 17.4 1000	0.1 6.0 14.5 1000	0.1 0.1 19.9 1000	6.2 20.7 0.6 1000	6.1 11.3 9.4 1000	0.1 4.2 15.3 1000	0.1 4.0 12.6 1000	0.1 4.8 15.7 1000

Note:

All monitoring locations in blue are outside the landfill facility

All exceedances are identified in red text

Wells G11-G21 are within waste mass

Date	Gas	G22	G23	G24	G 25	G 26	G27	G 28	G 29	G 30	G 31	G 32	G 33	G 34	G 35	G 36	G 37	G 38	G 39	G 41	G 43	G 44	G 45	G 46	Main Office	Weigh bridge office
25/08/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.4 18.7 998	0.0 0.2 20.2 998	0.0 0.7 19.8 998	0.0 0.2 20.3 998	0.0 0.2 20.2 998	0.0 3.1 17.8 998	0.0 2.5 15.8 998	0.0 4.8 12.3 997	0.0 0.0 20.5 997	0.0 0.1 20.8 997	0.0 0.1 20.9 997	0.0 0.1 20.9 997	0.0 0.0 21.1 997	0.0 0.1 21.1 997	0.0 3.6 17.5 997	0.0 0.2 21.0 997	0.0 0.0 21.1 997	0.0 0.4 20.6 997	0.0 1.4 19.5 997	0.0 0.8 19.5 997	0.0 0.1 20.4 997	0.0 1.0 19.5 997	0.0 0.5 19.7 997	0.0 0.0 21.1 997	0.0 0.0 21.1 997
28/09/2011	CH_4, CO_2, O_2 Air Pressure	0.0 2.0 17.8 1012	0.0 0.1 20.8 1012	0.0 0.0 20.9 1012	0.0 0.1 20.9 1012	0.0 0.0 21.0 1012	0.0 1.1 19.7 1014	0.0 1.5 18.9 1014	0.0 5.4 3.2 1014	0.0 0.0 20.5 1014	0.0 0.1 20.5 1014	0.0 0.1 20.6 1014	0.0 0.0 20.8 1014	0.0 0.1 20.7 1014	0.0 0.0 20.8 1014	0.0 1.4 19.5 1013	0.0 0.1 20.8 1014	0.0 0.0 20.7 1014	0.0 0.0 20.7 1014	0.3 0.7 19.9 1014	0.0 0.2 20.6 1014	0.0 2.8 17.7 1014	0.0 0.4 20.5 1014	0.0 0.5 20.5 1013	0.0 0.0 21.0 1014	0.0 0.0 21.0 1014
14/10/2011	CH_4, CO_2, O_2 Air Pressure	0.0 1.7 17.5 1019	0.0 0.1 20.6 1019	0.0 0.0 20.8 1019	0.0 0.0 20.8 1019	0.0 0.0 20.8 1019	0.0 1.0 19.6 1019	0.0 0.6 19.7 1019	0.0 5.8 8.5 1019	0.0 0.0 20.6 1019	0.0 0.0 20.6 1019	0.0 0.0 20.5 1019	0.0 0.0 20.5 1019	0.0 0.1 20.5 1019	0.0 0.0 20.6 1019	0.0 1.2 20.6 1018	0.0 0.0 20.5 1019	0.0 0.0 20.5 1019	0.0 0.0 20.4 1019	0.0 0.2 20.1 1019	0.0 0.0 20.4 1019	0.0 0.2 20.2 1019	0.0 0.5 19.8 1019	0.0 0.1 20.4 1019	0.0 0.0 20.7 1018	0.0 0.0 20.7 1018
10/11/2011 & 15/11/2011	CH_4, CO_2, O_2 Air Pressure	0.0 0.0 20.6 1006	0.0 0.2 20.3 1006	0.0 0.0 20.7 1006	0.0 0.0 20.8 1006	0.0 0.0 20.7 1006	0.0 3.3 17.8 1008	0.0 1.1 19.1 1008	0.0 3.6 14.7 1008	0.0 0.1 20.5 1008	0.0 1.3 19.7 1008	0.0 0.2 20.5 1008	0.0 0.1 20.7 1008	0.1 0.9 20.3 1008	0.0 0.1 20.8 1008	0.0 0.6 20.6 1006	0.0 0.0 20.8 1008	0.0 0.1 20.8 1008	0.0 0.1 20.8 1008	0.1 0.7 19.7 1006	0.0 0.1 20.7 1006	0.0 0.2 20.5 1006	0.0 0.4 20.1 1006	0.0 0.0 20.7 1006	0.0 0.0 20.7 1006	0.0 0.0 20.7 1006
05/12/2011	CH_4, CO_2, O_2 Air Pressure	0.1 0.6 19.5 1000	0.1 0.3 19.8 1000	0.1 1.3 19.1 1000	0.1 0.5 19.7 1000	0.0 0.6 19.1 1000	0.1 0.1 20.6 1000	0.1 1.4 19.3 1000	0.1 0.9 18.2 1001	0.1 0.5 19.6 1001	0. 1.3 19.2 1001	0.1 0.6 19.6 1001	0.1 0.3 19.8 1001	0.1 0.7 19.1 1001	0.1 0.2 19.9 1001	0.1 1.7 20.6 1001	0.1 0.2 19.9 1001	0.1 0.2 19.8 1001	0.1 0.4 19.7 1001	0.4 0.8 18.7 1000	0.1 0.3 19.7 1000	0.1 2.7 17.0 1000	0.1 0.4 19.7 1000	0.1 0.2 19.9 1000	0.1 0.1 20.1 1000	0.1 0.0 20.4 1000

Note:

All monitoring locations in blue are outside the landfill facility

All exceedances are identified in red text

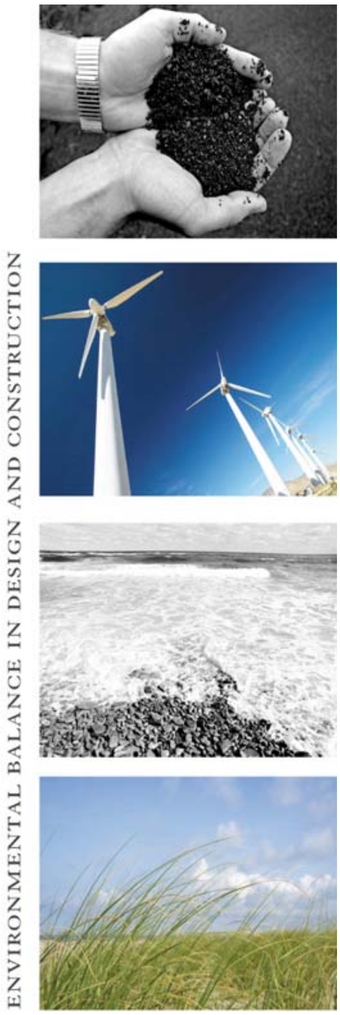
Wells G11-G21 are within waste mass

Appendix 7

Ecology

APPENDIX 7

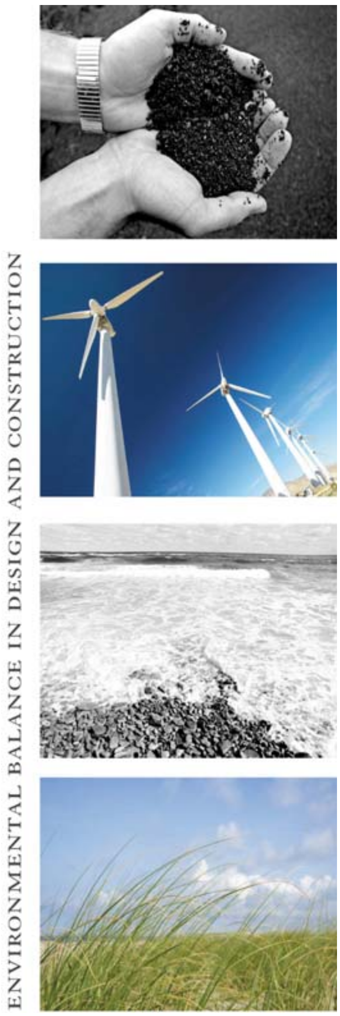
Scheme for Ecological Evaluation of Sites (after Nairn & Fossitt, 2004)



Rating	Qualifying Criteria
A	**Internationally Important** • Sites designated (or qualifying for designation as *SAC or *SPA under the EU Habitats or Birds Directives. • Undesignated sites containing good examples of Annex I priority habitats under the EU Habitats Directive. • Major salmon river fisheries. • Major salmonid (salmon, trout or char) lake fisheries.
B	**Nationally Important** • Sites or waters designated or proposed as an *NHA or statutory Nature Reserves. • Undesignated sites containing good examples of Annex I habitats (under EU Habitats Directive). • Undesignated sites containing significant numbers of resident or regularly occurring populations of Annex II species under the EU Habitats Directive or Annex I species under the EU Birds Directive or species protected under the Wildlife (Amendment) Act 2000. • Major trout river fisheries. • Water bodies with major amenity fishery value. • Commercially important coarse fisheries.
C	**High Value, Locally Important** • Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or significant populations of locally rare species. • Small water bodies with known salmonid populations or with good potential salmonid habitat. • Sites containing any resident or regularly occurring populations of Annex II species under the EU Habitats Directive or Annex I species under the EU Birds Directive. • Large water bodies with some coarse fisheries value.
D	**Moderate Value, Locally Important** • Sites containing some semi-natural habitat or locally important for wildlife. • Small water bodies with some coarse fisheries value or some potential salmonid habitat. • Any water body with unpolluted water (Q-value rating 4-5).
E	**Low Value, Locally Important** • Artificial or highly modified habitats with low species diversity and low wildlife value. • Water bodies with no current fisheries value and no significant potential fisheries value.

APPENDIX 7.2

NPWS Site Synopses of Designated Nature Conservation Sites within 10 km



SITE SYNOPSIS

SITE NAME: RIVER BARROW AND RIVER NORE

SITE CODE: 002162

This site consists of the freshwater stretches of the Barrow/Nore River catchments as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary as far downstream as Creadun Head in Waterford. The site passes through eight counties – Offaly, Kildare, Laois, Carlow, Kilkenny, Tipperary, Wexford and Waterford. Major towns along the edge of the site include Mountmellick, Portarlington, Monasterevin, Stradbally, Athy, Carlow, Leighlinbridge, Graiguenamanagh, New Ross, Inistioge, Thomastown, Callan, Bennettsbridge, Kilkenny and Durrow. The larger of the many tributaries include the Lerr, Fushoge, Mountain, Aughavaud, Owenass, Boherbaun and Stradbally Rivers of the Barrow and the Delour, Dinin, Erkina, Owveg, Munster, Arrigle and King's Rivers on the Nore. Both rivers rise in the Old Red Sandstone of the Slieve Bloom Mountains before passing through a band of Carboniferous shales and sandstones. The Nore, for a large part of its course, traverses limestone plains and then Old Red Sandstone for a short stretch below Thomastown. Before joining the Barrow it runs over intrusive rocks poor in silica. The upper reaches of the Barrow also runs through limestone. The middle reaches and many of the eastern tributaries, sourced in the Blackstairs Mountains, run through Leinster Granite. The southern end, like the Nore runs over intrusive rocks poor in silica. Waterford Harbour is a deep valley excavated by glacial floodwaters when the sea level was lower than today. The coast shelves quite rapidly along much of the shore.

The site is a candidate SAC selected for alluvial wet woodlands and petrifying springs, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate SAC for old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive - Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Nore Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon, Otter, Desmoulin's Whorl Snail *Vertigo moulinsiana* and the Killarney Fern.

Good examples of Alluvial Forest are seen at Rathsnagadan, Murphy's of the River, in Abbeyleix estate and along other shorter stretches of both the tidal and freshwater elements of the site. Typical species seen include Almond Willow (*Salix triandra*), White Willow (*S. alba*), Grey Willow (*S. cinerea*), Crack Willow (*S. fragilis*), Osier (*S. viminalis*), with Iris (*Iris pseudacorus*), Hemlock Water-dropwort (*Oenanthe crocata*), Angelica (*Angelica sylvestris*), Thin-spiked Wood-sedge (*Carex strigosa*), Pendulous Sedge (*C. pendula*), Meadowsweet (*Filipendula ulmaria*), Valerian (*Valeriana officinalis*) and the Red Data Book species Nettle-leaved Bellflower (*Campanula trachelium*). Three rare invertebrates have been recorded in this habitat at Murphy's of the River. These are: *Neoascia obliqua* (Diptera: Syrphidae), *Tetanocera freyi* (Diptera: Sciomyzidae) and *Dictya umbrarum* (Diptera: Sciomyzidae).

A good example of petrifying springs with tufa formations occurs at Dysart Wood along the Nore. This is a rare habitat in Ireland and one listed with priority status on Annex I of the EU Habitats Directive. These hard water springs are characterised by lime encrustations, often associated with small waterfalls. A rich bryophyte flora is typical of the habitat and two diagnostic species, *Cratoneuron commutatum* var. *commutatum* and *Eucladium verticillatum*, have been recorded.

The best examples of old Oak woodlands are seen in the ancient Park Hill woodland in the estate at Abbeyleix; at Kyleadohir, on the Delour, Forest Wood House, Kylecorragh and Brownstown Woods on the Nore; and at Cloghristic Wood, Drummond Wood and Borris Demesne on the Barrow, though other patches occur throughout the site. Abbeyleix Woods is a large tract of mixed deciduous woodland which is one of the only remaining true ancient woodlands in Ireland. Historical records show that Park Hill has been continuously wooded since the sixteenth century and has the most complete written record of any woodland in the country.

It supports a variety of woodland habitats and an exceptional diversity of species including 22 native trees, 44 bryophytes and 92 lichens. It also contains eight indicator species of ancient woodlands. Park Hill is also the site of two rare plants, Nettle-leaved Bellflower and the moss *Leucodon sciuroides.* It has a typical bird fauna including Jay, Long-eared Owl and Raven. A rare invertebrate, *Mitostoma chrysomelas,* occurs in Abbeyleix and only two other sites in the country. Two flies *Chrysogaster virescens* and *Hybomitra muhlfeldi* also occur. The rare Myxomycete fungus, *Licea minima* has been recorded from woodland at Abbeyleix.

Oak woodland covers parts of the valley side south of Woodstock and is well developed at Brownsford where the Nore takes several sharp bends. The steep valley side is covered by Oak (*Quercus* spp.), Holly (*Ilex aquifolium*), Hazel (*Corylus avellana*) and Birch (*Betula pubescens*) with some Beech (*Fagus sylvatica*) and Ash (*Fraxinus excelsior*). All the trees are regenerating through a cover of Bramble (*Rubus fruticosus* agg.), Foxglove (*Digitalis purpurea*) Wood Rush (*Luzula sylvatica*) and Broad Buckler-fern (*Dryopteris dilatata*).

On the steeply sloping banks of the River Nore about 5 km west of New Ross, in County Kilkenny, Kylecorragh Woods form a prominent feature in the landscape. This is an excellent example of a relatively undisturbed, relict Oak woodland with a very good tree canopy. The wood is quite damp and there is a rich and varied ground flora. At Brownstown a small, mature Oak-dominant woodland occurs on a steep slope. There is younger woodland to the north and east of it. Regeneration throughout is evident. The understorey is similar to the woods at Brownsford. The ground flora of this woodland is developed on acidic, brown earth type soil and comprises a thick carpet of Bilberry (*Vaccinium myrtillus*), Heather (*Calluna vulgaris*), Hard Fern (*Blechnum spicant*), Cow-wheat (*Melampyrum* spp.) and Bracken (*Pteridium aquilinum*).

Borris Demesne contains a very good example of a semi-natural broad-leaved woodland in very good condition. There is quite a high degree of natural re-generation of Oak and Ash through the woodland. At the northern end of the estate Oak species predominate. Drummond Wood, also on the Barrow, consists of three blocks of deciduous woods situated on steep slopes above the river. The deciduous trees are mostly Oak species. The woods have a well established understorey of Holly (*Ilex aquifolium*), and the herb layer is varied, with Brambles abundant. Whitebeam (*Sorbus devoniensis*) has also been recorded.

Eutrophic tall herb vegetation occurs in association with the various areas of alluvial forest and elsewhere where the flood-plain of the river is intact. Characteristic species of the habitat include Meadowsweet (*Filipendula ulmaria*), Purple Loosestrife (*Lythrum salicaria*), Marsh Ragwort (*Senecio aquaticus*), Ground Ivy (*Glechoma hederacea*) and Hedge Bindweed (*Calystegia sepium*). Indian Balsam (*Impatiens glandulifera*), an introduced and invasive species, is abundant in places.

Floating River Vegetation is well represented in the Barrow and in the many tributaries of the site. In the Barrow the species found include Water Starworts (*Callitriche* spp.), Canadian Pondweed (*Elodea canadensis*), Bulbous Rush (*Juncus bulbosus*), Milfoil (*Myriophyllum* spp.), *Potamogeton* x *nitens,* Broad-leaved Pondweed (*P. natans*), Fennel Pondweed (*P. pectinatus*), Perfoliated Pondweed (*P. perfoliatus*) and Crowfoots (*Ranunculus* spp.). The water quality of the Barrow has improved since the vegetation survey was carried out (EPA, 1996).

Dry Heath at the site occurs in pockets along the steep valley sides of the rivers especially in the Barrow Valley and along the Barrow tributaries where they occur in the foothills of the Blackstairs Mountains. The dry heath vegetation along the slopes of the river bank consists of Bracken (*Pteridium aquilinum*) and Gorse (*Ulex europaeus*) species with patches of acidic grassland vegetation. Additional typical species include Heath Bedstraw (*Galium saxatile*), Foxglove (*Digitalis purpurea*), Common Sorrel (*Rumex acetosa*) and Bent Grass (*Agrostis stolonifera*). On the steep slopes above New Ross the Red Data Book species Greater Broomrape (*Orobanche rapum-genistae*) has been recorded. Where rocky outcrops are shown on the maps Bilberry (*Vaccinium myrtillus*) and Wood Rush (*Luzula sylvatica*) are present. At Ballyhack a small area of dry heath is interspersed with patches of lowland dry grassland. These support a number of Clover species including the legally protected Clustered Clover (*Trifolium glomeratum*) - a species known from only one other site in Ireland. This grassland community is especially well developed on the west side of the mud-capped walls by the road. On the east of the cliffs a group of rock-dwelling species occur, i.e. English Stonecrop (*Sedum anglicum*), Sheep's-bit (*Jasione montana*) and Wild Madder (*Rubia peregrina*).

These rocks also support good lichen and moss assemblages with *Ramalina subfarinacea* and *Hedwigia ciliata*.

Dry Heath at the site generally grades into wet woodland or wet swamp vegetation lower down the slopes on the river bank. Close to the Blackstairs Mountains, in the foothills associated with the Aughnabrisky, Aughavaud and Mountain Rivers there are small patches of wet heath dominated by Purple Moor-grass (*Molinia caerulea*) with Heather (*Calluna vulgaris*), Tormentil (*Potentilla erecta*), Carnation Sedge (*Carex panicea*) and Bell Heather (*Erica cinerea*).

Saltmeadows occur at the southern section of the site in old meadows where the embankment has been breached, along the tidal stretches of in-flowing rivers below Stokestown House, in a narrow band on the channel side of Common Reed (*Phragmites*) beds and in narrow fragmented strips along the open shoreline. In the larger areas of salt meadow, notably at Carrickcloney, Ballinlaw Ferry and Rochestown on the west bank; Fisherstown, Alderton and Great Island to Dunbrody on the east bank, the Atlantic and Mediterranean sub types are generally intermixed. At the upper edge of the salt meadow in the narrow ecotonal areas bordering the grasslands where there is significant percolation of salt water, the legally protected species Borrer's Saltmarsh-grass (*Puccinellia fasciculata*) and Meadow Barley (*Hordeum secalinum*) (Flora Protection Order, 1987) are found. The very rare Divided Sedge (*Carex divisa*) is also found. Sea Rush (*Juncus maritimus*) is also present. Other plants recorded and associated with salt meadows include Sea Aster (*Aster tripolium*), Sea Thrift (*Armeria maritima*), Sea Couch (*Elymus pycnanthus*), Spear-leaved Orache (*Atriplex prostrata*), Lesser Sea-spurrey (*Spergularia marina*), Sea Arrowgrass (*Triglochin maritima*) and Sea Plantain (*Plantago maritima*).

Salicornia and other annuals colonising mud and sand are found in the creeks of the saltmarshes and at the seaward edges of them. The habitat also occurs in small amounts on some stretches of the shore free of stones.

The estuary and the other Habitats Directive Annex I habitats within it form a large component of the site. Extensive areas of intertidal flats, comprised of substrates ranging from fine, silty mud to coarse sand with pebbles/stones are present. Good quality intertidal sand and mudflats have developed on a linear shelf on the western side of Waterford Harbour, extending for over 6 km from north to south between Passage East and Creadaun Head, and in places are over 1 km wide. The sediments are mostly firm sands, though grade into muddy sands towards the upper shore. They have a typical macro-invertebrate fauna, characterised by polychaetes and bivalves. Common species include *Arenicola marina*, *Nephtys hombergii*, *Scoloplos armiger*, *Lanice conchilega* and *Cerastoderma edule*.

The western shore of the harbour is generally stony and backed by low cliffs of glacial drift. At Woodstown there is a sandy beach, now much influenced by recreation pressure and erosion. Behind it a lagoonal marsh has been impounded which runs westwards from Gaultiere Lodge along the course of a slow stream. An extensive reedbed occurs here. At the edges is a tall fen dominated by sedges (*Carex* spp.), Meadowsweet, Willowherb (*Epilobium* spp.) and rushes (*Juncus* spp.). Wet woodland also occurs. This area supports populations of typical waterbirds including Mallard, Snipe, Sedge Warbler and Water Rail.

The dunes which fringe the strand at Duncannon are dominated by Marram grass (*Ammophila arenaria*) towards the sea. Other species present include Wild Sage (*Salvia verbenaca*), a rare Red Data Book species. The rocks around Duncannon ford have a rich flora of seaweeds typical of a moderately exposed shore and the cliffs themselves support a number of coastal species on ledges, including Thrift (*Armeria maritima*), Rock Samphire (*Crithmum maritimum*) and Buck's-horn Plantain (*Plantago coronopus*).

Other habitats which occur throughout the site include wet grassland, marsh, reed swamp, improved grassland, arable land, quarries, coniferous plantations, deciduous woodland, scrub and ponds.

Seventeen Red Data Book plant species have been recorded within the site, most in the recent past. These are Killarney Fern (*Trichomanes speciosum*), Divided Sedge (*Carex divisa*), Clustered Clover (*Trifolium glomeratum*), Basil Thyme (*Acinos arvensis*), Hemp nettle (*Galeopsis angustifolia*), Borrer's Saltmarsh Grass (*Puccinellia fasiculata*), Meadow Barley (*Hordeum secalinum*), Opposite-leaved Pondweed (*Groenlandia densa*), Autumn Crocus

(*Colchicum autumnale*), Wild Sage (*Salvia verbenaca*), Nettle-leaved Bellflower (*Campanula trachelium*), Saw-wort (*Serratula tinctoria*), Bird Cherry (*Prunus padus*), Blue Fleabane (*Erigeron acer*), Fly Orchid (*Ophrys insectifera*), Broomrape (*Orobanche hederae*) and Greater Broomrape (*Orobanche rapum-genistae*). Of these the first nine are protected under the Flora Protection Order 1999. Divided Sedge (*Carex divisa*) was thought to be extinct but has been found in a few locations in the site since 1990. In addition plants which do not have a very wide distribution in the country are found in the site including Thin-spiked Wood-sedge (*Carex strigosa*), Field Garlic (*Allium oleraceum*) and Summer Snowflake (*Leucojum aestivum*). Six rare lichens, indicators of ancient woodland, are found including *Lobaria laetevirens* and *L. pulmonaria.* The rare moss *Leucodon sciuroides* also occurs.

The site is very important for the presence of a number of EU Habitats Directive Annex II animal species including Freshwater Pearl Mussel (*Margaritifera margaritifera* and *M. m. durrovensis*), Freshwater Crayfish (*Austropotamobius pallipes*), Salmon (*Salmo salar*), Twaite Shad (*Alosa fallax fallax*), three Lamprey species - Sea (*Petromyzon marinus*), Brook (*Lampetra planeri*) and River (*Lampetra fluviatilis*), the marsh snail *Vertigo moulinsiana* and Otter (*Lutra lutra*). This is the only site in the world for the hard water form of the Pearl Mussel *M. m. durrovensis* and one of only a handful of spawning grounds in the country for Twaite Shad. The freshwater stretches of the River Nore main channel is a designated salmonid river. The Barrow/Nore is mainly a grilse fishery though spring salmon fishing is good in the vicinity of Thomastown and Inistioge on the Nore. The upper stretches of the Barrow and Nore, particularly the Owenass River, are very important for spawning.

The site supports many other important animal species. Those which are listed in the Irish Red Data Book include Daubenton's Bat (*Myotis daubentoni*), Badger (*Meles meles*), Irish Hare (*Lepus timidus hibernicus*) and Frog (*Rana temporaria*). The rare Red Data Book fish species Smelt (*Osmerus eperlanus*) occurs in estuarine stretches of the site. In addition to the Freshwater Pearl Mussel, the site also supports two other freshwater Mussel species, *Anodonta anatina* and *A. cygnea*.

The site is of ornithological importance for a number of E.U. Birds Directive Annex I species including Greenland White-fronted Goose, Whooper Swan, Bewick's Swan, Bar-tailed Godwit, Peregrine and Kingfisher. Nationally important numbers of Golden Plover and Bar-tailed Godwit are found during the winter. Wintering flocks of migratory birds are seen in Shanahoe Marsh and the Curragh and Goul Marsh, both in Co. Laois and also along the Barrow Estuary in Waterford Harbour. There is also an extensive autumnal roosting site in the reedbeds of the Barrow Estuary used by Swallows before they leave the country.

Landuse at the site consists mainly of agricultural activities – many intensive, principally grazing and silage production. Slurry is spread over much of this area. Arable crops are also grown. The spreading of slurry and fertiliser poses a threat to the water quality of the salmonid river and to the populations of Habitats Directive Annex II animal species within the site. Many of the woodlands along the rivers belong to old estates and support many non-native species. Little active woodland management occurs. Fishing is a main tourist attraction along stretches of the main rivers and their tributaries and there are a number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. Both commercial and leisure fishing takes place on the rivers. There is net fishing in the estuary and a mussel bed also. Other recreational activities such as boating, golfing and walking, particularly along the Barrow towpath are also popular. There is a golf course on the banks of the Nore at Mount Juliet and GAA pitches on the banks at Inistioge and Thomastown. There are active and disused sand and gravel pits throughout the site. Several industrial developments, which discharge into the river, border the site. New Ross is an important shipping port. Shipping to and from Waterford and Belview ports also passes through the estuary.

The main threats to the site and current damaging activities include high inputs of nutrients into the river system from agricultural run-off and several sewage plants, overgrazing within the woodland areas, and invasion by non-native species, for example Cherry Laurel and Rhododendron (*Rhododendron ponticum*). The water quality of the site remains vulnerable. Good quality water is necessary to maintain the populations of the Annex II animal species listed above. Good quality is dependent on controlling fertilisation of the grasslands, particularly along the Nore. It also requires that sewage be properly treated before discharge. Drainage activities in the catchment can lead to flash floods which can damage the many Annex II species present.

Capital and maintenance dredging within the lower reaches of the system pose a threat to migrating fish species such as lamprey and shad. Land reclamation also poses a threat to the salt meadows and the populations of legally protected species therein.

Overall, the site is of considerable conservation significance for the occurrence of good examples of habitats and of populations of plant and animal species that are listed on Annexes I and II of the E.U. Habitats Directive respectively. Furthermore it is of high conservation value for the populations of bird species that use it. The occurrence of several Red Data Book plant species including three rare plants in the salt meadows and the population of the hard water form of the Pearl Mussel which is limited to a 10 km stretch of the Nore, add further interest to this site.

6.10.2006

SITE SYNOPSIS

SITE NAME: CLOGHRISTICK WOOD

SITE CODE: 000806

Cloghristick Wood is situated approximately 5 km north of Leighlinbridge. The woodland forms a fringe along the River Barrow where it flows through Milford. The wide flood-plain is occupied by a variety of coniferous and deciduous trees.

Oak (*Quercus* spp.), Beech (*Fagus sylvatica*) and Hazel (*Corylus avellana*) occur, although Willows (*Salix* spp.) are the dominant species. The ground flora comprises a range of wetland and woodland species.

The wood is of value as it is typical and, by standards prevailing in County Carlow, quite large.

SITE SYNOPSIS

SITE NAME: BALLYMOON ESKER

SITE CODE: 000797

Ballymoon is located about 3 km east of Bagenalstown. The site is an esker, a long hill of sand and gravel, which stretches from just south of Dunlecky Cross Roads to Ballymoon Castle. The area included within the site boundary is based on a desk review and only a portion of this site has been the subject of a field survey. The hill's sand deposits show some water-sorting where they are exposed. Sand has been quarried at frequent intervals along the structure and only the northernmost section, which supports pine trees, is intact.

Calcareous grassland covers much of the esker and at the southern end contains several rare plant species, two of which are legally protected (Flora Protection Order 1987), Green-winged Orchid (*Orchis morio*) and Basil Thyme (*Acinos arvensis*).

Basil Thyme is typically associated with eskers and calcareous soils. Since 1970 the species has only been seen at 4 sites and is apparently declining as a result of modern methods of weed control and exploitation of its esker habitat for gravel extraction.

Green-winged Orchid (*Orchis morio*) is typical of unimproved meadow pasture and sandhills. This species has suffered a dramatic decline in numbers and only 7 sites have been reported since 1970. The reason for this decline is apparently due to land reclamation and especially fertilizing of the old pasture sites in which it occurred.

In addition, the scarce Bee Orchid (*Ophrys apifera*) occurs. Other species included in the grassland are Yarrow (*Achillea millefolium*), Lady's Bedstraw (*Galium verum*), Common Bird's-foot-trefoil (*Lotus corniculatus*), Smooth Meadow-grass (*Poa pratensis*), Quaking-grass (*Briza media*) and sedges (*Carex flacca* and *Carex caryophyllea*).

This site is also of geomorphological interest as part of an esker well separated from the larger esker systems of the midlands, a rare phenomenon in the county.

SITE SYNOPSIS

SITE NAME: WHITEHALL QUARRIES

SITE CODE: 000855

Two disused shale/slate quarries 5km west of Bagnelstown. The quarry tips and the floors of the old working areas now provide a rich variety of dry acidic habitats, the substrate varying in stability and particle size etc. These have been colonised to a greater or lesser extent by a variety of plants typical of such dry habitats such as Bilberry (*Vaccinium myrtillus*). Although degraded by recent management, the vegetation has the potential to recover.

The flora of this area presents a sharp contrast to the flora of the surrounding region and as such is of ecological interest. Raptors nest in the quarry cliffs.→

SITE SYNOPSIS

SITE NAME: COAN BOGS NHA

SITE CODE: 002382

Coan Bogs NHA consists of two small areas of upland blanket bog located to the east of Castlecomer, Co. Kilkenny. The first bog lies in the townland of Coan East, 2.5 km to the north-east of Coan village at the altitude 270 m to 281 m. The second bog is situated 3 km to the north-west of Coan village in the townland of Smithstown. It lies at an altitude of 240 m. Bedrock geology for both areas is shale overlain locally by glacial till. Blanket bog vegetation is well developed in central areas of both bogs although cutover surrounds them. Plantation forestry also surrounds the sites.

Vegetation on the eastern bog is characterised by tall Ling Heather (*Calluna vulgaris*), Cross-leaved Heath (*Erica tetralix*), Hare's-tail Cottongrass (*Eriophorum vaginatum*) and lichen *Cladonia portentosa*. Round-leaved Sundew (*Drosera rotundifolia*) is also common. There are large hummocks of bog mosses *Sphagnum capillifolium* and *S subnitens.* Hollows containing some *S. papillosum* are dominated by Bog Asphodel (*Narthecium ossifragum*). Cranberry (*Vaccinium oxycoccos*), a species more characteristic of raised bogs, is also present and Bilberry (*V. myrtillus*) occurs on larger hummocks along with the moss *Hypnum jutlandicum*. Further east the bog becomes wetter with up to 60% bog moss cover. In this wet area Cranberry is abundant and another characteristic raised bog species, Bog-rosemary (*Andromeda polifolia*) occurs.

The western bog is also dominated by Ling Heather, Crossed-leaved Heath and Hare's-tail Cottongrass with some Bog Asphodel. Bog moss cover reaches 80% and moss *Hypnum jutlandicum* and Lichens (*Cladonia* spp.) also occur. Bog-rosemary and Round-leaved Sundew are also present. This bog becomes drier in the south with Deergrass (*Scirpus cespitosus*) more prevalent. Bog Asphodel occurs on bare peat by the southern cutover.

The cutover around the eastern bog is dominated by Purple Moor-grass *(Molinia caerulea*) with clear-felled plantations at the margins. Cutover on the northern side is planted with new conifer forest. Wet cutover on the eastern side is dominated by Purple Moor-grass with Ling Heather, Bilberry, the moss *Polytrichum commune* and scattered Willow (*Salix* spp.).

The western bog has cutover dominated by Birch (*Betula* spp.) scrub to the east and south and new plantation forest to the west.

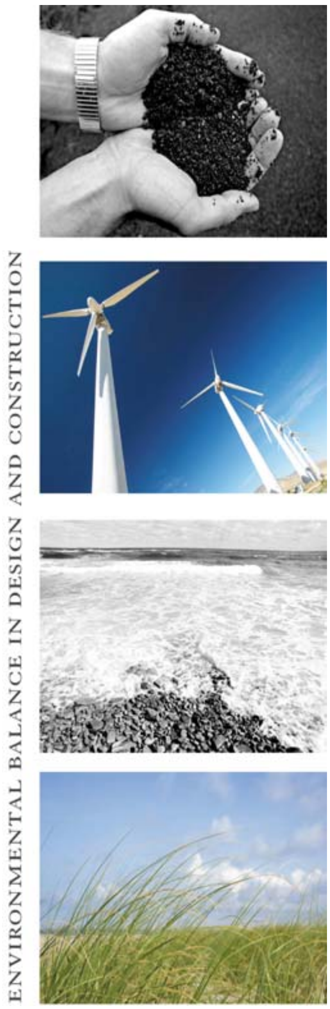
Current landuse on the margins of the western bog consists of mechanical peat-cutting and planting of conifer forest. There is some encroachment of conifer seedlings onto both bogs from surrounding forestry. These activities that have resulted in loss of habitat and damage to the hydrological condition of both areas, pose a continuing threat to their conservation.

Coan Bogs NHA is a site of considerable conservation significance consisting of upland blanket bog. This site, although small, is undisturbed and shows good characteristics of blanket bog with some raised bog indicator species. Blanket bog habitat is a globally scarce resource. It is largely confined to coastal regions at temperate latitudes with cool, wet, oceanic climates. North-west Europe contains some of the best-developed areas of blanket bog in the world. The most extensive areas are found in Ireland and Britain. Upland blanket bogs, due to their exposure to severe climatic conditions at high elevations, are particularly vulnerable to erosion by human activities and extensive areas are currently undergoing active erosion due mainly to overgrazing. The current area of intact upland blanket bog in Ireland represents only a fraction of the original resource, due to the combined impacts of afforestation and overgrazing, and intact examples are therefore extremely valuable for nature conservation. Their long-term survival requires sensitive management.

27.1.2004

APPENDIX 7.3

Natura Impact Statement



Natura Impact Statement
(Stage 2: Appropriate Assessment)

Impacts of Powerstown Landfill, Co. Carlow on Special Area of Conservation 002162

July 2011

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1. INTRODUCTION

The present report is required because surface water from Powerstown Landfill is discharged to the Powerstown Stream, c. 450m upstream of Special Area of Conservation 002162 (River Barrow and River Nore). Under Article 6(3) of the EU Habitats Directive, there is a requirement for an assessment of the implications for the designated site of any development which could potentially impact on the site's conservation objectives. As a screening process could not rule out the possibility of a significant negative impact on the SAC, Pascal Sweeney, Sweeney Consultancy, was contracted by Carlow County Council to carry out a Natura Impact Statement (Stage 2, Appropriate Assessment) to fulfil this obligation. The Department of the Environment, Heritage and Local Government guidance *"Appropriate Assessment of Plans and Projects in Ireland – guidance for Planning Authorities, 2009"* and the European Commission (2001) guidelines *"Assessment of plans and projects significantly affecting Natura 2000 sites - Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC"* are followed. As a conservation plan for the River Barrow and River Nore SAC is not yet available, this report focuses on potential impacts on each specific qualifying feature of the SAC, in the context of the particular site, as well as on the NPWS draft conservation objectives.

Details of the qualifications and experience of Pascal Sweeney, the author of this report, are given in Appendix 1.

2. DESCRIPTION

The development for which impacts on the Conservation Objectives of the River Barrow and River Nore SAC is being assessed, is an existing landfill site, for which the licence (code W0025-02) specifies that there are to be no direct emissions to groundwater and that no raw leachate, treated leachate or contaminated surface water shall be discharged to the Powerstown Stream. All leachate is transported to Mortarstown Waste Water Treatment Plant for disposal. The surface water discharge to the Powerstown Stream is monitored chemically by Carlow Co. Co. and the Powerstown Stream is monitored both chemically and biologically, upstream and downstream of the discharge point.

Because Powerstown Landfill is in operation, its current impact on the Qualifying Interests and Conservation Objectives of the River Barrow and River Nore SAC can be directly assessed.

In this report section, the site of the proposed development is assessed in terms of:

- the presence downstream of the discharge of any protected habitats (Annex I of the EU Habitats Directive);
- the presence downstream of the discharge of any species listed in Annex II of the EU Habitats Directive;
- the water quality of the Powerstown Stream and the River Barrow;
- existing ecological records.

2.1 Relevance to Management of the SAC Site

The Powerstown Landfill is not directly connected with or necessary to the management of the SAC site.

2.2 Site Assessment

Field work was carried out on 7 July, 2011.

The Powerstown Stream was walked from the landfill site, to the confluence with the River Barrow. A general assessment of the site was carried out in line with the Heritage Council draft Guidelines for Survey of Habitats (Draft 2, April 2005) and habitats were classified to level 3 of the Fossitt (2000) classification system. To illustrate the general habitat quality, photographs were taken using a digital camera. Grid references were recorded using a GPS handset.

The status of protected species was assessed as follows:

- The presence of the freshwater pearl mussel (*Margaritifera margaritifera*) was checked for by reference to available records on the distribution of this species.
- The habitat quality for salmon (*Salmo salar*) was assessed, based on the criteria outlined by Bardonnet and Baglinière (2000) for the physical instream requirements of this species for spawning, nursery and adult habitat.
- The habitat quality for the three species of lamprey, the brook lamprey (*Lampetra planeri*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*) was assessed, based on the criteria outlined by Maitland (1980) and by Johns (2002) for the physical instream requirements of these species for spawning, nursery and adult habitat. Available records on the distribution of these species were also checked.
- The habitat quality for crayfish (*Austropotamobius pallipes*) was assessed, based on the criteria outlined by Holdich (2003) for the physical instream requirements of this species and by direct observation.
- The presence of the otter (*Lutra lutra*) was checked for by examination of hard riverside surfaces for the presence of spraints. The habitat quality for this species was assessed, based on the criteria outlined by Chanin (2003). Available records on the distribution of this species were also checked.
- The floating river vegetation habitat was assessed, based on the criteria outlined by Life in UK Rivers (2003).

Available records on the distribution of other protected species and the proximity of protected terrestrial habitats were checked.

Available chemical and biological water quality data were examined.

2.3 Results of Site Assessment

2.3.1 Habitat Description and Classification

The Powerstown Stream, downstream of the surface water discharge, is mainly a shallow, eroding watercourse (Habitat Code FW1), with riffle over stones (Photograph 1, 2) but with some areas of deposition of finer material (Photo 3). There is heavy shading by trees and bushes along most of the southern bank. In less shaded parts, there is some strong growth of marginal plants, mainly *Nasturtium officinale.* The final c. 20m of the stream, to the confluence with the River Barrow at IGR S7013 6859, has recently been dredged. Bovines have access to the stream along most of its course downstream of the road bridge (Photo 4). Downstream of the confluence, the river Barrow is deep and slow-flowing (Habitat Code FW2). Here, the main instream plants are *Nuphar lutea* and *Potamogeton natans,* with *Callitrice spp.* occasional in occurrence.

2.3.2 Protected Habitats and Species

The physical habitat of the Powerstown Stream makes it suitable for the following protected species. Riffle areas are suitable for lamprey spawning, while the depositions of finer material are suitable for burrowing ammocoetes (juveniles).

The habitat is very suitable for crayfish. A recently detached crayfish claw was found (Photo 6).

While the stream is better trout habitat than salmon habitat (trout were seen), it could be used by salmon for spawning and nursery, if the water quality was good enough.

Freshwater pearl mussels do not occur in the Powerstown Stream and is apparently now extinct in the main channel of the River Barrow (Lucey, 1998).

While no otter spraints were found, the habitat is suitable and there is evidence that a good supply of prey is available. Baily and Rochford (2006) recorded positive results at nearly 73% of the sites surveyed within the South Eastern River Basin District, which includes the River Barrow, indicating a widespread distribution of the species.

The main channel of the River Barrow can be classified as a habitat with floating river vegetation.

2.3.3 Biological Water Quality Data

Since 2001, the biological water quality of the Powerstown Stream has been monitored yearly by Conservation Services, by analysis of the macroinvertebrate communities, upstream and downstream of the surface water discharge. Results, expressed as Q-values, are presented in Appendix 4. Since 2005, the Q-value recorded downstream of the discharge point has been the same as that recorded upstream. Since 2007, Q3-4 was recorded at both the upstream and downstream site.

The Q-values recorded in the Powerstown Stream and the River Barrow by EPA are presented in Appendix 5. On the last three sampling occasions (2003, 2006 and 2009), EPA recorded Q4 at the site on the Powerstown Stream downstream of the landfill. Q4 is defined by the European Communities Environmental Objectives (Surface Waters) Regulations 2009 as "Good Ecological Status" and is the standard which, in accordance with these regulations, must be achieved by December 2015.

It should be noted that, in the three years when biological sampling overlapped, the Conservation Services assessment of biological water quality at the site downstream of the landfill was lower than that of EPA. Conservation Services assigned Q3 in 2003 and 2006, and Q3-4 in 2009, while EPA assigned Q4 on all three occasions. This suggests that the Conservation Services assessment is more conservative than EPA and that the Powerstown Stream is possibly in slightly better biological condition than the annual biological monitoring results indicate.

The Powerstown Stream enters the River Barrow between EPA Sites 2600 and 2680. In the last three rounds of biological monitoring (2003, 2006 and 2009) EPA recorded Q4 at Site 2680, with an improvement from Q3-4 at Site 2600 seen in 2003 and 2009. These results indicate that the Powerstown Stream is not negatively influencing the biological water quality of the River Barrow.

2.3.4 Chemical Water Quality Data

Quarterly chemical analysis results that are relevant to the status of the SAC Qualifying Interests are presented in Appendix 6. Apart from suspended solids, none of these results exceed the limits set by the European Communities (Quality of Salmonid Waters) Regulations of 1988 (S.I. No. 293 of 1988) for designated Salmonid Waters. (It should be noted, however, that the River Barrow is not a designated Salmonid Water). Suspended solids levels were generally higher upstream of the surface water discharge.

Orthophosphate results do not indicate any enrichment of the Powerstown Stream by discharge.

Overall, the chemical monitoring does not indicate any significant negative impact of the surface water discharge from the landfill on the Powerstown Stream.

2.3 NATURA 2000 Site

The Site Synopsis for Special Area of Conservation 002162 (River Barrow and River Nore) is given in Appendix 7, all the Qualifying Interests are listed in Appendix 8 and the Conservation Objectives for the site are given in Appendix 9.

3. NATURA IMPACT STAGE TWO – APPROPRIATE ASSESSMENT

3.1 Potential Effects of the Proposed Development on SAC Qualifying Interests.

3.1.1 Annex I Habitats.

Floating River Vegetation (Habitat Code 3260).

Floating river vegetation occurs in the River Barrow downstream of the confluence of the Powerstown Stream. As the chemical monitoring results do not indicate an increase in plant nutrients and as the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on this Qualifying Interest.

Petrifying Springs (Habitat Code 7220).

This habitat is not present close to the area of the landfill and could not be negatively affected.

Eutrophic Tall Herbs (Habitat Code 6430)

Tall herb fringes occur along the banksides of the River Barrow, where it is deep and slow-flowing. While hydrophilous tall herb fringe communities are not listed by Curtis *et al.* (2009) among the water-dependant Annex I habitats, it would appear that this habitat type, while not vulnerable to slight pollution, could be affected by major changes in trophic conditions. However, as the chemical monitoring results do not indicate an increase in plant nutrients and as the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on this Qualifying Interest.

Old Oak Woodlands (Habitat Code 91A0) and **Dry Heath (Habitat Code 4030).**

Terrestrial habitats not present close to the area of the landfill and could not be negatively affected.

Alluvial Wet Woodlands (Habitat Code 91E0).

Alluvial wet woodland occurs along banks of the River Barrow, particularly in the lower reaches and the tidal section. This habitat is not present close to the area of the landfill and could not be negatively affected

Estuary (Habitat Code 1130) and **Tidal Mudflats & Sandflats (Habitat Code 1140).**
Saline habitats, far downstream of the landfill. As the chemical monitoring results do not indicate an increase in plant nutrients and as the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on these Qualifying Interests.

3.1.2 Annex II Species.

Desmoulins' Whorl Snail (*Vertigo moulinsiana*) **(Species Code 1060).**
Vertigo moulinsiana is found in calcareous wetlands, usually adjacent to lowland rivers and lakes (Kerney, 1999). It is known to occur farther downstream in the SAC, near Borris, and there is an old record of it having been found on floating debris at Graiguenamanagh (E. Moorkens, *pers. comm*.).The habitat by the Powerstown Stream is not suitable for this species. As this species is not present close to the area of the landfill and could not be negatively affected.

Freshwater Pearl Mussel (*Margaritifera margaritifera*) **(Species Code 1029)**.
The freshwater pearl mussel is apparently now extinct in the main channel of the River Barrow (Lucey, 1998). A live specimen of freshwater pearl mussel was last found in the River Barrow in 1991, c. 5km upstream of Graiguenamanagh (Grid Ref. S734 477). This location is downstream of the confluence of the Mountain River, which supports a freshwater pearl mussel population and from which this specimen was probably washed into the River Barrow (E. Moorkens, *pers. comm*.). As no viable pearl mussel population is present in the River Barrow, this species could not be affected.

Nore Freshwater Pearl Mussel (*Margaritifera m. durrovensis*) **(Species Code 1990)**.
Within SAC 002162, the Nore freshwater pearl mussel is a sub-species which occurs only in a 10km stretch of the main channel of the River Nore and is not in any part of the River Barrow. Therefore, it could not be affected.

Twaite Shad (*Alosa fallax*) **(Species Code 1103)**.
Twaite shad is an anadromous fish which enters large estuaries in early summer to spawn in gravels near the end of the freshwater reaches. Adult shad are known to occur in the lower parts of the River

Barrow. There is evidence that Twaite shad spawn below the weir at Saint Mullin's. The main threat to the shad population in the River Barrow is the recently arrived Asian clam (Sweeney, 2009) which is likely to have a very significant negative impact on spawning areas. Other threats to Irish shad populations include deterioration of water quality and habitat degradation. However, as the chemical monitoring results do not indicate an increase in plant nutrients and as the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on this Qualifying Interest, no impacts on this species is considered possible, given the distance to Saint Mullin's.

Sea Lamprey (*Petromyzon marinus*) **(Species Code 1095)**, **Brook Lamprey** (*Lampreta planeri*) **(Species Code 1096)** and **River Lamprey** (*Lampreta fluviatilis*) **(Species Code 1099)**.

King (2006) recorded juvenile sea and brook/river lampreys in tributaries of this part the River Barrow, but none in any of the seven main channel sites assessed downstream of Carlow Town. The habitat in the Powerstown Stream is very suitable for lamprey spawning and nursery. A significant drop in water quality or a serious silt insult during the spawning season could negatively affect any lamprey present. However, as the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on these Qualifying Interests.

Atlantic Salmon (*Salmo salar*) **(Species Code 1106)**.

O'Reilly (2002) states that the River Barrow is a fair to good salmon river. While there is some suitable salmon spawning and nursery habitat in the Powerstown Stream, the suitability of the biological water quality is in question. The water quality recorded by Conservation Services would be too poor for a viable salmon nursery stream. The slightly better water quality recorded by EPA would be just suitable, but not ideal. However, as there is no deterioration in the biological water quality from the upstream site to the downstream, there is no evidence of any negative impact on this Qualifying Interest.

White-Clawed Crayfish (*Austropotamobius pallipes*) **(Species Code 1092)**.

Crayfish are present in the Powerstown Stream and are reported by Demers *et al.*, (2005) to be fairly well distributed in the River Barrow catchment. As the biological results do not indicate any recent deterioration in biological water quality downstream of the discharge, there is no evidence of any negative impact on this Qualifying Interest.

Otter (*Lutra lutra*) **(Species Code 1355)**.

Within the South Eastern River Basin District, which includes the River Barrow, Baily and Rochford (2006) recorded positive results at nearly 73% of sites surveyed, indicating a widespread distribution of the species. As the surface water discharge is not negatively affecting otter habitat quality nor availability of prey species, there is no evidence of any negative impact on this Qualifying Interest.

Killarney Fern (*Trichomanes speciosum*) **(Species Code 1421).**

Killarney fern is a terrestrial species, found on very sheltered, damp rock faces (Stace, 1991). As this species is not present close to the area of the landfill and could not be negatively affected.

3.2 Assessment of Significance

The Powerstown Landfill is not resulting in any loss or fragmentation of habitats for which the SAC is designated.

The Powerstown Landfill is not causing significant disturbance to or affecting the population density of any of the species for which the SAC is designated.

The Powerstown Landfill is not causing any significant change to the water resource nor to water quality.

3.3 Potential Cumulative Impacts.

Point sources, diffuse runoff and inputs from tributaries of unsatisfactory water quality are affecting the biological water quality of the River Barrow along the course of the river. This can be seen in the EPA Q-ratings (Appendix 5).

The following facilities in the catchment of the River Barrow between Athy and New Ross have waste licences:

Ballylinan Landfill Site (Tegral Building Products Ltd.), Licence Code W0046-01. This facility does not discharge to surface water. The licence also specifies that there are to be no direct emissions to groundwater.

Ray Whelan Ltd. Waste Transfer Station, Licence Code W0158-01. The licence specifies emission limits for surface water discharges and that there are to be no direct emissions to groundwater.
Athy Civic Amenity Centre, Licence Code W0175-01. The licence specifies that there are to be no emissions to surface water. The licence also specifies conditions and limits for emission to sewer.

Also in the catchment of this section of river, the following have IPPC licences:
Braun Oral B, Code P0287-01. The licence specifies emission limits to the Carlow UDC sewer and also specifies measures for the protection of groundwater and surface water.
Peerless Rugs Europe Ltd., Code P0261-01. The licence specifies conditions and limits for emission to sewer. The licence also specifies the monitoring requirements for surface water discharges of non-process water and actions to be taken if contamination is detected.
Clogrennane Lime Ltd., Code P0400-02. This facility has no emissions to water of environmental significance.
Richard Keenan & Co. Ltd., Code P0555-01. The licence specifies measures for the protection of groundwater and surface water.

Provided that the facilities listed above comply with the terms of their licences, they will not add to cumulative impact on the biological water quality of the River Barrow, or on the Conservation Objectives of Special Area of Conservation 002162.

4. MITIGATION MEASURES

As no negative impacts on the Qualifying Interests of SAC 002162 were detected, it can be stated with full confidence that the Powerstown Landfill is not contributing to any significant cumulative impacts on Conservation Status of the Qualifying Interests of the SAC and is not affecting the site’s Conservation Objectives and no mitigation measures, additional to those already in place, are necessary.

APPENDIX 1

QUALIFICATIONS AND EXPERIENCE OF PASCAL SWEENEY

QUALIFICATIONS:

B.Sc. 1977, UCD (Honours Zoology)

M.Sc. 2000, UCC (Dept. Zoology, Ecology and Plant Science).

MAIN RELEVANT EXPERIENCE:

Freshwater Ecology:

Research:

M.Sc. thesis on aquatic insect populations and eutrophication in the Killarney Lakes.

Irish Lakes Project: Assessment of lake profundal macroinvertebrate community structure in relation to trophic status for a large multi-disciplined project, designed to develop monitoring methodologies for Irish lakes. Co-author of the Final Report (EPA R&D Series No. 12).

Three Rivers Project: Biological research for the development of river basin management systems for the Rivers Boyne, Liffey and Suir (Funded by Dept. of the Environment and Local Government).

National Museum Collection: Compiled of specimen collections of freshwater and estuarine oligochaete worms (Funded by the Royal Irish Academy)

National Biodiversity Data Centre: Database Manager for families of Irish aquatic oligochaete worms.

Natterjack Toad Population Assessment: Two year contract from NPWS to monitor natterjack toad populations and breeding ponds in Co. Kerry (commenced Spring 2011).

Biological Water Quality Monitoring:

Monitoring of biological water quality of rivers (Q-rating) for local authorities (e.g. Wexford Co. Co., North Tipperary Co. Co., Clare Co. Co.), industries (e.g. Glanbia, Dairygold, Irish Sugar, Readimix, Anglo-American Mining) and Eastern River Basin District Catchment Monitoring and Management Project.

Biological water quality assessments of river catchments in Munster and south Leinster for the North South 2 Freshwater Pearl Mussel Sub-Basin Plans.

Impact Assessment:

Impact assessment of proposed developments on freshwater habitats and recommendation of mitigation measures. These developments include roads, gas pipelines, landfills, quarries, hydropower stations, intensive agriculture and industries.

Habitats Directive Natura Impact Statements:

Stage 1, Screening: Reports for 12 small proposed developments in Counties Cork, Waterford and Carlow.

Stage 2, Appropriate Assessment: Reports for 49 local authority waste water treatment plants (23 in Co. Carlow, 25 in Co. Kilkenny and one in Co. Kildare); for four local authority water abstractions in Counties Tipperary and Carlow); for four flood defence schemes (Fermoy, Tullow, Leighlinbridge and Tinnahinch), for one bridge widening project (Grange Br., Co Kilkenny) and for 12 small proposed developments in Counties Cork, Tipperary and Carlow).

Terrestrial Ecology:

Rural Environment Protection Scheme (REPS) and Agri-Environment Options Scheme (AEOS):

Approved as an Environmental Planner (Code 00087) and given a REPS Planning Agency (Code PL044) by Dept. of Agriculture in 1995 following a training course.

Prepared 21 full REPS Plans for participants in REPS 1.

Surveying of lands in NHA/SAC/SPA sites and preparation of Environmental Reports, with management recommendations for REPS/AEOS applicants throughout Munster (over 600 Environmental Reports prepared).

Commonage Framework Planning:

Approved as an Environmental Commonage Framework Planner in 1999 following a training course. Surveyed habitats, assessed vegetation condition and recommended management requirements on commonage blocks in North Cork, Sheep's Head Peninsula, Galtee Mountains and Blackstairs Mountains.

Hen Harrier Farm Planning:

Approved as an NPWS Environmental Farm Planner in 2008 following a training course.
Assessed habitat and vegetation suitability for hen harriers and prescribed management requirements on farms in Cork, Kerry and Limerick. (31 plans to date).

Habitat Surveys and Management Planning of Coillte Property:

Surveyed potential Biodiversity Areas within Forest Management Units 301 (Waterford Uplands), 302 (Waterford Lowlands), 303 (Mid-East Cork). Recommended management requirements, based on habitat and species information collected.

Native Woodland Scheme:

Approved as a Participating Ecologist for the purposes of the Native Woodland Scheme in 2002, following a training course.
Surveying of sites for native woodland conservation and establishment. Preparation of the ecological aspects of the Ecological Survey/Management Plans. (49 plans).

Planning Application Ecological Reports:

Ecological reports to accompany applications for planning for private dwellings located within or close to SAC sites. These reports were prepared prior to the requirement for Habitats Directive reports (33 reports in Co. Cork).

APPENDIX 2

REFERENCES

Bailey, M. and Rochford J. (2006) Otter Survey of Ireland 2004/2005. Irish Wildlife Manuals, No. 23. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Bardonnet, A. and Baglinière, J. (2000). Freshwater habitat of Atlantic salmon. Can. J. Fish. Aquat. Sci. 57: 497 – 506

Chanin, P. (2003) Ecology of the European Otter. Conserving Natura 2000 Rivers Ecology Series No. 10, English Nature, Peterborough.

Clabby, K. *et al* (2006). Interim Report on the Biological Survey of River Quality, Results of the 2004 Investigations *EPA.*

Chilibeck, B., G. Chislett, and G. Norris (1992) Land development guidelines for the protection of aquatic habitat. Department of Fisheries and Oceans, Canada. Habitat management division. Ministry of Environment Lands and Parks. Integrated Management Branch.

Demers, A., Lucey, J., McGarrigle, M. and Reynolds, J. (2005) the distribution of the white-clawed crayfish (*Austropotamobius pallipes*) in Ireland. Biology and Environment: proceeding of the Royal Irish Academy: 105B: 65-69.

Doherty, D., O'Maoiléidigh, N., and McCarthy, T.K. (2004). The biology, ecology and future conservation of the Twaite shad (*Alosa fallax* Lace 'PE' DE), Allis shad (*Alosa alosa* L.) and Killarney shad (*Alosa fallax killarniensis* Tate Regan) in Ireland. Biology and Environment: proceeding of the Royal Irish Academy: 104B: 93-102.

EC (2001). Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC

Hendry, D. and Cragg-Hine, K. (2003) Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Monitoring Series No. 7, English Nature, Peterborough.

Johns, M. (2002). Lampreys: relicts from the past. British Wildlife. 13: 381 - 388.

Life in UK Rivers (2003). Monitoring Watercourses Characterised by *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation Communitites. Conserving Natura 2000 Rivers Monitoring Series No. 11, English Nature, Peterborough.

King, J. (2006) The status and distribution of lamprey in the River Barrow SAC. Irish Wildlife Manuals No. 21. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Lucey, J. (1998). The Barrow, the Nore and the Suir. In: C. Moriarty (ed.*) Studies of Irish rivers and lakes. Essays on the occasion of the XXVII Congress of Societas Internationalis Limnologiae (SIL)*, 99-118 Marine Institute, Dublin

Luker, M. and Montague, K. (1994) Control of pollution from highway drain discharges. Construction Industry Research and Information Association Report 142. CIRIA.

Moorkens, E.A. (2006). Irish non-marine molluscs – an evaluation of species threat status. *Bull. Ir. Biogeog. Soc.* 30: 348-371

Skinner,A, Young M. & Hastie L. (2003). Ecology of the Freshwater Pearl Mussel. Conserving Natura 2000 Rivers Ecology Series No. 2 English Nature, Peterborough.

Solbe, J. (1988). Water quality for Salmon and Trout. Atlantic Salmon Trust.

Stace, C. (1991). New flora of the British Isles. *Cambridge University Press.*

Special Area of Conservation 002162 Site Synopsis, National Parks and Wildlife Service.

Svobodova et al (1993). Water Quality and Fish Health. EIFAC Technical Paper 54. European Inland Fisheries Advisory Commission.

Sweeney, P. (2009). First record of Asian clam *Corbicula fluminea* (Müller) in Ireland. *Irish Naturalists' Journal*. 30: 147-148.

Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCárthaigh, M., Craig M. and Quinn, R. (2005). Water Quality in Ireland 2001-2003. EPA.

APPENDIX 3
PHOTOGRAPHS

Photo 1. Powerstown Stream, eroding habitat.

Photo 2. Powerstown Stream, eroding habitat.

Photo 3. Powerstown Stream, deposition of finer material.

Photo 4. Powerstown Stream, cattle access.

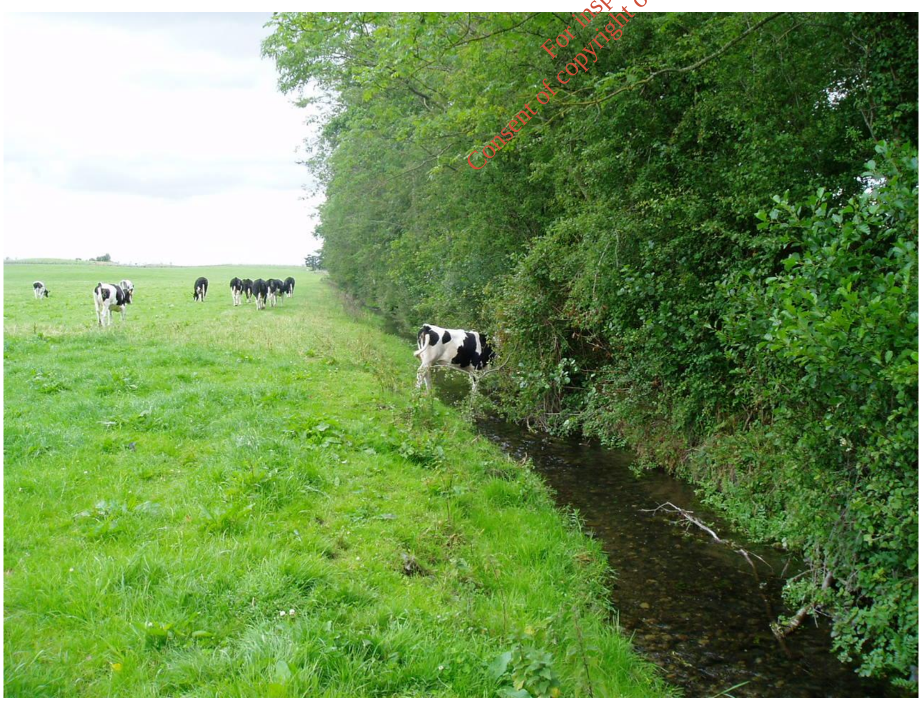

Photo 5. River Barrow.

Photo 6. Crayfish claw.

APPENDIX 4

Biological Water Quality Monitoring Results for Powerstown Stream

Q-value assessments, carried out by Conservation Services

	Site ST2 (upstream of landfill)	Site ST1 (downstream of landfill)
March 2001	Q3 Moderately Polluted	Q3 Moderately Polluted
March 2002	Q3-4 Slightly Polluted	Q3 Moderately Polluted
September 2003	Q3 Moderately Polluted	Q3 Moderately Polluted
September 2004	Q3-4 Slightly Polluted	Q3 Moderately Polluted
November 2005	Q3-4 Slightly Polluted	Q3-4 Slightly Polluted
September 2006	Q3 Moderately Polluted	Q3 Moderately Polluted
September 2007	Q3-4 Slightly Polluted	Q3-4 Slightly Polluted
September 2008	Q3-4 Slightly Polluted	Q3-4 Slightly Polluted
August 2009	Q3-4 Slightly Polluted	Q3-4 Slightly Polluted
September 2010	Q3-4 Slightly Polluted	Q3-4 Slightly Polluted

Site ST1 is the same as EPA site 0400 (see Appendix 5)

APPENDIX 5

EPA Biological Water Quality Results

River and Code: **POWERSTOWN** **14P02**
Tributary Of: 14B01 BARROW OS Catchment No: 183
OS Grid Ref of confluence: S 687 523

Biological Quality Ratings (Q Values)

Station Nos.	**1989**	**1993**	**1997**	**2000**	**2003**	**2006**	**2009**
0200	4	3-4	3-4	3-4	3-4	n/s	-
0400	4	4	3-4	3-4	4	4	4

Station No.	***Station Location***	***National X***	***Grid Ref. Y***	***Discovery Series No.***	***County Code***
0200	Br SE of Powerstown	266638	150792	68	KK
0400	Br u/s Barrow R confl	268492	152047	68	KK

River and Code: **BARROW** **14B01**
Tributary Of: 14B01 BARROW
OS Catchment No: 183
OS Grid Ref of confluence: S 722 388

Biological Quality Ratings (Q Values)

Station Nos.	1980	1982	1986	1989	1991	1994	1997	2000	2003	2005	2006	2008	2009
0050	5	5	5	5	-	5	4-5	4-5	4-5	-	4	-	4
0100	3-4	4-5	4	3	-	3-4	4	4	3-4	-	3	-	4-5
0200	4	4	4	3-4	-	3-4	4	4	3-4	-	4	-	4
0300	5	-	4	4	-	4	3-4	4	4	-	4	-	3-4
0400	5	-	4	4	-	-	-	-	-	-	-	-	-
0500	4	-	4	4	-	3-4	3-4	3-4	3-4	-	3-4	-	3-4
0550	-	-	-	3-4	-	-	-	-	-	-	-	-	-
0600	4	-	4	4	-	4	4	3-4	3-4	-	3-4	-	-
0700	4	4	4-5	4-5	-	4	4	4	4	-	3-4	-	3-4
0760	-	-	-	-	-	-	-	4	-	-	-	-	-
0780	-	-	-	-	-	-	-	-	-	-	-	-	3
0800	3-4	-	4	4	-	4	-	-	-	-	-	-	-
0850	-	-	-	-	-	-	3-4	-	-	-	-	-	-
0900	4	4	4	4	-	4	3-4	3-4	3-4	-	3-4	-	3-4
1000	4	-	4-5	4	-	4	3-4	3-4	4	-	3-4	-	4
1200	5	-	4	3	-	3	-	-	-	-	-	-	-
1300	4	-	4-5	3-4	-	4	-	3-4	3-4	-	3	-	4
1400	4	-	4	4	-	4	4	4	4	-	4	-	-
1500	4	4	4	4	-	4	3-4	3-4	4	-	3-4	-	3-4
1590	-	-	-	-	-	-	3-4	3-4	3-4	-	-	-	-
1600	3	3-4	4	3-4	-	3-4	-	-	-	-	-	-	-
1800	4	4	4	4	-	3-4	-	-	-	-	-	-	-
1900	4	4	4	4	-	4	3-4	4	4	-	4	-	n/s
2000	3	3-4	3-4	3	-	4	3-4	4	4	-	-	-	-
2150	-	3-4	4	4	-	4	-	-	-	-	-	-	-
2200	-	-	-	-	-	-	-	3	4	-	3-4	-	3-4
2400	-	3	1	-	-	-	-	-	-	-	-	-	-
2450	-	3	3-4	4	-	3	3	3	3	-	-	-	-
2455	-	-	-	-	-	-	-	-	-	-	4	-	3-4
2500	3	3	3-4	3-4	-	-	-	-	-	-	-	-	-
2600	3-4	3	3	3-4	-	3-4	3	3	3-4	-	4	-	3-4
2680	-	-	-	-	-	-	3-4	3-4	4	-	4	-	4
2700	3	3-4	3-4	3	-	3	-	-	-	-	-	-	-
2750	-	-	-	-	-	-	4	4	4	-	-	-	-
2800	3	3-4	3-4	3	-	3	-	-	-	-	-	-	-
2900	3	2-3	2-3	2-3	-	3	3-4	3-4	4	-	4	-	4
2910	-	-	3-4	3-4	-	4	4	3-4	3-4	-	4	-	-
3000	4	4	3-4	3-4	-	3-4	3-4	4	3-4	-	4	-	-
3100	4	4	4	3	-	3-4	-	-	3-4	-	3-4	-	3-4
3300	4	4-5	4	4	-	4	-	-	3-4	-	4	-	4
3500	4	4	4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	4	4
3600	-	4	4	-	-	-	-	-	-	-	-	-	-

The Powerstown Stream enters the River Barrow upstream of Site 2680.

Station No.	Station Location	National X	Grid Ref. Y	Discovery Series No.	County Code
0050	Tinnahinch Br	235155	210490	54	LA
0100	Ford S of Rearyvalley	236128	213025	54	LA
0200	Ballyclare Br	238591	214722	54	LA
0300	Twomile Br	242280	211786	54	LA
0400	Bay Br	0	0	54	LA
0500	Borness Br	246396	209279	54	LA
0550	Br SE of Hammerlane	0	0	54	OF
0600	Portnahinch Br	249067	210029	54	OF
0700	Kilnahown Br	251371	210753	54	LA
0760	Barrow Br	253997	212626	55	LA
0780	Portarlington: Spa Br	254267	212860	55	LA
0800	1km d/s Portarlington	0	0	55	LA
0850	D/s Portarlington STW (RHS)	256216	212270	55	LA
0900	Ford S of Trascan	258196	212310	55	LA
1000	Pass Br	262277	210933	55	KE
1200	1km d/s Monasterevan Br	0	0	55	KE
1300	Ford E of Fisherstown House	263295	205798	55	LA
1400	Dunrally Br	263649	201794	55	LA
1500	Bert Br	265925	196929	55	KE
1590	u/s Athy at Boat Club	268061	194455	55	KE
1600	Athy Br	0	0	55	KE
1800	Ardreigh Lock	0	0	55	LA
1900	Tankardstown Br	270366	188203	61	LA
2000	Maganey Br	271712	184733	61	LA
2150	Weir near Knockbeg College	0	0	61	LA
2200	New Br 1km u/s Carlow Br	272007	177797	61	LA
2400	1.5km d/s Graigue Br	0	0	61	LA
2450	At Dolmen Hotel	270638	174158	61	LA
2455	Br at Dolmen Hotel	270591	174098	61	LA
2500	d/s Clogrennan Lock	0	0	61	LA
2600	Milford Br	269917	170497	61	CW
2680	Cardinal Moran Br	269482	166332	61	CW
2700	Leighlinbridge	269067	165467	61	CW
2750	At Island nr Killinane Ho	269534	163800	61	CW
2800	u/s Bagenalstown	270355	163054	61	CW
2900	Royal Oak Br (LHS)	268937	161444	61	CW
2910	Royal Oak Br (RHS)	268937	161444	61	CW
3000	Fenniscourt Lock	269757	159377	68	CW
3100	Goresbridge (100m u/s on LHS)	268437	153717	68	KK
3300	Ballyteigelea Br	271000	150410	68	KK
3500	Graiguenamanagh Br	270973	143540	68	KK
3600	St Mullins	0	0	68	KK

APPENDIX 6
CHEMICAL DATA – CARLOW Co. Co. POWERSTOWN ROUTINE MONITORING

Site	***Quarter***	***BOD mg/l O2***	***COD mg/l O2***	***Suspended Solids mg/l***	***Ortho-phosphate mg/l P***	***Nitrite mg/l N***	***Ammonium mg/l N***	***Dissolved Oxygen % O2***	***Conductivity @ 25°C uS/cm***	***Temperature °C***	**pH**	**Zinc ug/l**	**Copper ug/l**
ST2 Upstream of discharge	Q1 2008	0.9	13	38.8	-		0.083	93.8	805	8.1	7.7		
	Q2 2008	0.9	<8	77.8	<0.006	0.013	0.031	88	799	10.0	7.7		
	Q3 2008	0.6	18	<9.0	<0.006	-	0.02	86.1	853	15.3	8		
	Q4 2008	0.9	<8	15	nm	-	0.024	85.3	832	10.4	7.6		
	Q1 2009	0.8	<8	8	-	-	0.017	91	848	6.2	8		
	Q2 2009	0.7	<8	<24	0.02	-	0.009	103	821	10.9	8.1	<100	<30
	Q3 2009	1.4	<20	nm			0.04	94	890	14.0	7.7		
	Q4 2009	1.9	<20	21			0.06	84	827	8.7	7.7		
	Q1 2010	0.8	<20	33			0.11	89	704	5.8	7.7		
	Q2 2010	0.6	<20	11			0.03	114	757	12.1	7.9		
	Q3 2010	0.5	<20	<5			0.02	86.3	818	15.4	7.9		
	Q4 2010	NM	<20	6	0.05	NM	0.53	83	826	12.1	7.9	<30	<5
	Q1 2011	0.6	<20	9	0.02	-	0.02	113	816	7.9	8.1	22	<0.5
ST1 Downstream of discharge	Q1 2008	0.8	<8	16.8	NR	NR	0.186	88.5	820	8.4	7.7		
	Q2 2008	0.7	<8	38.3	0.007	0.015	0.195	91.6	802	11.5	7.7		
	Q3 2008	0.7	35	<13.6	<0.006	NR	0.12	109.3	834	15.9	7.7	<30	6.66
	Q4 2008	0.6	<8	<12	NR	NR	0.14	nm	821	-	7.6		
	Q1 2009	0.8	<8	16	NR	NR	0.13	98	843	7.3	7.9		
	Q2 2009	1	<8	nm	0.014		0.17	101	813	10.9	7.8	<100	<30
	Q3 2009	0.6	20	nm			0.11	91	871	14	7.6		
	Q4 2009	0.7	<20	15			0.14	85	819	8.7	7.8		
	Q1 2010	1.4	21	35			0.29	86	716	5.8	7.6		
	Q2 2010	0.9	<20	<5			0.26	120	769	12.7	7.8		
	Q3 2010	0.5	34	<5			0.1	87	803	15.1	7.6		
	Q4 2010	NM	<20	<5	0.04	NM	0.34	74	820	11.5	7.6	<30	<5
	Q1 2011	0.5	<20	<5	0.02	-	0.09	102	811	8.7	7.8	18	<0.5

APPENDIX 7

River Barrow and River Nore SAC Site Synopsis

(downloaded from www.npws.ie)

SITE NAME: RIVER BARROW AND RIVER NORE
SITE CODE: 002162

This site consists of the freshwater stretches of the Barrow/Nore River catchments as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary as far downstream as Creadun Head in Waterford. The site passes through eight counties – Offaly, Kildare, Laois, Carlow, Kilkenny, Tipperary, Wexford and Waterford. Major towns along the edge of the site include Mountmellick, Portarlington, Monasterevin, Stradbally, Athy, Carlow, Leighlinbridge, Graiguenamanagh, New Ross, Inistioge, Thomastown, Callan, Bennettsbridge, Kilkenny and Durrow. The larger of the many tributaries include the Lerr, Fushoge, Mountain, Aughavaud, Owenass, Boherbaun and Stradbally Rivers of the Barrow and the Delour, Dinin, Erkina, Owveg, Munster, Arrigle and King's Rivers on the Nore. Both rivers rise in the Old Red Sandstone of the Slieve Bloom Mountains before passing through a band of Carboniferous shales and sandstones. The Nore, for a large part of its course, traverses limestone plains and then Old Red Sandstone for a short stretch below Thomastown. Before joining the Barrow it runs over intrusive rocks poor in silica. The upper reaches of the Barrow also runs through limestone. The middle reaches and many of the eastern tributaries, sourced in the Blackstairs Mountains, run through Leinster Granite. The southern end, like the Nore runs over intrusive rocks poor in silica. Waterford Harbour is a deep valley excavated by glacial floodwaters when the sea level was lower than today. The coast shelves quite rapidly along much of the shore.

The site is a candidate SAC selected for alluvial wet woodlands and petrifying springs, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate SAC for old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Nore Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon, Otter, *Vertigo moulinsiana* and the plant Killarney Fern.

Good examples of Alluvial Forest are seen at Rathsnagadan, Murphy's of the River, in Abbeyleix estate and along other shorter stretches of both the tidal and freshwater elements of the site. Typical species seen include Almond Willow (*Salix triandra*), White Willow (*S. alba*), Grey Willow (*S. cinerea*), Crack Willow (*S. fragilis*), Osier (*S. viminalis*), with Iris (*Iris pseudacorus*), Hemlock Water-dropwort (*Oenanthe crocata*), Angelica (*Angelica sylvestris*), Thin-spiked Wood-sedge (*Carex strigosa*), Pendulous Sedge (*C. pendula*), Meadowsweet (*Filipendula ulmaria*), Valerian (*Valeriana officinalis*) and the Red Data Book species Nettle-leaved Bellflower (*Campanula trachelium*). Three rare invertebrates have been recorded in this habitat at Murphy's of the River. These are: *Neoascia obliqua* (Diptera: Syrphidae), *Tetanocera freyi* (Diptera: Sciomyzidae) and *Dictya umbrarum* (Diptera: Sciomyzidae).

A good example of petrifying springs with tufa formations occurs at Dysart Wood along the Nore. This is a rare habitat in Ireland and one listed with priority status on Annex I of the EU Habitats Directive. These hard water springs are characterised by lime encrustations, often associated with small waterfalls. A rich bryophyte flora is typical of the habitat and two diagnostic species, *Cratoneuron commutatum* var*. commutatum* and *Eucladium verticillatum*, have been recorded.

The best examples of old Oak woodlands are seen in the ancient Park Hill woodland in the estate at Abbeyleix; at Kyleadohir, on the Delour, Forest Wood House, Kylecorragh and Brownstown Woods on the Nore; and at Cloghristic Wood, Drummond Wood and Borris Demesne on the Barrow, though other patches occur throughout the site. Abbeyleix Woods is a large tract of mixed deciduous woodland which is one of the only remaining true ancient woodlands in Ireland. Historical records show that Park Hill has been continuously wooded since the sixteenth century and has the most complete written record of any woodland in the country. It supports a variety of woodland habitats and an exceptional diversity of species including 22 native trees, 44 bryophytes and 92 lichens. It also contains eight indicator species of ancient woodlands. Park Hill is also the site of two rare plants, Nettle-leaved Bellflower and the moss *Leucodon sciuroides.* It has a typical bird fauna including Jay, Long-eared Owl and Raven. A rare invertebrate, *Mitostoma chrysomelas,* occurs in Abbeyleix and only two other sites in the country. Two flies *Chrysogaster virescens* and *Hybomitra muhlfeldi* also occur. The rare Myxomycete fungus, *Licea minima* has been recorded from woodland at Abbeyleix.

Oak woodland covers parts of the valley side south of Woodstock and is well developed at Brownsford where the Nore takes several sharp bends. The steep valley side is covered by Oak (*Quercus* spp.), Holly (*Ilex aquifolium*), Hazel (*Corylus avellana*) and Birch (*Betula pubescens*) with some Beech (*Fagus sylvatica*) and Ash (*Fraxinus excelsior*)*.* All the trees are regenerating through a cover of Bramble (*Rubus fruticosus* agg.)*,* Foxglove (*Digitalis purpurea*) Wood Rush (*Luzula sylvatica*) and Broad Buckler-fern (*Dryopteris dilatata*)*.*

On the steeply sloping banks of the River Nore about 5 km west of New Ross, in County Kilkenny, Kylecorragh Woods form a prominent feature in the landscape. This is an excellent example of a relatively undisturbed, relict Oak woodland with a very good tree canopy. The wood is quite damp and there is a rich and varied ground flora. At Brownstown a small, mature Oak-dominant woodland occurs on a steep slope. There is younger woodland to the north and east of it. Regeneration throughout is evident. The understorey is similar to the woods at Brownsford. The ground flora of this woodland is developed on acidic, brown earth type soil and comprises a thick carpet of Bilberry (*Vaccinium myrtillus*)*,* Heather (*Calluna vulgaris*)*,* Hard Fern (*Blechnum spicant*)*,* Cowwheat (*Melampyrum* spp.) and Bracken (*Pteridium aquilinum*)*.*

Borris Demesne contains a very good example of a semi-natural broad-leaved woodland in very good condition. There is quite a high degree of natural re-generation of Oak and Ash through the woodland. At the northern end of the estate Oak species predominate. Drummond Wood, also on the Barrow, consists of three blocks of deciduous woods situated on steep slopes above the river. The deciduous trees are mostly Oak species. The woods have a well established understorey of Holly (*Ilex aquifolium*), and the herb layer is varied, with Brambles abundant. Whitebeam (*Sorbus devoniensis*) has also been recorded.

Eutrophic tall herb vegetation occurs in association with the various areas of alluvial forest and elsewhere where the flood-plain of the river is intact. Characteristic species of the habitat include Meadowsweet (*Filipendula ulmaria*), Purple Loosestrife (*Lythrum salicaria*), Marsh Ragwort (*Senecio aquaticus*), Ground Ivy (*Glechoma hederacea*) and Hedge Bindweed (*Calystegia sepium*). Indian Balsam (*Impatiens glandulifera*), an introduced and invasive species, is abundant in places.

Floating River Vegetation is well represented in the Barrow and in the many tributaries of the site. In the Barrow the species found include Water Starworts (*Callitriche* spp.), Canadian Pondweed (*Elodea canadensis*), Bulbous Rush (*Juncus bulbosus*), Milfoil (*Myriophyllum* spp.), *Potamogeton* x *nitens,* Broad-leaved Pondweed (*P. natans*), Fennel Pondweed (*P. pectinatus*), Perfoliated Pondweed (*P. perfoliatus*) and Crowfoots (*Ranunculus* spp.). The water quality of the Barrow has improved since the vegetation survey was carried out (EPA, 1996).

Dry Heath at the site occurs in pockets along the steep valley sides of the rivers especially in the Barrow Valley and along the Barrow tributaries where they occur in the foothills of the Blackstairs Mountains. The dry heath vegetation along the slopes of the river bank consists of Bracken (*Pteridium aquilinum*) and Gorse (*Ulex europaeus*) species with patches of acidic grassland vegetation. Additional typical species include Heath Bedstraw (*Galium saxatile*), Foxglove (*Digitalis purpurea*), Common Sorrel (*Rumex acetosa*) and Bent Grass (*Agrostis stolonifera*). On the steep slopes above New Ross the Red Data Book species Greater Broomrape (*Orobanche rapum-genistae*) has been recorded. Where rocky outcrops are shown on the maps Bilberry (*Vaccinium myrtillus*) and Wood Rush (*Luzula sylvatica*) are present. At Ballyhack a small area of dry heath is interspersed with patches of lowland dry grassland. These support a number of Clover species including the legally protected Clustered Clover (*Trifolium glomeratum*) – a species known from only one other site in Ireland. This grassland community is especially well developed on the west side of the mud-capped walls by the road. On the east of the cliffs a group of rock-dwelling species occur, i.e. English Stonecrop (*Sedum anglicum*), Sheep's-bit (*Jasione montana*) and Wild Madder (*Rubia peregrina*). These rocks also support good lichen and moss assemblages with *Ramalina subfarinacea* and *Hedwigia ciliata*.

Dry Heath at the site generally grades into wet woodland or wet swamp vegetation lower down the slopes on the river bank. Close to the Blackstairs Mountains, in the foothills associated with the Aughnabrisky, Aughavaud and Mountain Rivers there are small patches of wet heath dominated by Purple Moor-grass (*Molinia caerulea*) with Heather (*Calluna vulgaris*), Tormentil (*Potentilla erecta*), Carnation Sedge (*Carex panicea*) and Bell Heather (*Erica cinerea*).

Saltmeadows occur at the southern section of the site in old meadows where the embankment has been breached, along the tidal stretches of in-flowing rivers below Stokestown House, in a narrow band on the channel side of Common Reed (*Phragmites*) beds and in narrow fragmented strips along the open shoreline. In the larger areas of salt meadow, notably at Carrickcloney, Ballinlaw Ferry and Rochestown on the west bank; Fisherstown, Alderton and Great Island to Dunbrody on the east bank, the Atlantic and Mediterranean sub types are generally intermixed. At the upper edge of the salt meadow in the narrow ecotonal areas bordering the grasslands where there is significant percolation of salt water, the legally protected species Borrer's Saltmarsh-grass (*Puccinellia fasciculata*) and Meadow Barley (*Hordeum secalinum*) (Flora Protection Order, 1987) are found. The very rare Divided Sedge (*Carex divisa*) is also found. Sea Rush (*Juncus maritimus*) is also present. Other plants recorded and associated with salt meadows include Sea Aster (*Aster tripolium*), Sea Thrift (*Armeria maritima*), Sea Couch (*Elymus pycnanthus*), Spear-leaved Orache (*Atriplex prostrata*), Lesser Sea-spurrey (*Spergularia marina*), Sea Arrowgrass (*Triglochin maritima*) and Sea Plantain (*Plantago maritima*).

Salicornia and other annuals colonising mud and sand are found in the creeks of the saltmarshes and at the seaward edges of them. The habitat also occurs in small amounts on some stretches of the shore free of stones.

The estuary and the other Habitats Directive Annex I habitats within it form a large component of the site. Extensive areas of intertidal flats, comprised of substrates ranging from fine, silty mud to coarse sand with pebbles/stones are present. Good quality intertidal sand and mudflats have developed on a linear shelf on the western side of Waterford Harbour, extending for over 6 km from north to south between Passage East and Creadaun Head, and in places are over 1 km wide. The sediments are mostly firm sands, though grade into muddy sands towards the upper shore. They have a typical macro-invertebrate fauna, characterised by polychaetes and bivalves. Common species include *Arenicola marina*, *Nephtys hombergii*, *Scoloplos armiger*, *Lanice conchilega* and *Cerastoderma edule*.

The western shore of the harbour is generally stony and backed by low cliffs of glacial drift. At Woodstown there is a sandy beach, now much influenced by recreation pressure and erosion. Behind it a lagoonal marsh has been impounded which runs westwards from Gaultiere Lodge along the course of a slow stream. An extensive reedbed occurs here. At the edges is a tall fen dominated by sedges (*Carex* spp.), Meadowsweet, Willowherb (*Epilobium* spp.) and rushes (*Juncus* spp.). Wet woodland also occurs. This area supports populations of typical waterbirds including Mallard, Snipe, Sedge Warbler and Water Rail.

The dunes which fringe the strand at Duncannon are dominated by Marram grass (*Ammophila arenaria*) towards the sea. Other species present include Wild Sage (*Salvia verbenaca*), a rare Red Data Book species. The rocks around Duncannon ford have a rich flora of seaweeds typical of a moderately exposed shore and the cliffs themselves support a number of coastal species on ledges, including Thrift (*Armeria maritima*), Rock Samphire (*Crithmum maritimum*) and Buck's-horn Plantain (*Plantago coronopus*).

Other habitats which occur throughout the site include wet grassland, marsh, reed swamp, improved grassland, arable land, quarries, coniferous plantations, deciduous woodland, scrub and ponds.

Seventeen Red Data Book plant species have been recorded within the site, most in the recent past. These are Killarney Fern (*Trichomanes speciosum*), Divided Sedge (*Carex divisa*), Clustered Clover (*Trifolium glomeratum*), Basil Thyme (*Acinos arvensis*)*,* Hemp nettle (*Galeopsis angustifolia*)*,* Borrer's Saltmarsh Grass (*Puccinellia fasiculata*)*,* Meadow Barley (*Hordeum secalinum*)*,* Opposite-leaved Pondweed (*Groenlandia densa*)*,* Autumn Crocus (*Colchicum autumnale*)*,* Wild Sage (*Salvia verbenaca*), Nettle-leaved Bellflower (*Campanula trachelium*)*,* Saw-wort (*Serratula tinctoria*)*,* Bird Cherry (*Prunus padus*)*,* Blue Fleabane (*Erigeron acer*)*,* Fly Orchid (*Ophrys insectifera*), Broomrape (*Orobanche hederae*) and Greater Broomrape (*Orobanche rapum-genistae*)*.* Of these the first nine are protected under the Flora Protection Order 1999. Divided Sedge (*Carex divisa*) was thought to be extinct but has been found in a few locations in the site since 1990. In addition plants which do not have a very wide distribution in the country are found in the site including Thin-spiked Wood-sedge (*Carex strigosa*)*,* Field Garlic (*Allium oleraceum*) and Summer Snowflake (*Leucojum aestivum*). Six rare lichens, indicators of ancient woodland, are found including *Lobaria laetevirens* and *L. pulmonaria.* The rare moss *Leucodon sciuroides* also occurs.

The site is very important for the presence of a number of EU Habitats Directive Annex II animal species including Freshwater Pearl Mussel (*Margaritifera margaritifera* and *M. m. durrovensis*), Freshwater Crayfish (*Austropotamobius pallipes*), Salmon (*Salmo salar*), Twaite Shad (*Alosa fallax fallax*), three Lamprey species - Sea (*Petromyzon marinus*), Brook (*Lampetra planeri*) and River (*Lampetra fluviatilis*), the marsh snail *Vertigo moulinsiana* and Otter (*Lutra lutra*). This is the only site in the world for the hard water form of the Pearl Mussel *M. m. durrovensis* and one of only a handful of spawning grounds in the country for Twaite Shad. The freshwater stretches of the River Nore main channel is a designated salmonid river. The Barrow/Nore is mainly a grilse fishery though spring salmon fishing is good in the vicinity of Thomastown and Inistioge on the Nore. The upper stretches of the Barrow and Nore, particularly the Owenass River, are very important for spawning.

The site supports many other important animal species. Those which are listed in the Irish Red Data Book include Daubenton's Bat (*Myotis daubentoni*)*,* Badger (*Meles meles*), Irish Hare (*Lepus timidus hibernicus*) and Frog (*Rana temporaria*). The rare Red Data Book fish species Smelt (*Osmerus eperlanus*) occurs in estuarine stretches of the site. In addition to the Freshwater Pearl Mussel, the site also supports two other freshwater Mussel species, *Anodonta anatina* and *A. cygnea*.

The site is of ornithological importance for a number of E.U. Birds Directive Annex I species including Greenland White-fronted Goose, Whooper Swan, Bewick's Swan, Bartailed Godwit, Peregrine and Kingfisher. Nationally important numbers of Golden Plover and Bar-tailed Godwit are found during the winter. Wintering flocks of migratory birds are seen in Shanahoe Marsh and the Curragh and Goul Marsh, both in Co. Laois and also along the Barrow Estuary in Waterford Harbour. There is also an extensive autumnal roosting site in the reedbeds of the Barrow Estuary used by Swallows before they leave the country.

Landuse at the site consists mainly of agricultural activities – many intensive, principally grazing and silage production. Slurry is spread over much of this area. Arable crops are also grown. The spreading of slurry and fertiliser poses a threat to the water quality of the salmonid river and to the populations of Habitats Directive Annex II animal species within the site. Many of the woodlands along the rivers belong to old estates and support many non-native species. Little active woodland management occurs. Fishing is a main tourist attraction along stretches of the main rivers and their tributaries and there are a number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. Both commercial and leisure fishing takes place on the rivers. There is net fishing in the estuary and a mussel bed also. Other recreational activities such as boating, golfing and walking, particularly along the Barrow towpath are also popular. There is a golf course on the banks of the Nore at Mount Juliet and GAA pitches on the banks at Inistioge and Thomastown. There are active and disused sand and gravel pits throughout the site. Several industrial developments, which discharge into the river, border the site. New Ross is an important shipping port. Shipping to and from Waterford and Belview ports also passes through the estuary.

The main threats to the site and current damaging activities include high inputs of nutrients into the river system from agricultural run-off and several sewage plants, overgrazing within the woodland areas, and invasion by non-native species, for example Cherry Laurel and Rhododendron (*Rhododendron ponticum*). The water quality of the site remains vulnerable. Good quality water is necessary to maintain the populations of the Annex II animal species listed above. Good quality is dependent on controlling fertilisation of the grasslands, particularly along the Nore. It also requires that sewage be properly treated before discharge. Drainage activities in the catchment can lead to flash floods which can damage the many Annex II species present. Capital and maintenance dredging within the lower reaches of the system pose a threat to migrating fish species such as lamprey and shad. Land reclamation also poses a threat to the salt meadows and the populations of legally protected species therein.

Overall, the site is of considerable conservation significance for the occurrence of good examples of habitats and of populations of plant and animal species that are listed on Annexes I and II of the E.U. Habitats Directive respectively. Furthermore it is of high conservation value for the populations of bird species that use it. The occurrence of several Red Data Book plant species including three rare plants in the salt meadows and the population of the hard water form of the Pearl Mussel which is limited to a 10 km stretch of the Nore, add further interest to this site.

16.1.2003

APPENDIX 8

River Barrow and River Nore SAC Qualifying Interests

(from www.npws.ie)

Annex I Habitats

EU Habitat Code	Habitat Name
91A0	Old sessile oak woods with Ilex and Blechnum in British Isles
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
1310	Salicornia and other annuals colonizing mud and sand
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)
1410	Mediterranean salt meadows (Juncetalia maritimi)
4030	European dry heaths
7220	Petrifying springs with tufa formation (Cratoneurion)
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
1320	Spartina swards (Spartinion maritimae)
1140	Mudflats and sandflats not covered by seawater at low tide
1130	Estuaries

Annex II Species

EU Species Code	Species Taxonomic Name	Species Common Name
1029	*Margaritifera margaritifera*	Freshwater Pearl Mussel
1990	*Margaritifera durrovensis*	Nore Pearl Mussel
1016	*Vertigo moulinsiana*	Desmoulins' whorl snail
1095	*Petromyzon marinus*	Sea Lamprey
1096	*Lampetra planeri*	Brook Lamprey
1099	*Lampetra fluviatilis*	River Lamprey
1102	*Alosa alosa*	Allis Shad
1103	*Alosa fallax*	Twaite Shad
1106	*Salmo salar*	Atlantic Salmon
1355	*Lutra lutra*	European Otter
1092	*Austropotamobius pallipes*	White Clawed Crayfish
1421	*Trichomanes speciosum*	Killarney Fern

APPENDIX 9

NPWS Generic Draft Conservation Objectives for cSAC 002162

The overall aim of the Habitats Directive is to maintain or restore the favourable conservation status of habitats and species of community interest. These habitats and species are listed in the Habitats and Birds Directives and Special Areas of Conservation and Special Protection Areas are designated to afford protection to the most vulnerable of them. These two designations are collectively known as the Natura 2000 network.

European and national legislation places a collective obligation on Ireland and its citizens to maintain at favourable conservation status areas designated as candidate Special Areas of Conservation. The Government and its agencies are responsible for the implementation and enforcement of regulations that will ensure the ecological integrity of these sites.

According to the EU Habitats Directive, favourable conservation status of a habitat is achieved when:

• its natural range, and area it covers within that range, is stable or increasing, and

• the ecological factors that are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and

• the conservation status of its typical species is favourable as defined below.

The favourable conservation status of a species is achieved when:

• population data on the species concerned indicate that it is maintaining itself, and

• the natural range of the species is neither being reduced or likely to be reduced for the foreseeable future, and

• there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Objective: To maintain or restore the favourable conservation condition of the Annex I habitat(s) and /or the Annex II species for which the SAC has been selected:

Margaritifera margaritifera [1029]

Austropotamobius pallipes [1092]

Petromyzon marinus [1095]

Lampetra planeri [1096]

Lampetra fluviatilis [1099]

Alosa fallax [1103]

Salmo salar (only in fresh water) [1106]

Estuaries [1130]

Mudflats and sandflats not covered by seawater at low tide [1140]

Salicornia and other annuals colonizing mud and sand [1310]

Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330]

Lutra lutra [1355]

Mediterranean salt meadows (Juncetalia maritimi) [1410]

Trichomanes speciosum [1421]

Margaritifera durrovensis (Margaritifera margaritifera) [1990]

Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]

European dry heaths [4030]

Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]

Petrifying springs with tufa formation (Cratoneurion) [7220]

Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]

Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]

Appendix 8

Revised Design Calculations for Attenuation Pond

Powerstown Landfill Site, Surface Water Attenuation Volume

Return Period	30 Years					
Capped area (in ha)	***3.5***	35000 m2	Paved Area (Ha)	0.9	9470 m2
Runoff coeficient (capping)	0.3		Runoff Coeff	1.0	

Ref. Met. Office - Oak Park

Rainfall duration hrs	**Rainfall Depth*1.1** mm	**Total volume of runoff** m^3	**Average flow** m^3/s
0.25	19.1	382.226	0.425
0.5	24.4	487.667	0.271
1	29.7	593.109	0.165
2	36.3	724.911	0.101
4	44.0	878.680	0.061
6	49.5	988.515	0.046
12	61.6	1230.152	0.028
24	71.5	1427.855	0.017
48	84.7	1691.459	0.010

Outlet flow = Qbar = ***0.0159*** m^3/s

Duration hrs	**Runoff** m^3/s	**Flow to be stored** m^3/s	**Storage Volume** m^3
0.25	0.4247	0.409	368
0.5	0.2709	0.255	459
1	0.1648	0.149	536
2	0.1007	0.085	611
4	0.0610	0.045	650
6	0.0458	0.030	645
12	0.0285	0.013	544
24	0.0165	-	-
48	0.0098	-	-

Use Storage size **650** m^3

For the given Storm events the following retention times apply

Duration Hrs	Retention times hrs
0.25	6.4
0.5	8.0
1	9.4
2	10.7
4	11.4
6	11.3
12	9.5
24	-
48	-

54000 m2
5.400 ha
0.05400 km2

Greenfield Site Area km2	SAAR mm	SOIL	QBAR m3/s
0.05400	950	0.225	0.0096

Notes: S1(50), S2(50)

1) QBAR = 0.00108 $(Area^{0.89})(SAAR^{1.17})(Soil^{2.17})$ for catchments less than 24ha
(Inst. Hyd. Report No. 124)

Q30 = Qbar * 1.65 = **0.0159** m3/s

Sizing of the Surface Water Attenuation Pond

Site: **Powerstown Landfill and Civic Amenity Facility**

Location: Pond at Boundary to North East of Site

Live volume =		**650**	m3	Volume required by T30Q30	
Length of the pond, L =		77	m	input	
Width of the Pond, W=		16	m	input	
Side slope = 1V:ZH	Z =	3		input	
Free board =		0.65	m	input	
Live depth =		1.3	m	input	from invert of orifice outfall
Permanent depth =		0.5	m	input	
Total depth =		2.45	m		
Live and dead storage (total water) depth =		1.8	m		3m is Max. allowable
Surface Area of the pond =		1232	m2		
Top water level length =		73.1	m		
Top water level width =		12.1	m		
Area at top water level, A =		885	m2		
Permanent water level length =		65.3	m		
Permanent water level width =		4.3	m		
Area at permanent water level, a =		280.79	m2		
Bottom width, b =		1.3	m		
Bottom Length, l =		62.3	m		
Bottom area =		80.99	m2		
Calculated live volume = H/3*(A+a+sqrt(Aa))* =		**721**	m3	Volume provided in 'As Built' Attenuation Pond	
Permanent volume** =		85	m3		
Freeboard volume =		685	m3		
Total volume excavation =		1491	m3		

Check for Efficient Nutrient Removal & Suspended Solids Removal:

*CIRIA B14 Section 6.4.2. states that the requirement for the effective removal of nutrients i.e. 50 -60 % removal is to provide a live volume of 150 - 250 m3 per impervious hectare

Impervious Area	1.95	ha	X	250	m3	=	487.5	m3	ok

Appendix 9

Groundwater Monitoring Results




Surface Water Monitoring Results

Parameter	Monitoring Location	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011
Ammonia mg/l N	ST1 d/s	0.186	0.195	0.12	0.14	0.13	0.17	0.11	0.14	0.29	0.26	0.1	0.34	0.09	0.09	0.02	0.04
	ST2 u/s	0.083	0.031	0.02	0.024	0.017	0.009	0.04	0.06	0.11	0.03	0.02	0.53	0.02	0.02	<0.01	0.02
	Pond Inlet	nm	nm	nm	nm	nm	0.01	0.05	0.01	0.11	<0.01	0.02	0.33	0.05	0.01	<0.01	0.01
	Pond Outlet	nm	nm	nm	nm	nm	0.009	0.07	<0.01	0.06	<0.01	<0.01	0.4	0.23	0.03	<0.01	<0.01
Chloride mg/l	ST1 d/s	29	29	30	26	30	26	23	20	27	26	22	24	26	25	27	25
	ST2 u/s	27	25	25	24	27	24	21	19	25	22	21	23	23	23	25	23
	Pond Inlet	nm	nm	nm	nm	nm	21	20	21	21	18	17	7	19	17	17	8
	Pond Outlet	nm	nm	nm	nm	nm	21	21	22	21	19	17	16	18	18	17	16
Conductivity µS/cm	ST1 d/s	820	802	834	821	843	813	871	819	716	769	803	820	811	784	798	852
	ST2 u/s	805	799	853	832	848	821	890	827	704	757	818	826	816	817	797	861
	Pond Inlet	nm	nm	nm	nm	nm	740	753	747	733	724	733	342	736	747	770	253
	Pond Outlet	nm	nm	nm	nm	nm	727	735	734	747	726	722	712	720	726	745	745
Suspended Solids mg/l	ST1 d/s	16.8	38.3	<13.6	<12	16	nm	nm	15	35	<5	<5	<5	<5	10	nr	<5
	ST2 u/s	38.8	77.8	<9.0	15	8	<24	nm	21	33	11	<5	6	9	12	56	<5
	Pond Inlet	nm	nm	nm	nm	nm	nm	nm	<5	97	<5	<5	<5	25	8	84	16
	Pond Outlet	nm	nm	nm	nm	nm	nm	nm	<5	96	<5	<5	<5	<5	<5	<5	<5

nm not measured
u/s upstream
d/s downstream

Appendix 10

Closure, Restoration and Aftercare Management Plan (CRAMP)

May 2011

CARLOW COUNTY COUNCIL

COMHAIRLE CHONTAE CHEATHARLOCHA

Powerstown Landfill

Waste Licence Reg. No. W0025-03

Closure, Restoration and Aftercare Management Plan

(CRAMP)

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Title: Closure, Restoration and Aftercare Management Plan (CRAMP)

Job Number: E0797

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Revision Record

Issue No.	Date	Description	Remark	Prepared	Checked	Approved
1	03/05/11	CRAMP	Final	JA	SM	SM

Closure, Restoration and Aftercare Management Plan

Powerstown Landfill & Civic Amenity Site.,
Waste Licence W0025-03,
Carlow County Council

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1.0 Introduction

Malone O'Regan has been commissioned by Carlow County Council to carry out a Closure, Restoration and Aftercare Management Plan (CRAMP) for the Powerstown Landfill & Civic Amenity (PLCA) site.

The site operates under the conditions of the EPA Waste licence W0025-03. While there is no specific requirement to carry out a CRAMP under the current waste licence, condition 4 of the licence does outline details required in decommissioning and restoring the Powerstown landfill facility.

Specifically condition 4.1 of the Waste Licence W0025-03 states the following:

4.1 The licensee shall restore the facility on a phased basis. The Restoration and Aftercare Plans for the facility shall include the plan submitted in Attachment G and Section 2.12.14 of the EIS unless where otherwise required under conditions of this licence.

Furthermore, the following conditions also apply with regard to closure, restoration and aftercare:

4.2 Unless otherwise agreed by the Agency, filled cells shall be permanently capped within 24 months of the cells having been filled to the required level.

4.3 The final profile/height of the facility
4.3.1 The final profile of the facility shall be based on that shown in Drawing No.2003- 120-0 1-0 12 - "Proposed Final Contours" subject to the maximum slopes on the extended areas being no greater than 1 in 3.
4.3.2 The maximum final height of the facility shall be 64.0 mOD Malin.

4.4 Final Capping

4.4.1 Unless otherwise agreed with the Agency, the final capping shall consist of the following:
a) Top soil (150- 300mm)
b) Subsoil, such that the total thickness of top and sub-soils is at least 1m.
c) Drainage layer of 0.5m thickness having a minimum hydraulic conductivity of $1x10^{-4}$ m/s or an equivalent geosynthetic layer.
d) Compacted mineral layer of a minimum 0.6m thickness with a permeability of less than $1x10^{-9}$ m/s or a geosynthetic material (e.g. GCL) or similar that provides equivalent protection.
e) Gas collection layer of natural material (minimum thickness 0.3m) or a geosynthetic layer.
In the case of the unlined landfill area, in addition to the above, the compacted mineral layer shall be augmented by a 1mm flexible membrane layer, such as LLDPE.

4.5 No material or object that is incompatible with the proposed restoration of the facility shall be present within one metre of the final soil surface levels.

4.6 Where tree planting is to be carried out above waste-filled areas, a synthetic barrier shall be used to augment the clay cap. Combined topsoil and subsoil depths shall be a minimum of 1m.

4.7 The restoration of the landfill facility shall be completed within 12 months of completion of final capping at the landfill facility.

4.8 Soil Storage

4.8.1All soils shall be stored to preserve the soil structure for future use.

4.9 A final validation report to include a certificate of completion for the Restoration and Aftercare Plan, for all or part of the site as necessary, shall be submitted to the Agency within three months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment.

1.1 Methodology

The 'Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision' published by the EPA in 2006 was used as a methodology for the preparation of the plan documented herein. Due regard has also been given to the landfill manuals 'Landfill Restoration and Aftercare' and 'Landfill Site Design' published by the EPA in 1999 and 2000.

The objectives of this report include:

- Evaluation of the existing site (pollution control, environmental monitoring, current non-compliances, etc.),
- Consideration of criteria that will be required for a successful closure,
- Estimation of costs associated with successful closure criteria,
- Plan implementation, updating and review.

The following documents were also consulted in order to prepare the CRAMP:

- PLCA Environmental Management System (EMS) 2009.
- PLCA Awareness, Training and Corrective Action Procedure.
- PLCA Waste Licence Review Application by Fehily Timoney & Co. (June 2003).
- PLCA Restoration and Aftercare Plan (2002).
- Environmental Impact Statement (EIS) for the proposed Extension of Powerstown Landfill (Fehily Timoney & Co., June 2003).
- PLCA Annual Environmental Reports (AER) 2008 and 2009.
- An Bord Pleanala (ABP) Inspector's Report, Extension to Powerstown Landfill Site, County Carlow (File Ref. PL01.EL.2020).

A site walkover and interview of key staff members was also carried out in October 2010 to ascertain the full extent of current operations and restoration measures completed to date.

1.2 CRAMP Report Structure

Sections 1 and 1.1 above provide an overview of the need for the CRAMP and methodology for the assessment.

Section 2 provides a site description and evaluation which sets out the background to determining Section 3 – Scope of the CRAMP.

Section 3 outlines the scope of the CRAMP in terms of infrastructure, activities and issues that are covered in the plan.

Section 4 describes the proposed criteria to be used to demonstrate successful non clean closure, restoration and aftercare.

Section 5 describes the CRAMP in a Project Management style with discrete stages and associated tasks.

Section 6 outlines the management team responsible for implementing the CRAMP.

Sections 7 & 8 set out the estimated cost of the closure, restoration and aftercare management as described in previous sections of this document and describe the financial provisions in place.

Section 9 describes the CRAMP review and the requirement for a documented closure validation audit.

2.0 Site Assessment

2.1 Site Location and Overview

2.1.1 Site Location

PLCA is a municipal landfill and civic amenity site owned and operated by Carlow County Council. The site covers approximately 23.9 ha in the townland of Powerstown, located adjacent to the N9 Kilkenny to Carlow road. The facility is approximately 4Km north of Leighlinbridge and approximately 6km south of Carlow Town. The site boundaries include the Powerstown Stream, a tributary of the River Barrow, to the north, the N9 roadway to the west, a third class road which is used to access the site to the south and agricultural lands to the east.

2.1.2 Landfill Site Overview

The landfill facility has been developed in three phases:

- Phase one consisting of the old uncontained landfill to the south of the site covering an area of approximately 2.5 ha. This landfill was filled from 1976 to 1990 and is permanently capped.
- Phase Two consisting of the engineering landfill cells 1 to 13, which were filled since the closure of the old landfill since 1990 until August 2006. Cells 1-5 were permanently capped in 2002. Cells 6-13 to the east of the site were permanently capped during 2008.
- Phase Three consists of four engineered landfill cells (Cells 15-18), currently being filled with municipal waste.

The landfill is currently licensed to accept waste at an annual rate of approximately 40,000 tonnes. The current estimated remaining capacity is 174,153 m^3 based on calculations by Fehily Timoney & Company using the most recent topographical survey (March 2010) and a Survey Control Centre software package. On this basis the current phase is expected to close in 2014, however it may be open for longer as waste acceptance rates have dropped in recent times due to the economic slowdown.

The site layout is shown in Figure1.

2.1.3 Site Facilities

Site facilities include the Civic Amenity Facility, green waste/compost area, waste quarantine/ inspection area and the administration building. Services onsite include ESB, water supply and sanitary facilities. The sewage and wastewater from the administration building is directed to a small waste water treatment system for primary treatment.

The heating for the office is supplied from an aboveground bunded oil tank which is located adjacent to the office.

Site security consists of a chainlink perimeter fence, security gate and CCTV at the site entrance and selected points around the perimeter.

2.2 Environmental Sensitivity

2.2.1 Geology

Site investigations indicate that sand and gravel deposits are extensive beneath the site. It is estimated that over 15m thick of sand and gravel lie directly on fresh, coarse limestone. The sand and gravel is fluvio-glacial in origin. Peaty silt, marl and boulder sediments are present in small areas of Phase 2. The finer grained silts are generally confined to low points and hollows in the ground.

2.2.2 Hydrology

PLCA is located within the catchment area of the River Barrow, located approximately 600m west of the landfill. The River Barrow rises in the Slieve Bloom Mountains in County Laois and flows for approximately 170 km through Counties Kildare, Carlow and Wexford before entering the sea at Waterford Harbour. The Powerstown stream, a tributary of the River Barrow, flows in a westerly direction along the boundary of the site towards the River Barrow.

2.2.3 Hydrogeology

The principal aquifer beneath the site and surrounding Barrow Lowlands is dolomitised Lower Carboniferous limestone. Fluvio-glacial sand and gravel deposits are extensive and widespread throughout the River Barrow Valley and where sufficiently thick are classified as locally important gravel aquifers. Groundwater is present at or near the surface in the peaty silts and marls, however these sediments are not considered as aquifers. Regionally groundwater flow direction beneath the site within the sand and gravel deposits is west towards the River Barrow; and local northern flow component beneath the site discharges to the Powerstown Stream. Regionally groundwater movement within the dolomitised limestone is dominated fissure flow and flow direction is generally to the west.

2.2.4 Sensitive Receptors

There are approximately 15 dwellings within 500m of the site with the nearest sensitive receptor located within 50 m of the site boundary.

2.2.5 RBME Returns

Further information relating to the environmental sensitivity of the site and its environs is included in the OEE Methodology for Determining the Enforcement Category for the site in Appendix 1. The facility, in terms of location, is classified as within a high enforcement category due to the proximity of ecological and sensitive receptors and due to the groundwater vulnerability status.

2.3 Environmental Evaluation

2.3.1 Onsite Control Systems

Landfill Gas Management
Landfill gas is emitted from the landfill through two processes; namely through direct emissions of uncaptured landfill gas from the waste body to atmosphere and through the capture of gas in the landfill gas collection system which is directed to the landfill gas flare.

Improvements in the gas collection system were carried out during 2008-2009 in phase 1 and 2. A network of landfill gas collection pipes were incorporated as part of the final capping of the cells 6-13 (phase 2). The gas collection system consists of vertical gas extraction wells drilled into the existing waste mass at approximately 40 meter centres. The wells are actively abstracted and are directed to the new gas flare system which was installed in 2008 and has a capacity of 1000m^3/h.

Additional temporary gas wells and an associated collection pipework system were installed in 2009 at the active cells in order to increase the collection rates in Cells 15 and 16 (phase 3).

Gas monitoring wells are located in the following locations:

- Main office area and weighbridge where continuous monitoring gas analysers are in place.
- Perimeter boreholes G1-G46.
- Landfill Gas boreholes TP11-TP17.

A map with all the monitoring locations is included in Appendix B.

Leachate Control
The leachate in the landfill is contained within the lined cells (phase 2 and 3). The provision of earthen bunds around the waste cells ensures that there is no sudden release of leachate from the waste body. Leachate is pumped from the landfill cells to a storage lagoon and a tank before being transported to a local waste water treatment plant. A supervisory control and data acquisition system (SCADA) is in place for phase 3 in order to monitor leachate levels in lined cells and leakage into the leak detection/collection layer.

Surface Water Management
Surface water run-off at Powerstown landfill is collected by a series of engineered channels and drains. All surface water run off is directed to a surface water retention pond, whereby suspended solids present in the water are allowed to settle before the water is discharged via an overflow pipe to the nearby Powerstown Stream. Continuous monitoring (Total Organic Carbon (TOC), pH, conductivity) is carried out in the stormwater retention pond and is connected to the SCADA.

2.3.2 Environmental Performance

The main objective for Carlow County Council is to fully implement the conditions of the waste licence W0025-03. The facility operates under an Environmental Management System (EMS), the main goal of which is to promote the continual environmental improvement through specific environmental objectives. The EMS defines the responsibility and authority for initiating further investigation and corrective action in the event of a non-compliance.

As part of this assessment a description of the main environmental issues at the site are described below. The assessment also includes any complaints and incidents recorded during 2009.

Environmental Issues

Groundwater
Ongoing groundwater monitoring data (specifically data for ammoniacal nitrogen and chloride) in down gradient groundwater wells (GW1, GW2 and GW8) compared to up gradient wells (RCA1 and RCA2) indicates that the quality of groundwater downgradient of the facility has been impacted on to some degree. It is considered that leachate percolating from the unlined landfill may be contributing to the deterioration of groundwater quality. According to the AER 2009, a previous assessment (GESL, 2001) concluded that there is significant attenuation of contaminants leaving the landfill structure and that this attenuation is attributed to an estimated annual through flow of 4000m^3 in the bedrock aquifer beneath the landfill.

There are currently no private wells located within 500m of the facility which could be impacted on.

Surface Water
Chemical water quality assessment of the Powerstown Stream is carried out quarterly by the EPA. Monitoring results indicate that there is no significant difference in water quality between upstream and downstream stations, with the exception of ammonia which is slightly elevated downstream.

The biological assessment shows that the water quality remains the same relative to the 2007 assessment. Historically the biological water quality of the stream has fluctuated between moderately and slightly polluted. However, the cause of historical deteriorations and recovery of biological water quality is unlikely to result from activities at the site as the assessment shows similar conditions both upstream and downstream.

In addition to the monitoring of the Powerstown Stream, the waste licence requires that the outlet from the Surface Water Retention Pond be monitored. Analysis indicated that the trigger level of 5 mg/l for Total Organic Carbon was not exceeded during 2009.

Odour
Odour monitoring is carried out by Odour Monitoring Ireland. A number of zones of surface emissions from flanked and open areas and a number of wellheads that exceeded recommended limits (as per condition 8.14.6 of the waste licence) were identified during 2009. These were mainly associated with inadequate landfill gas extraction from the active cells (Cells 15 and 16). As recommended in the odour assessment report a number of mitigation measures were put in place. These measures are outlined below:

- Partial permanent capping on the northern and eastern flanks of Cells 15 and 16.
- Extension of the temporary capping on some flanks.
- Vertical extraction wells and pipework.

Furthermore, the completion of capping works in cells 6-13 during 2008 improved the control of fugitive landfill gas to the atmosphere. In addition an odour management plan has been established and implemented by the facility in accordance with condition 8.14 of the waste licence.

Landfill gas
Landfill gas monitoring was carried out within the main office area and within the weighbridge office at Powerstown landfill during 2008. All reported monitoring results for carbon dioxide and methane were below the relevant ELVs and in compliance with the Licence requirements throughout 2009.

Elevated methane levels were found at perimeter boreholes during 2009, which either enter the waste body or are located very close to the waste, at the unlined landfill. In these cases methane would be expected to migrate from the waste body to the borehole.

Elevated carbon dioxide levels which are not in the vicinity of the unlined landfill will be investigated during 2011; these are at TP13, TP17, G1, G4, G5, G6, G7, G8, G43, G44. In these cases migration of carbon dioxide from the waste body would not be expected.

Reported Incidents
There were 14 incidents reported to the EPA during 2009. All incidents related to power failures on the site and in the local area which resulted in the flare shutting down. The EPA were duly informed.

Complaints
In total 22 complaints were received during 2009. A total of 19 complaints were received during 2009 in relation to odour. However this is a decrease in comparison to those received during 2008 (29 complaints) and is far less than the amount received in 2006 (over three hundred). The completed final capping of cells 6-13, the installation of a new gas collection system and the continuous operation of the new 1000m^3 capacity flare all helped to improve odour control and reduce odour emanating from the landfill. An odour management plan has also been established and implemented by the facility in accordance with condition 8.14 of the waste licence.

Three complaints were received in relation to flies during 2009, however investigation showed that the landfill could not be solely responsible for any fly nuisance, as the surrounding land is intensively farmed. Furthermore, the risk of fly infestations are kept to a minimum by good operating practices which include efficient compaction of waste, restricting the size of the tipping area and covering of waste at the end of each day. As an additional precautionary measure, the tipping area, plant, machinery and landfill offices were sprayed with insecticide twice during 2009.

3.0 Statement of Scope

3.1 Scope
The proposed CRAMP addresses the “known” liabilities that may occur and require attention during the closure, restoration and aftercare management plan. This will mainly include the following:

- Landfilling cessation.

- Final capping and slope stability works.
- Equipment and infrastructure management.
- Landscaping and future land use.
- Leachate management.
- Landfill gas collection and management.
- Operation of the gas flare system.
- Aftercare general maintenance including infrastructure and equipment.
- Aftercare environmental monitoring (groundwater, surface water, odour, landfill gas, leachate, meteorology, pest control, slope stability and topography survey).

3.2 Exclusions

An Environmental Liabilities Risk Assessment (ELRA) is carried out in order to assess any outstanding risks (unknown liability) which may lead to a potential environmental hazard occurring. The scope of this risk assessment will cover all risks including those to surface water, groundwater, atmosphere, land and human health. The ELRA for the site is due for completion in December 2010.

This CRAMP excludes future use of the civic amenity after closure of the landfill.

4.0 Criteria for Successful Closure, Restoration and Aftercare Management Plan

Successful 'clean closure' requires that there are no remaining environmental liabilities in existence at the site. In practice, for a facility such as a landfill, monitoring will be required for at least a 30-year-period. Therefore the landfill site (Category 3) will be subject to 'non-clean closure' and an aftercare management plan will have to be maintained as part of this report and its revisions. Criteria that will be required in order to successfully reach a 'non-clean closure' for the landfill site are outlined below:

- Landfill operations ceased to the required level and that appropriate factors of safety are present (slope stability).
- Capping of landfill is complete in accordance with conditions of the waste licence and to the required levels.
- Documented and fully costed report on the movements and disposal of hazardous and non-hazardous waste dispatched from the site, if any.
- Documented and fully costed reports to ensure that all equipment have been dispatched from the site i.e. either returned to supplier or sold respectively.
- Landscaping is completed to the appropriate agreed future land use for the site.
- Monitoring parameters for groundwater, surface water, leachate, landfill gas and odour settle to acceptable levels for 30 years after official closure.
- Reporting of all monitoring carried out in accordance with the licence and liaison with the EPA.
- Landfill settlement has reduced to non- detectable levels.
- Amount of landfill gas produced is no longer sufficient to require a gas flare. Decommissioning of the gas management will then be undertaken.
- Leachate is no longer generated. Decommissioning of the leachate management system will then be undertaken.
- A documented and fully costed validation report to include a certificate of completion for the Restoration and Aftercare Plan.

The intended use of the restored site on completion of the restoration process and a site specific restoration plan must be carried out so that the landfill can be restored on a phased basis. The plan will outline the restoration programme and detail the works, the timings, expertise and materials required for successful restoration.

Non Clean Closure Declaration
The landfill will be subject to 'non-clean closure' and a restoration and an aftercare plan will have to be maintained.

5.0 Programme to Achieve Stated Criteria

5.1 Introduction
The CRAMP is constructed in a Project Management style format with a number of stages. The individual stages are in a logical sequence however some overlap in terms of time-lines and works is expected.

The individual stages are outlined below:

Stage 1:	Cessation of waste acceptance in the landfill
Stage 2:	Capping (final profile, slope stability and capping)
Stage 3:	Restoration
Stage 4:	Decommissioning of equipment/ infrastructure
Stage 5:	Waste Disposal/ Recovery and Soil/Spoil Removal
Stage 6:	Aftercare Management (Landfill gas management and monitoring, groundwater monitoring, leachate management and monitoring, surface water monitoring, topographical surveys)

5.2 Stage 1: Cessation of Waste Acceptance in the landfill
The remaining capacity of Phase 3 is estimated at 174,153 m^3 (April 2010) and therefore the current phase is expected to close in 2014 however it may be open for longer as waste acceptance rates have dropped in recent times due to the economic slowdown.

The final layer of waste deposited in each phase will be free from large objects. No material or objects that it is incompatible with the proposed restoration of the facility shall be present within one metre of the final soil surface levels.

A topographical survey will be completed on cessation of landfilling.

Upon the cessation of Phase 3 the landfill will be capped and closed in accordance with the provisions of the Landfill Directive.

5.3 Stage 2: Final capping

Final profile
According to condition 4.3.2 of the licence the maximum final height of the facility shall be 64.0 mOD (Malin Head), which is the same height as the old landfill. These levels pertain to the finished height after all subsoil and topsoil layers are completed.

Slope Stability Analysis
Before capping commences on all side-slopes, a Stability Assessment will be carried out in order to determine that the appropriate factors of safety are present. If settlement is found to be interfering with the integrity of the cap or interfering with run-off from the landform, measures will be taken to reinforce the cap or reshape the landform as required.

Final capping
Phase 1 and 2 are permanently capped. No final capping for phase 3 has been carried out yet during 2009 or 2010 due to the reduced waste intake and until settlement of the completed waste mass occurs. Capping works will therefore be phased; however in accordance with condition 4.2 of the waste licence, filled cells will be permanently capped within 24 months of the cells having been filled to the required level.

Over the final layer of waste, an engineered restoration cap will be placed in accordance with condition 4.3 of the Waste Licence, consisting of:

- Top soil (150- 300mm)
- Subsoil, such that the total thickness of top and sub-soils is at least 1m.
- Drainage layer of 0.5m thickness having a minimum hydraulic conductivity of $1x10^{-4}$ m/s or an equivalent geosynthetic layer.
- Compacted mineral layer of a minimum 0.6m thickness with a permeability of less than $1x10^{-9}$ m/s or a geosynthetic material (e.g. GCL) or similar that provides equivalent protection.
- Gas collection layer of natural material (minimum thickness 0.3m) or a geosynthetic layer.

5.4 Stage 3: Decommissioning of equipment/ infrastructure

Site Facilities
As the civic amenity area will continue operating it is anticipated that site facilities including the administration building, oil tank and the waste water treatment system will be retained.

The current perimeter fencing, gates and CCTV network will also be retained.

Site Machinery
The following items of mobile and stationary plant are used at the facility:

- Landfill compactor
- Track machine
- Dump truck
- Road sweeper
- Water tanker
- Weighbridge
- Site tractor & trailers
- Static compactors in the Civic Amenity Facility

Vehicles used for the landfill may be sold for reuse or reused by Carlow County Council in other facilities. If the weighbridge is no longer needed, it will also be sold or reused in other facilities.

The rest of the equipment will remain onsite, as the Waste Amenity Facility will continue operating.

5.5 Stage 4: Waste Disposal/ Recovery and Soil/ Spoil Removal

It is not envisaged that there will be any residual waste resulting from the closure of the facility. However, a minimal quantity of lubricant oil used for machinery may be disposed off-site.

There will be no contaminated ground or spoil that requires specialist treatment on cessation of the landfill activities. No residual materials will remain.

5.6 Stage 5: Restoration

Landscaping and Land Use

After the completion of the landfilling operations and capping (refer to stage 1 and 2) the area will be grassed to reflect the surrounding landscape. Due regard will be given to the EPA publication 'Landfill manuals- landfill restoration and aftercare'.

The long term use intended for the restored landfill is grazing. Sheep grazing is recommended rather than cattle grazing as this will reduce the risk of poaching.

The site will then be seeded with species appropriate for grazing. Table P.1 of the EPA publication 'Landfill manuals- landfill restoration and aftercare' provides a list of the species of grasses for meadows and pastures and wildflowers that could be sown either as a pure wildflower stand, or in a mix with grasses to establish a wildflower meadow.

The settling pond will be planted with species appropriate to a wetland location. Table Q.1 of the EPA publication 'Landfill manuals- landfill restoration and aftercare' provides a list of the species appropriate for wetlands and Ponds.

5.7 Stage 6: Aftercare Plan

5.7.1 Aftercare Maintenance

Landscaping

Maintenance will not arise as the land use will be grazing. Additional seeding will be carried out if required.

It is proposed that Carlow County Council will continue to manage the existing hedgerows and trees surrounding the site. In the event that supplemental planting is required this additional planting will be carried out with a similar semi-mature plant species to allow integration into the hedgerow in as quick as possible.

Surface Profile and Capping System

In the event that maintenance to the capping system is required, it will be ensured that the repaired cap is properly sealed to prevent the ingress of water and that the various layers are relaid.

If required Carlow County Council will employ soil specialists to undertake soil maintenance checks to assess the physical and chemical status of the soils.

Operation of Gas flare and gas collection system

The landfill gas flare is maintained under contract by a specialist company. Regular maintenance, testing and monitoring will be carried out to ensure the flare is working correctly. In the event that a malfunction of the flare is detected, the contractor will be contacted and required to rectify the fault without delay.

In accordance with the EPA publication 'Landfill manuals- landfill restoration and aftercare', once gas extraction is exhausted, the gas compound will be decommissioned and all redundant equipment removed by a specialist contractor. Carlow County Council will ensure that the works required have minimal impact on the afteruse and users of the restored site.

Operation Leachate management system

Leachate will be managed in accordance with condition 5.15 of waste licence W0025-03 and the onsite leachate handling procedure until no more leachate is generated.

The existing SCADA will facilitate the remote monitoring of the depth of leachate within the cells and the remote / automatic activation of the leachate pumps. For each leachate monitoring borehole not connected to the SCADA, cell levels will be monitored monthly to ensure that they do not exceed 1 metre.

Storage lagoons/ tanks will be visually inspected regularly to ensure that a sufficient free area is maintained. The operation of the pumps will also be inspected on a regular basis.

Leachate will continue to be removed on a regular basis by enclosed tankers for treatment to the Mortarstown Waste Water Treatment Plant (or other designated plant such as Tullow or Bagenalstown).

Drainage, lagoons and bund structures

The effectiveness of the drainage system will be monitored and any remedial works to the drainage layer or surface water collection system will be carried out where required.

All drainage ditches and outfalls carrying run-off from the site will be regularly checked to ensure that effective surface water flows are being maintained. Any depressions created through settlement will be re-profiled to ensure surface water run-off.

In accordance with conditions 3.11.5 and 5.16.2 of the licence, all lagoon structures on the facility, the existing leachate tank and the diesel bund will be integrity tested every three years by an independent and qualified chartered engineer until such time that they are no longer in use.

In accordance with the EPA publication 'Landfill manuals- landfill restoration and aftercare', when the leachate collection and treatment system is no longer required, all leachate from the collection chambers and storage lagoons will be removed and these will be cleaned out and backfilled with inert material for health and safety reasons. The pumps, treatment plant and any ancillary structures will be removed from the site and sold/ reused.

Equipment calibration and maintenance
All treatment/ abatement and emission control equipment (including the SCADA) will be calibrated and maintained, in accordance with condition 5.16 of the licence and the instructions issued by the manufacturer/supplier/ installer.

Infrastructure
All pathways and access points associated with the afteruse of the site will be checked regularly to ensure their integrity and maintenance work will be carried out if required.

The existing perimeter fencing and gate will be inspected and maintained on a regular basis. Any observed damage will be repaired immediately.

5.7.1 Aftercare Environmental Monitoring

Landfill Gas Flare
Landfill gas flare will be monitored in accordance with Schedule D7 of the waste Licence W0025-03.

Landfill Gas Monitoring
It is envisaged that landfill gas monitoring will be carried out biannually during the aftercare phase. Monitoring will be carried out in locations shown in Schedule D1 (Table D.1.1) of the licence and for the parameters shown in Schedule D2 (Table D.2.1) of the licence. However monitoring frequencies may vary under certain conditions and monitoring should be increased when:

- Increases in gas quantity or changes in gas quality are observed during monitoring;
- Control systems are altered;
- Pumping of leachate ceases or leachate levels rise within the wastes; or buildings or services are constructed within 250 m of the boundary of the waste.

Where regular monitoring has shown that conditions at the site are stable, then the frequency of the monitoring may be reduced. However it is recommended that gas monitoring should never be less than six monthly intervals.

Monitoring will continue until either:

- The maximum concentration of methane gas from the landfill remains less than 1% by volume (20% LEL) and the concentration of carbon dioxide from the landfill remains less than 1.5% by volume measured at all monitoring points within the wastes over a 24 month period taken on at least four separate occasions when atmospheric pressure was falling and was below 1,000 mbar; or
- An examination of the waste using an appropriate sampling method provides a 95% level of confidence that the biodegradation process has ceased.

Surface Water, Groundwater and Leachate monitoring

Surface Water, groundwater and leachate monitoring for the suite of parameters stipulated in Table D.5.1 of the Waste Licence.

Table 1 below outlines the surface water, groundwater and leachate monitoring frequency and locations during the aftercare phase.

Table 1. Surface Water, Groundwater and Leachate monitoring frequency and locations during the aftercare phase

Parameters	Surface Water Monitoring	Groundwater Monitoring	Leachate monitoring
Visual Inspection/ Odour	Biannually	Biannually	Biannually
Groundwater Level	NA	Biannually	NA
Ammoniacal Nitrogen	Biannually	Biannually	Annually
BOD	Biannually	NA	Annually
COD	Biannually	NA	Annually
Chloride	Biannually	Biannually	Annually
Dissolved Oxygen	Biannually	Biannually	NA
Electrical Conductivity	Biannually	Biannually	Annually
pH	Biannually	Biannually	Annually
Total Suspended Solids	Biannually	NA	NA
Temperature	Biannually	Biannually	Biannually
Metals/non metals	Annually	Annually	Annually
Cyanide (total)	NA	Annually	Annually
Fluoride	NA	Annually	Annually
List I/II organic substances	NA	Annually	
Mercury	Annually	Annually	Annually
Sulphate	Annually	Annually	Annually
Total Alkalinity	Annually	Annually	NA
Total P/ orthophosphate	Annually	Annually	Annually
Total Oxidised Nitrogen	Annually	Annually	Annually
Total Organic Carbon	NA	Biannually	NA
Residue on evaporation	NA	Annually	NA
Biological assessment	Annually	NA	NA
Monitoring Locations	ST1 and ST2 at Powerstown Stream	As per Table D1.1 of the licence.	Leachate lagoon (LG) and leachate tank (LT)

Odour Monitoring
Odour monitoring will be carried out annually by an independent external consultant. The independent assessment involves the use of a continuous kinematic VOC/GPS to detect areas of potential landfill gas leakages from the site.

Dust and Noise monitoring
Dust and noise monitoring will not be necessary during the aftercare phase.

Topographical and Stability Assessment
A topographical survey will also be required on an annual basis particularly during the first 5 years of restoration to assess the settling behaviour of the level of the landfill body. In addition, stability assessment will be necessary to assess the structural integrity of the landfill body.

Pest Control
Bird control will not be necessary once the landfill is finally capped.

Pest control will be carried out by a specialist private contractor. It is envisaged that rodent control will be carried out quarterly and fly control measures will be put in place when required.

.
Meteorological Monitoring
The following meteorological parameters will be recorded during the aftercare phase:

- Monthly precipitation volume.
- Monthly average, maximum and minimum temperatures.
- Monthly evaporation.
- Monthly humidity average

Meteorological data will be obtained from the nearest Met Éireann meteorological station (Oak Park).

6.0 Management of the CRAMP

To ensure comprehensive management of the CRAMP as it progresses, a technical review team will co-ordinate, supervise and manage the CRAMP and be responsible for its implementation.

6.1 Technical Review Team

This team will include personnel who will oversee various significant aspects of the CRAMP and will include:

- an environmental management team who will oversee technical aspects of implementing the CRAMP;
- a financial management team who will oversee costs associated with implementation;
- an operational management team who have a working knowledge of facility infrastructure and processes.

The selection of team personnel will be conducted by all interested parties prior to the implementation of this CRAMP. The results of the Technical Review Team selection will be supplied to the EPA for approval prior to commencement of the CRAMP.

It is likely that the team will comprise the following:

- Pat Connolly, Senior Executive Engineer (Carlow County Council).
- Fergus Mulhare, Landfill Manager.
- Mary Walsh, Deputy Landfill Manager.
- Landfill gas flare operating company.

It is envisaged that specialists such as landscapers, environmental consultants and pest control specialist contractors will be needed for specific tasks.

6.2 Co-ordination with Relevant Authorities

Prior to the closure of the landfill, Carlow County Council will conduct all necessary communications related to the CRAMP implementation with all relevant authorities listed below:

Environmental Protection Agency
Headquarters,
Johnstown Castle Estate,
Co. Wexford
T: 053-9160600

Inland Fisheries Ireland
Anglesea Street,
Clonmel,
Co. Tipperary.
Tel: 052 6180055

7.0 Costs Associated with the CRAMP

The costs associated with the CRAMP are estimated and outlined below. These are best estimates based on current knowledge of existing site conditions and costs of such work at the present time. As capping of the old landfill (phase 1) and phase 2 are completed these costs are excluded from Table 2. A timescale of 30 years is used in developing these costs. A contingency of 25% has also been included.

Table 2: Estimated Costs

Item	Description	Estimated Cost (€) 30-year period
1	Final capping of phase 3	2,570,000
2	Landscaping (seeding phase 3)	30,000
3	Servicing of flare, gas management/flaring and monitoring	270,000
4	Leachate management (based on leachate volume of 4,113m^3 when landfill is restored as per Appendix E of EIS)	370,170
5	Environmental Monitoring • Groundwater • Surface water • Landfill gas • Odour	399,743
6	Topographical survey and settlement and stability report (5 years)	40,000
7	Pest control	45,000
8	Inspection of bund structures and lagoons	10,000
9	Annual Environmental Report	103,800
10	General site maintenance	100,000
11	Closure validation audit and report	5,000
12	Contingency 15%	591,557
	TOTAL Estimate CRAMP (excl VAT)	4,535,270

8.0 Financial Provision

In accordance with condition 12.2.1 and 12.2.2 of the licence, Carlow County Council are required to establish, maintain and review a fund to assure the EPA they are financially capable of implementing the restoration and aftercare plan required by Condition 4.

Carlow County Council, as a local authority, has made the necessary provisions, for the development, management, restoration and aftercare of Powerstown Waste Management Facility. Carlow County Council is committed to the ongoing provision of funding for all site development works, environmental monitoring costs and restoration and aftercare works at Powerstown Landfill for the duration of the waste licence.

9.0 CRAMP Review and Validation

CRAMP review

The CRAMP will be maintained, reviewed and updated on an annual basis in accordance with condition 12.2.3 of the licence. Any proposed amendments to the CRAMP will be notified to the EPA and reported in the AER. All proposed amendments will be subject to agreement with the EPA prior to implementation.

Condition 12.2.3 of Waste Licence W0025-03 states the following:

12.2.3 The licensee shall revise the cost of restoration and aftercare annually and any details of the necessary adjustments to the fund or guarantee must, within two weeks of the revision, be forwarded to the Agency for its agreement. Any adjustment agreed by the Agency shall be effected within four weeks of said written agreement.

An annual statement including the financial provisions for the CRAMP will be submitted in the AER in accordance with condition 12.3.1.

Condition 12.3.1 of the Waste Licence W0025-03 states the following:

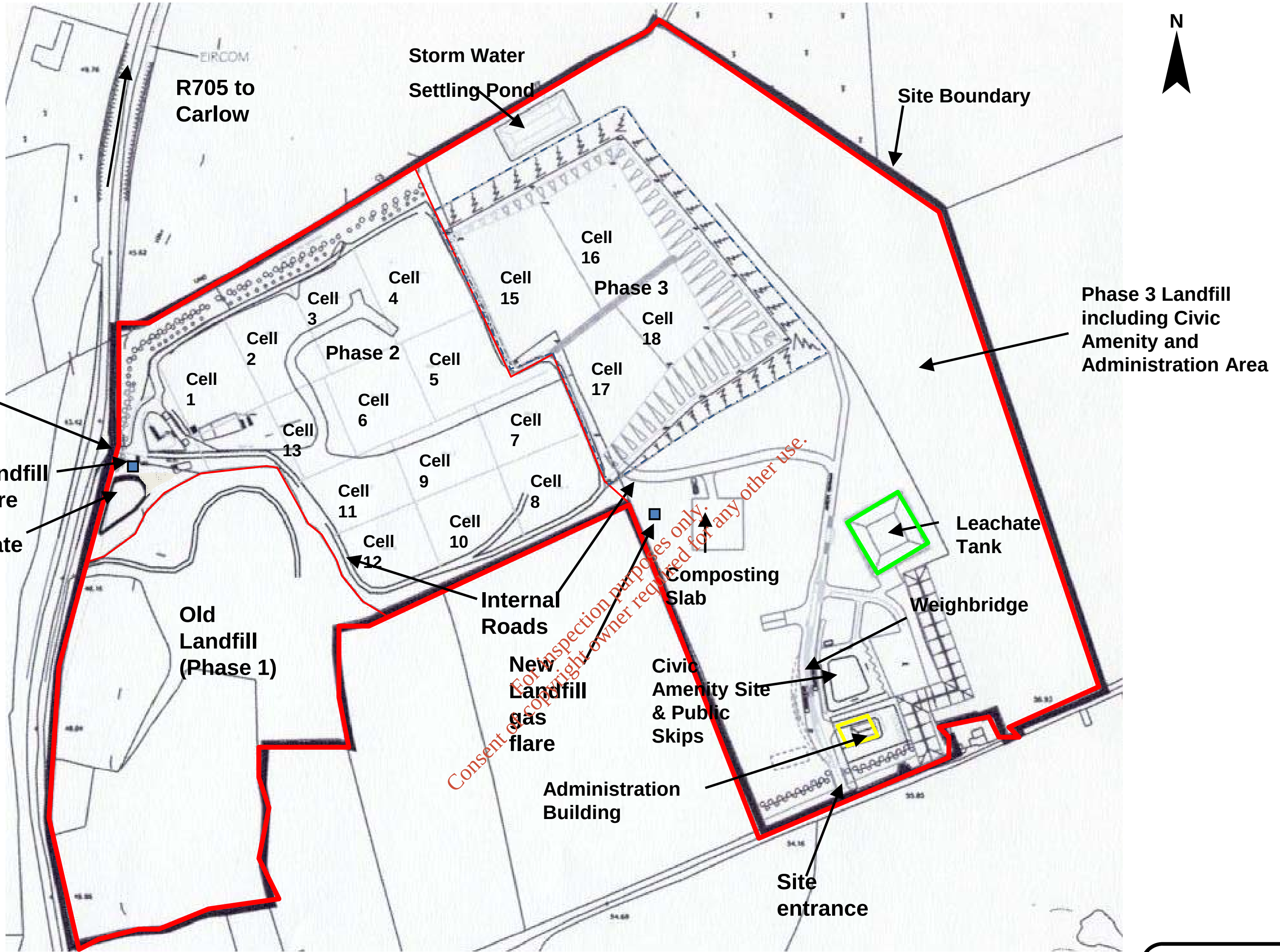
12.3.1 The licensee shall as part of the AER, provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

Documentation and Certification of Restoration and Aftercare Management Plan

Upon closure of the facility a closure validation audit will be carried out by an independent consultant. The audit may be carried out for each distinct area separately and then a final audit will be carried out upon closure of the entire facility to verify the completion of each stage of the CRAMP. All monitoring results will be reviewed and the monitoring programme will be closed out upon agreement with the EPA.

In accordance with condition 4.9 of the Waste licence W0025-03, a final validation report to include a certificate of completion for the Restoration and Aftercare Plan, for all or part of the site as necessary, will be submitted to the EPA within three months of execution of the plan. Relevant tests, inspections and monitoring will be carried out and a full report will be prepared and submitted to the EPA to confirm there is no continuing risk to the environment at the site.

FIGURES



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Client				Drawing			
Carlow County Council				Site Layout			
Job: Powerstown Landfill Facility CRAMP							
Job Number	Drawing Number	Status		Sht. Size	Scale	Date	Drawn
E0797	Figure 1	Final		A4	NTS	May '11	JA

APPENDIX A

OEE METHODOLOGY FOR DETERMINING ENFORCEMENT CATEGORY OF LICENCE FOR 2011 (Completed using 2009 data)

Organisation Name	**Carlow Co Council**	
Licence Number	**W0025-03**	
Reporting Period	01/01/2009 - 31/12/2009	
Completed By	**Name**	Fergus Mulhare
	Position	Executive Scientist
	Email	fmulhare@carlowcoco.ie
	Direct Tel.	**059 91 72478**
EPA Version	7.2	

Full instructions for the use of this spreadsheet are contained in the accompanying Guidance Document. The user should attempt to fill in the spreadsheet following the order of worksheets listed below. A password is not required to use the tool. You are not required to type into any of the cells (except the facility name, reg. number and completed-by in the introduction form, and comments in the comments box's if required) but select answers are already provided from drop-down or pop-up menus which appear when you click on the relevant cell. It is important to answer ALL questions (even if only using the n/a answer). To ensure that all questions are correctly answered, use the 'check' tab, top right of sheets 2,3,4,5,7,8 and 9 before moving on to the next sheet. Email queries to: **rbme@epa.ie**

SHEET DESCRIPTION	INSTRUCTIONS
1. Complexity Attributes	Guidance Document
2. Emissions to Air	Guidance Document
3. Discharges to Water	Guidance Document
4. Discharges to Sewer	Guidance Document
5. Waste Management	Guidance Document
6. Emissions Summary	Guidance Document
7. Location	Guidance Document
8. Operator Management	Guidance Document
9. Enforcement Record	Guidance Document
10. Enforcement Category Summary	Guidance Document

Email queries to: rbme@epa.ie

Complexity Attributes

Organisation Name	Carlow Co Council
Licence Number	W0025-03

Band	Score
G1	1
G2	2
G3	3
G4	4
G5	5

Number	Schedule 1 of Protection of the Environment Act, 2003 Schedule 3 & 4 of the Waste Management Act, 1996 [1]	Description of Activity [2]	Complexity Band	Score
1	D1	Deposit on, in or under land. □□□□ The quantity selected was --> (closed unlined landfills) □□□□	G4	4
2	D5	Specially engineered landfill, including placement into lined discreet cells which are capped and isolated from one another and	G4	4
			TOTAL	8

[1] As amended by the Protection of the Environment Act, 2003.

[2] Add main activity and a second activity only if there is one (see Appendix 2 of Guidance Document).

☐ Licensed activities have not commenced on site.

☐ Licensed activities have ceased on site.

Score	Enforcement Category
≥ 5	High
3 - 4	Medium
≤ 2	Low

COMPLEXITY ENFORCEMENT CATEGORY **High**

Comments

Emissions to Air

☐ **This form was not required.**

Number	Description	Quantity Emitted	Emissions Score	Total Points
1. ENVIRONMENTAL THEMES				
1.1	CH_4 (kg/yr)	> 100 000	3	3
1.2	CO_2 (kg/yr)	Not applicable	0	0
1.3	NH_3 (kg/yr)	Not applicable	0	0
1.4	NOx as NO_2 (kg/yr)	> 100 000	3	3
1.5	SOx as SO_2 (kg/yr)	75 000 - 150 000	2	2
2. METALS AND COMPOUNDS				
2.1	Total As, as As (kg/yr)	Not applicable	0	0
2.2	Total Cr (kg/yr)	Not applicable	0	0
2.3	Total Cu (kg/yr)	Not applicable	0	0
2.4	Total Hg (kg/yr)	Not applicable	0	0
2.5	Total Ni (kg/yr)	Not applicable	0	0
2.6	Total Zn (kg/yr)	Not applicable	0	0
3. CHLORINATED ORGANIC SUBSTANCES				
3.1	Dichloromethane (DCM) (kg/yr)	Not applicable	0	0
3.2	Trichloromethane (kg/yr)	Not applicable	0	0
4. ODOUR				
4.1	Distance from facility boundary at which odours are detected	< 50 m	1	1
5. NOISE				
5.1	Is the daytime/ nighttime noise level exceeded or is there any clearly audible tonal or impulsive component in the noise emission from the activity at a noise sensitive location as a result of on-site activities?	No		0
6. OTHER COMPOUNDS				
			TOTAL	**9**

Enforcement Category	Total Score
High $\geq$ 6	3
Medium 3 - 5	2
Low $\leq$ 2	1

☐ **In the last 12 months have there been > 3 non-compliances with emission limit values for emissions to air?**

AIR EMISSIONS SCORE **3**

Comments

Discharges to Water

☐ **This form was not required.**

Number	Description	Quantity Discharged	Emissions Score	Total Points
1. ENVIRONMENTAL THEMES				
1.1	Total Nitrogen (kg/yr)	< 25 000	1	1
1.2	Total Phosphorous (kg/yr)	< 2 500	1	1
2. METALS AND COMPOUNDS				
2.1	Total Cr (kg/yr)	< 25	1	1
2.2	Total Cu (kg/yr)	< 25	1	1
2.3	Total Ni (kg/yr)	< 10	1	1
2.4	Total Zn (kg/yr)	< 50	1	1
3. CHLORINATED ORGANIC SUBSTANCES				
3.1	Dichloromethane (DCM) (kg/yr)	Not Applicable	0	0
4. OTHER COMPOUNDS				
4.1	BOD (kg/yr)	< 10 000	1	1
4.2	Suspended Solids (kg/yr)	< 10 000	1	1
6. OTHER				
			TOTAL	**8**

Enforcement Category	Total Score
High ≥ 6	3
Medium 3 - 5	2
Low ≤ 2	1

☐ **In the last 12 months have there been > 3 non-compliances with emission limit values for discharges to water?**

DISCHARGES TO WATER SCORE | 3

Comments

Discharges to Sewer

☐ **This form was not required.**

Number	Description	Quantity Discharged	Emissions Score	Total Points
	1. ENVIRONMENTAL THEMES			
1.1	Total Nitrogen (kg/yr)	Not Applicable	0	0
1.2	Total Phosphorous (kg/yr)	Not Applicable	0	0
	2. METALS AND COMPOUNDS			
2.1	Total Cr (kg/yr)	< 25	1	1
2.2	Total Cu (kg/yr)	< 25	1	1
2.3	Total Ni (kg/yr)	< 10	1	1
2.4	Total Zn (kg/yr)	< 50	1	1
	3. CHLORINATED ORGANIC SUBSTANCES			
3.1	Dichloromethane (DCM) (kg/yr)	Not Applicable	0	0
	4. OTHER COMPOUNDS			
4.1	BOD (kg/yr)	< 10 000	1	1
4.2	Suspended Solids (kg/yr)	Not Applicable	0	0
	5. OTHER			
			TOTAL	**5**

Enforcement Category	Total Score
High ≥ 6	3
Medium 3 - 5	2
Low ≤ 2	1

☐ **In the last 12 months have there been > 3 non-compliances with emission limit values for discharges to sewer?**

DISCHARGES TO SEWER SCORE 2

Comments

Waste Management

☐ **This form was not required.**

Number	Description	Quantity of Waste (tonnes/annum)	Yes/No	Points Available	Points Scored
NON-HAZARDOUS WASTE (LAST 12 MONTHS)					
1	Quantity of non-hazardous waste disposed of on-site	>2,000	Yes	7	7
		200 - 2,000	No	5	
		<200	No	3	
		0	No	0	
2	Quantity of non-hazardous waste disposed of off-site	> 2,000	No	4	0
		200 - 2,000	No	3	
		< 200	No	2	
		0	Yes	0	
3	Quantity of non-hazardous waste recovered on-site	> 2,000	Yes	4	4
		200 - 2,000	No	3	
		< 200	No	2	
		0	No	0	
4	Quantity of non-hazardous waste recovered off-site	> 2,000	No	3	0
		200 - 2,000	No	2	
		< 200	No	1	
		0	Yes	0	
HAZARDOUS WASTE (LAST 12 MONTHS)					
5	Quantity of hazardous waste disposed of on-site	> 500	No	9	0
		10 - 500	No	7	
		< 10	No	5	
		0	Yes	0	
6	Quantity of hazardous waste disposed of off-site	> 500	No	7	0
		10 - 500	No	5	
		< 10	No	3	
		0	Yes	0	
7	Quantity of hazardous waste recovered on-site	> 500	No	7	
		10 - 500	No	5	
		< 10	No	3	
		0	No	0	
8	Quantity of hazardous waste recovered off-site	> 500	No	4	0
		10 - 500	No	3	
		< 10	No	2	
		0	Yes	0	
LANDSPREADING					
9	Are organic wastes sent off-site for landspreading?		No	2	0
10	Is the waste stabilised or does it undergo treatment prior to landspreading?		N/A	-1	
				TOTAL	**11**

Enforcement Category	Total Score
High ≥ 9	3
Medium 5 - 8	2
Low ≤ 4	1

☐ **In the last 12 months have there been > 3 non-compliances with regard to waste management?**

WASTE MANAGEMENT SCORE 3

Comments

Emissions Summary

Sheet Reference	Score
Emissions to Air	3
Emissions to Water	3
Emissions to Sewer	2
Waste Management	3

EMISSIONS SCORE [1]	54

Score	Enforcement Category
≥ 9	High
5 - 8	Medium
≤ 4	Low

EMISSIONS ENFORCEMENT CATEGORY	High

Note[1]: The "Emissions Score" is calculated from the multiplication of the scoring for Emissions to Air, Emissions to Water, Emissions to Sewer and Waste Management.

Location

Number	Parameters	Yes/No	Points Available	Points Scored
	NEAREST SENSITIVE RECEPTOR			
1	a) If within 50m of the site boundary	Yes	5	5
	b) If greater than 50m but less than 250m of boundary	No	3	
	c) If greater than 250m but less than 1km of boundary	No	1	
	d) Not Applicable	No	0	
	PROTECTED ECOLOGICAL SITES			
	Distance from site boundary to protected areas designated as pNHA (Irish Wildlife Acts 1976,2000), cSAC (Habitats Directive 1992) and/or SPA (Birds Directive 1979):			
2	a) Within or directly bordering protected site	No	2	1
	b) < 1 km to protected site	Yes	1	
	c) > 1 km from protected site	No	0	
	GROUNDWATER PROTECTION			
	Aquifer Classification			
3	a) Is the site underlain by a Regionally Important Aquifer?	Yes	2	2
	b) Is the site underlain by a Locally Important Aquifer?	No	1	
	c) Is the site underlain by a Poor Aquifer?	No	0	
	Vulnerability			
4	a) Is the vulnerability of the site classified as extreme?	Yes	3	3
	b) Is the vulnerability of the site classified as high?	No	2	
	c) Is the vulnerability of the site classified as Moderate?	No	1	
	d) Is the vulnerability of the site classified as low or is no information available on the vulnerability of the site?	No	0	
	Source Protection Zones			
5	Is the subject site located within a Source Protection Zone or is any well located within 1km of the site's boundary?	No	3	0
	SENSITIVITY OF RECEIVING WATERS			
6.1	Class A River	No	3	2
	Class B River	Yes	2	
	Class C River	No	1	
	Class D River	No	0	
	Not Applicable	No	0	
6.2	Designated Coastal, Estuarine, Shellfish & Bathing Waters	No	2	0
	Potentially Eutrophic Coastal & Estuarine Waters	No	1	
	Not Applicable	Yes	0	
			TOTAL	**13**

Score	Enforcement Category
≥ 13	High
7 - 12	Medium
≤ 6	Low

LOCATION ENFORCEMENT CATEGORY **High**

Comments

Operator Management

Number	Description	Yes/No	Points Available	Points Scored
	ENVIRONMENTAL MANAGEMENT			
1.1	Does the facility have an Environmental Management System (EMS) in place?	Yes	-1	-1
1.2	Is the EMS subject to an external audit with a published methodology?	Yes	-3	-3
1.3	Is an Enviornmental Training Plan being implemented at the facility?	Yes	-1	-1
1.4	Is there an Environmental Committee which meets regularly at the facility?	Yes	-1	-1
			SUB TOTAL	**-6**
			MIN	**-6**

Number	Description	Frequency	Yes/No	Points Available	Points Scored
	INCIDENTS				
2.1	In the last year, has there been any release or notifiable incidents under notification condition of licence?	12 or more	No	12	
		6 - 11	No	8	
		1 - 5	No	4	
		0	No	0	
				SUB TOTAL	**0**
				MAX	**12**
				TOTAL	**-6**

Score	Enforcement Category
≥ 3	High
2	Medium
≤ 1	Low

OPERATOR MANAGEMENT ENFORCEMENT CATEGORY **Low**

Comments

Enforcement Record

Number	Description	Frequency	Yes/No	Points Available	Points Scored
1	Number of complaints received by the agency within the last year?	None	No	0	1
		1-5	Yes	1	
		6-10	No	2	
		11 or more	No	3	
2	Number of non-compliances noted by the agency within the last year?	None	No	0	3
		1-5	Yes	3	
		6-10	No	5	
		11 or more	No	9	
3	Have any Section Notices been issued within the last year?	None	No	0	
		≥ 1	No	5	
4	Are there soil or groundwater contamination issues on the site?		No	3	0
				TOTAL	4

☐ **Licensee has been successfully convicted by the Agency in the last 12 months.**

Score	Enforcement Category
≥ 12	High
6 - 11	Medium
≤ 5	Low

ENFORCEMENT RECORD CATEGORY **Low**

Comments

Enforcement Category Summary

Organisation Name	Carlow Co Council
Case Number	W0025-03

Fixed Attributes	Enforcement Category
Complexity	High
Location	High

Enforcement Category due to Fixed Attributes	B1

Sheet Reference	Enforcement Category
Complexity	High
Emissions	High
Location	High
Operator Management	Low
Enforcement Record	Low

Enforcement Category Based Upon Above 7 Attributes	A2
FINAL ENFORCEMENT CATEGORY FOR YOUR FACILITY [1]	A2

Note[1]: If different from above, a default may have been applied.

APPENDIX B

NOTES:

1. This Drawing is the property of Carlow Co. Council, it is a confidential document and must not be copied, used or it's contents divulged without prior written consent.

2. Use figured dimensions only, if in doubt ask.

CARLOW COUNTY COUNCIL
COUNTY OFFICES, ATHY ROAD, CARLOW
JOHN MULHOLLAND DIRECTOR OF SERVICES, INFRASTRUCTURE/WATER SERVICES
ph: 059-9170300, fax: 059-9141503,

PROJECT: MONITORING POINTS IN POWERSTOWN

TITLE: LAYOUT MAP

SCALE:	1:1000 @ A0	REVISIONS:	DRAWING NO.: MON_POW-01
DATE:	17 November 2006		
DESIGNED:			
DRAWN:	B. Griffin		
CHECKED:	G. Whelan		

Appendix 11

Archaeological Reports

ARCHAEOLOGICAL MONITORING
OF
POWERSTOWN, CO. CARLOW

ON BEHALF OF

CLARE CIVIL ENGINEERS

DAN SCHNEIDER

DECEMBER 2005

IRISH ARCHAEOLOGICAL CONSULTANCY LTD

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1. INTRODUCTION

1.1 General

The following report details a programme of archaeological monitoring carried out at Powerstown, Co. Carlow (Figures 1-3), in advance of an extension of the Powerstown Landfill. Dan Schneider of Irish Archaeological Consultancy Ltd undertook this work on the 7th & 10th November 2005 on behalf of Clare Civil Engineers.

Archaeological monitoring 'involves an archaeologist being present in the course of the carrying out of developments' and has been defined as being carried out 'so as to identify and protect archaeological deposits, features or objects which may be uncovered or otherwise affected by the works' (Department of Arts, Heritage, the Gaeltacht and Islands, 1999b).

1.2 The Development

The proposed development consists of a $35,000m^2$ extension of the present Powerstown Landfill site.

2. ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

2.1 General

Carlow is the second smallest county in Ireland with an area of only 221,424 acres. Under the name of Catherlogh, it is thought to have been created in the reign of King John (1199-1216 AD). Leinster was confirmed as a liberty to William Marshal, Earl of Pembroke, by King John, and Carlow, among other counties in this area, had the privileges of a palatinate on descending to one of the earls heiresses.

The county's landscape is in general level or gently undulating, except the elevated tract of ridge of Old Leighlin, situated on the navigable river Barrow. The geology of Carlow is dominated by granite however it is not a uniform moorland. The mica-schists and Silurian slates of its eastern flank are seen in the diversified and hilly country on the pass over the shoulder of Mt. Leinster, between Newtownbarry and Borris. The highland drops westward to the valley of the Barrow, Carlow and Bagenalstown lying on Carboniferous Limestone, which abuts the granite. On the west of the hollow, the high edge of the Castlecorner coalfields rises, scarps of limestone, grit, and coal-measures succeeding one another on the ascent. Formerly clay-ironstone was raised from the Upper Carboniferous strata. The soil is of great natural richness, and the country is among the most generally fertile in the island, resulting in a rich agricultural history.

2.2 Prehistoric Period

During the Late Mesolithic Period (5500-4000 BC), people existed as hunter/gathers, who took advantage of the natural resources to be found on the coastline and along rivers and lakesides. This period of prehistory is characterised mainly by discarded flint tools and the debris from their manufacture. During the Neolithic Period (4000-2400 BC) the population became more settled, with a subsistence based on crop growing and stock-raising.

However it is not until the Bronze Age Period (c.2500BC-1500BC) that evidence emerges for the presence of human activity within the region of the study area. This stems form the discovery *fulacht fiadh* site c. 100m NW of the proposed development site. Over 4500 *fulacht fiadh* or burnt mounds have been recorded in the country making them the most common prehistoric monument in Ireland (Waddell, 174). *Fulacht fiadhs* consist of a low mound of burnt stone commonly in horseshoe shape and are found in low lying marshy areas or close to streams. Recent scientific dating of a randomly excavated sample has shown a predominance of second millennium BC dates for their use. (Brindley and Lanting, 55-56).

Most knowledge for the Iron Age (c.600BC-400AD) stems from Irish folklore, the epic poems and legends of warriors kings and queens that are traditionally believed to be Celtic in origin. However these stories come from an oral society and were first recorded by early medieval monks. They are based on fantasy rather than fact and thus reflect more the times in which they were written than the past they are concerned with. That said they do have the potential to shed light on the Iron Age. During this period new influences came into Ireland that gradually introduced the knowledge and use of iron, although for several centuries bronze continued to be widely used. However this amalgamation of newcomers into Irish society was not without its conflicts. The saga of the destruction of Dinn Righ, a large hill fort near Leighlinbridge. This fort was, according to tradition destroyed by Labraidh Loinseach who is said to have come from Gaul with the first wave of Celtic settlers about 300 BC.

2.3 Early Medieval Period

The Early Medieval Period is (c. 400-1160 AD) depicted in the surviving sources as entirely rural characterised by the basic territorial unit known as *túath.* Byrne (1973) estimates that there were probably at least one hundred and fifty kings in Ireland at any given time during this period, each ruling over his own *túath*. Ringforts represent individual defended family homesteads and primarily date to the period 500 - 1000 AD (Lynn 1975, 30). Although most excavated ringforts have been dated to this period, some have earlier origins and may have been originally constructed during the Iron Age, or even earlier.

The ringfort or *rath* is considered to be the most common indicator of settlement during the Early Medieval Period. The most recent study of the ringfort (Stout 1997) has suggested that there is a total of 45,119 potential ringforts or enclosure sites throughout Ireland. They are typically enclosed by an earthen bank and exterior ditch, and range from 25m to 50m in diameter. The smaller sized and single banked type (univallate) were more likely to be home to the lower ranks of society while larger examples with more than one bank (bivallate/trivallate) housed the more powerful kings and lords.

Enclosure sites belong to a classification of monument whose precise nature is unclear. Often they may represent ringforts, which have either been damaged to a point where they cannot be positively recognised, or which are smaller or more irregular in plan than the accepted range for a ringfort. An early medieval date is generally likely for this site type, though not a certainty. Three curvilinear enclosures were noted in aerial photography, CW012:094, CW096 and CW012:097, which were located c. 300m NW of the proposed development site, c. 800m SE of the proposed development site and c.900m SE of the proposed development site respectfully.

This period is also characterised by the foundation of a large number of ecclesiastical sites throughout Ireland, in the centuries following the introduction of Christianity in the 5^{th} century AD. These early churches tended to be constructed of wood or post-and-wattle (Farrelly and O'Brien 2002, 228). Between the late 8^{th} and 10^{th} centuries, mortared stone churches gradually replaced the earlier structures. Many of the sites, some of which were monastic foundations, were probably originally defined by an enclosing wall or bank similar to that found at the coeval secular sites. This enclosing feature was probably built more to define the sacred character of the area of the church than as a defence against aggression. An inner and outer enclosure can be seen at some of the more important sites; the inner enclosure surrounding the sacred area of church and burial ground and the outer enclosure providing a boundary around living quarters and craft areas. Where remains of an enclosure survive, it is often the only evidence that the site was an early Christian foundation. Ecclesiastical remains survive *c*. 1km SE of the proposed development site. Fragments of a granite solid wheeled cross with slightly projecting arms were located in field known as 'Churchfield'. The top and bottom of the cross are missing. There are mouldings in low relief of a cross on the wheel. It is undecorated except for a central boss on one face, which is thought to be a facemask. Holy well was located in the same field. It is thought that an early church is possibly also located in this field.

2.4 Later Medieval Period

The political structure of the Anglo-Normans centred itself around the establishment of shires, manors, castles, villages and churches. In the initial decades after the Norman invasion a distinctive type of earth and timber fortification was constructed-the motte and bailey. However in certain areas of Ireland Anglo-Norman settlers constructed square or rectangular enclosures, now termed moated sites. Their main defensive feature is a wide, often water filled, fosse with an internal bank. As in the case of ringforts, which they resemble in appearance and size, these enclosures protected a house and outbuildings usually built of wood. They appear to have been constructed in the latter part of the 13th century though little precise information is available (Power, 1992). It has been pointed out (Barry, 1981) that the distribution of moated sites in counties Cork and Limerick occur along the frontier zone between Gaelic and Anglo Norman settlements and they may have been built by the colonists in response to the Gaelic resurgence of the late 13th and 14th centuries. Moated sites were also built in Britain and elsewhere in northwest Europe (Power 1992). An example of a moated site is located c. 300m NE of the proposed development. This is located in arable lowland, ill-drained in a small hollow, surrounded by sloping ground on all sides. The fosse at the western end can be felt underfoot. There are no other identifiable traces of the monument. A record exists of its removal in 1939.

Carlow remained a total Gaelic enclave until after the Cromwellian wars of 1650. After the Norman Invasion Art McMurrough Kavanagh became King of Leinster. He attacked the Norman forces with such frequency that King Richard II came to Ireland personally to resolve the issue in 1394 with an estimated 10,000 men. A treaty was agreed and King Richard II returned to England but he had barely reached home when Art McMurrough Kavanagh struck again and a series of battles culminated in a peace engagement at Kellistown near Tullow where the King's cousin, Roger Mortimer was routed and slain. In fury King Richard II returned to Ireland to defeat Art McMurrough Kavanagh but he inflicted defeat after defeat on the King's forces. Richard's war in Ireland gave his enemies their chance. Bolingbroke usurped England's throne, the ill-fated Richard returned to his death and Art McMurrough Kavanagh of Borris won back his kingdom.

2.5 Post Medieval Period

Carlow was of early importance in the Post-Medieval Period. In the reign of Edward III (1327-1377 AD). the kings exchequer was removed thither, and £500, a large sum during that period, applied towards surrounding the town with a strong wall. In the early part of the reign of Queen Elizabeth I (1533-1603), the castle was taken, and the town burned by the Irish chieftain, Rory Og O'More (d. 1578). When summoned to surrender by Henry Ireton (1611-1651), the Commonwealth general, during the war of 1641, Carlow submitted without resistance. In the insurrection of 1798 the castle was attacked by an undisciplined body of insurgents. They were speedily repulsed, and suffered severe loss, no quarter being given: and, in the confusion of their flight, many of the insurgents took refuge in houses, which the kings troops immediately set on fire. Carlow obtained a charter of incorporation as early as the 13th century, and was reincorporated, with enlarged privileges, by King James I . The corporation, which was styled The Sovereign, Free Burgesses and Commonalty of the Borough of Catherlogh, was authorized to return two members to the Irish parliament. The town returned one member to the Imperial parliament until 1885.

2.6 Summary of Previous Archaeological Fieldwork

A survey of the Excavations Bulletin (Bennett 1987-2002) has revealed that no archaeological fieldwork has been carried out in or within the immediate vicinity of the proposed development area.

3. ARCHAEOLOGICAL MONITORING

3.1 Introduction

A continuous archaeological presence was maintained throughout all sub-surface works associated with construction on the site. Excavation of the area of the proposed landfill took place with a bulldozer under archaeological supervision on the 7th & 10th November 2005.

3.2 Results

The ground level of the area proposed for development was reduced by c. 40-50cm to the natural subsoil (Plates 1-3). This area was formally a greenfield site. The stratigraphy on site consisted of natural medium slightly grey silt of c. 20-30cm, below which was natural subsoil, a light grey gravely sand.

3.3 Conclusions

No features or finds of archaeological significance was uncovered during monitoring of the proposed development.

4. NON-TECHNICAL SUMMARY

This report describes the findings from archaeological monitoring carried out in Powerstown, Co. Carlow (see Figures 1-3). On the 7th & 10th November 2005, Irish Archaeological Consultancy Ltd monitored construction works of the proposed landfill on behalf of Clare Civil Engineers.

A detailed study of the archaeological and historical background of the site and the surrounding area revealed that the region in which the proposed development first witnessed focused settlement in the Bronze Age Period. Settlement continued in this region to the modern day however the landscape remained characterised by open rural greenfields.

Nothing of archaeological significance was noted in the area of the proposed development during monitoring of the groundworks.

5. REFERENCES

Carlow Website: http://www.rootsweb.com/~irlcar2/history.htm

Department of Arts, Heritage, Gaeltacht and the Islands. 1999a. *Framework and Principles for the Protection of the Archaeological Heritage*, Dublin: Stationery Office.

Department of Arts, Heritage, Gaeltacht and the Islands. 1999b. *Policy and Guidelines on Archaeological Excavation*. Dublin: Stationery Office.

Institute of Field Archaeologists. 1994a. *Standards and Guidance for Archaeological Monitoring.* Manchester: IFA.

Institute of Field Archaeologists. 1994b. *Standards and Guidance for Archaeological Field Evaluations.* Manchester: IFA.

Lambrick, G. 1993. 'Environmental Assessment and the Cultural Heritage: Principles and Practice'. In I Ralston and R Thomas (eds). *Environmental Assessment and Archaeology.* Birmingham: Institute of Field Archaeologists. Occasional paper 5, 9-15.

Lambrick, G, and Doyle, I W 2000. *Review of Archaeological Assessment and Monitoring Procedures in Ireland*. Kilkenny: The Heritage Council of Ireland.

APPENDIX 1: RMP SITES WITHIN THE SURROUNDING AREA

RMP No.:	CW012:023
Townland:	Powerstown
Parish:	Clomelsh
Barony:	Carlow
Classification:	Moated Site – Rectangular Enclosure Site
Description:	Removed since 1939. Located in arable lowland, ill-drained in a small hollow, surrounded by sloping ground on all sides. The hollow is very uneven some gravel and tree stumps have been dumped in it. The fosse at the western end can be felt underfoot. This may act as a modern drain in this area. There are no other identifiable traces of the monument.
Reference:	SMR File

RMP No.:	CW012:044
Townland:	Orchard
Parish:	Nunery
Barony:	Idrone east
Classification:	Early Ecclesiastical Remains
Description:	Located in field known as 'Churchfield'. Part of cross formally stood on ridge above the road, which is now located beside a modern gateway on the east side of the road between Millford and Leighlinbridge. Cross is made of granite solid wheeled with slightly projecting arms. The top and bottom of the cross are missing. There are mouldings in low relief of a cross on the wheel. Ti is undecorated except for a central boss on one face, which is thought to be a face mask. Holy well was located in the same field. Thought possible that a church is also located in this field.
Reference:	SMR File

RMP No.:	CW021:089
Townland:	Cloghristick
Parish:	Clomelsh
Barony:	Carlow
Classification:	Fulacht Fiadh Site
Description:	Adjacent to small stream flowing west to Rover Barrow in arable field at the base of a short slope 2 areas of burnt and shattered stone only visible after ploughing
Reference:	SMR File
RMP No.:	CW012:094
Townland:	Cloghristick
Parish:	Clomelsh
Barony:	Carlow
Classification:	Curvilinear enclosure
Description:	Cropmark identified in aerial photography.
Reference:	SMR File

RMP No.:	CW012:096
Townland:	Garryhundon
Parish:	Clomelsh

Barony:	Carlow
Classification:	Curvilinear enclosure
Description:	Cropmark identified in aerial photography.
Reference:	SMR File

RMP No.:	CW012:097
Townland:	Garryhundon
Parish:	Clomelsh
Barony:	Carlow
Classification:	Curvilinear enclosure
Description:	Cropmark identified in aerial photography.
Reference:	SMR File

APPENDIX 2: STRAY FINDS WITHIN THE SURROUNDING AREA

Information on artefact finds from the study area in County Carlow has been recorded by the National Museum of Ireland since the late 18th century. Location information relating to these finds is important in establishing prehistoric and historic activity in the study area.

Museum No:	1973:46
Townland:	Garryhindon
Parish:	Clonmilsh
Barony:	Carlow
Find:	Fragmentary human skeleton
Find place:	N/A
Description:	No further information in file
Reference:	NMI file
Museum No:	1995:162-6
Townland:	Garryhindon
Parish:	Clonmilsh
Barony:	Carlow
Find:	Hone Whetstone, Four pieces slag
Find place:	Ploughed field
Description:	No further information in file
Reference:	NMI file
Museum No:	2002:90
Townland:	Garryhindon
Parish:	Clonmilsh
Barony:	Carlow
Find:	Bronze dagger
Find place:	Ath na Binna, River Barrow. Found in spoil from drainage.
Description:	A flat, bronze dagger of triangular shape with slightly rounded butt. Both sides of the blade decorated by shallow groove which parallels the inner one for part of its length on the upper part of the blade. There are four rivet holes in the butt and a notch or torn rivet hole on the outer edge of each side. Harbison's type Corkey
Reference:	NMI file

APPENDIX 3: LEGISLATIVE FRAMEWORK PROTECTING THE ARCHAEOLOGICAL RESOURCE

Protection of Cultural Heritage

The cultural heritage in Ireland is safeguarded through national and international policy designed to secure the protection of the cultural heritage resource to the fullest possible extent (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the *European Convention on the Protection of the Archaeological Heritage* (Valletta Convention), ratified by Ireland in 1997.

The Archaeological Resource

The *National Monuments Act 1930 to 1994* and relevant provisions of the *National Cultural Institutions Act 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A national monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act 1930 Section 2).

A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places, and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Ownership and Guardianship of National Monuments

The Minister may acquire national monuments by agreement or by compulsory order. The state or local authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

Register of Historic Monuments

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the register is illegal without the permission of the Minister. Two months notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Preservation Orders and Temporary Preservation Orders

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Record of Monuments and Places

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands to establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994. All recorded monuments on the proposed development site are represented on the accompanying maps.

Section 12(3) of the 1994 Act provides that 'where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the work until two months after the giving of notice'.

Architectural and Built Heritage Resource

The main laws protecting the built heritage are the *Architectural Heritage (National Inventory) and National Monuments (Miscellaneous Provisions) Act 1999* and the *Local Government (Planning and Development) Acts 1963-1999*. The Architectural Heritage Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The National Inventory of Architectural Heritage (NIAH) records all built heritage structures within specific counties in Ireland. As inclusion in the inventory does not provide statutory protection, the document is used to advise local authorities on compilation of a Record of Protected Structures as required by the *Local Government (Planning and Development) Act 1999*.

Protection under the Record of Protected Structures and County Development Plan

The 1999 Act requires local authorities to establish a Record of Protected Structures (RPS) to be included in the County Development Plan (CDP). This plan includes objectives designed to protect the cultural heritage during the planning process. Buildings recorded in the RPS can include recorded monuments, structures listed in the NIAH, or buildings deemed to be of architectural, archaeological or artistic importance by the Minister. Sites, areas or structures of archaeological, architectural or artistic interest listed in the RPS receive statutory protection from injury or demolition under the 1999 Planning Act. Damage to or demolition of a site registered on the RPS is an offence. The RPS list is not always comprehensive in every county.

The local authority has the power to order conservation and restoration works to be undertaken by the owner of the protected structure if it considers the building in need of repair. An owner or developer must make a written request to the local authority to carry out any works on a protected structure and its environs, which will be reviewed within three months of application. Failure to do so may result in prosecution.

APPENDIX 4: IMPACT ASSESSMENT AND THE ARCHAEOLOGICAL RESOURCE

Potential Impacts on Archaeological Remains

Impacts can be identified from detailed information about a project, the nature of the area affected and the range of archaeological resources potentially affected. Development can affect the archaeological resource of a given landscape in a number of ways.

- Permanent and temporary land-take, associated structures, landscape mounding, and their construction may result in damage to or loss of archaeological remains and deposits, or physical loss to the setting of historic monuments and to the physical coherence of the landscape.
- Archaeological sites can be affected adversely in a number of ways: disturbance by excavation, topsoil stripping and the passage of heavy machinery; disturbance by vehicles working in unsuitable conditions; or burial of sites, limiting accessibility for future archaeological investigation.
- Hydrological changes in groundwater or surface water levels can result from construction activities such as de-watering and spoil disposal, or longer-term changes in drainage patterns. These may desiccate archaeological remains and associated deposits.
- Visual impacts on the historic landscape sometimes arise from construction traffic and facilities, built earthworks and structures, landscape mounding and planting, noise, fences and associated works. These features can impinge directly on historic monuments and historic landscape elements as well as their visual amenity value.
- Landscape measures such as tree planting can damage sub-surface archaeological features, due to topsoil stripping and through the root action of trees and shrubs as they grow.
- Ground consolidation by construction activities or the weight of permanent embankments can cause damage to buried archaeological remains, especially in colluviums or peat deposits.
- Disruption due to construction also offers in general the potential for adversely affecting archaeological remains. This can include machinery, site offices, and service trenches.
- Although not widely appreciated, positive impacts can accrue from developments. These can include positive resource management policies, improved maintenance and access to archaeological monuments, and the increased level of knowledge of a site or historic landscape as a result of archaeological assessment and fieldwork.

Predicted Impacts

There is no standard scale against which the severity of impacts on the archaeological and historic landscape may be judged. The severity of a given level of land-take or visual intrusion varies with the type of monument, site or landscape features and its existing environment. Severity of impact can be judged taking the following into account:

- The proportion of the feature affected and how far physical characteristics fundamental to the understanding of the feature would be lost;
- Consideration of the type, date, survival/condition, fragility/vulnerability, rarity, potential and amenity value of the feature affected;
- Assessment of the levels of noise, visual and hydrological impacts, either in general or site specific terms, as may be provided by other specialists.

Impacts are defined as ‘the degree of change in an environment resulting from a development’ (EPA, 1995, 31]. They are described as profound, significant or slight impacts on archaeological remains. They may be negative, positive or neutral, direct, indirect or cumulative, temporary or permanent.

APPENDIX 5: MITIGATION MEASURES AND THE ARCHAEOLOGICAL RESOURCE

Potential Mitigation Strategies for Archaeological Remains
Mitigation is defined as features of the design or other measures of the proposed development that can be adopted to avoid, prevent, reduce or offset negative effects.

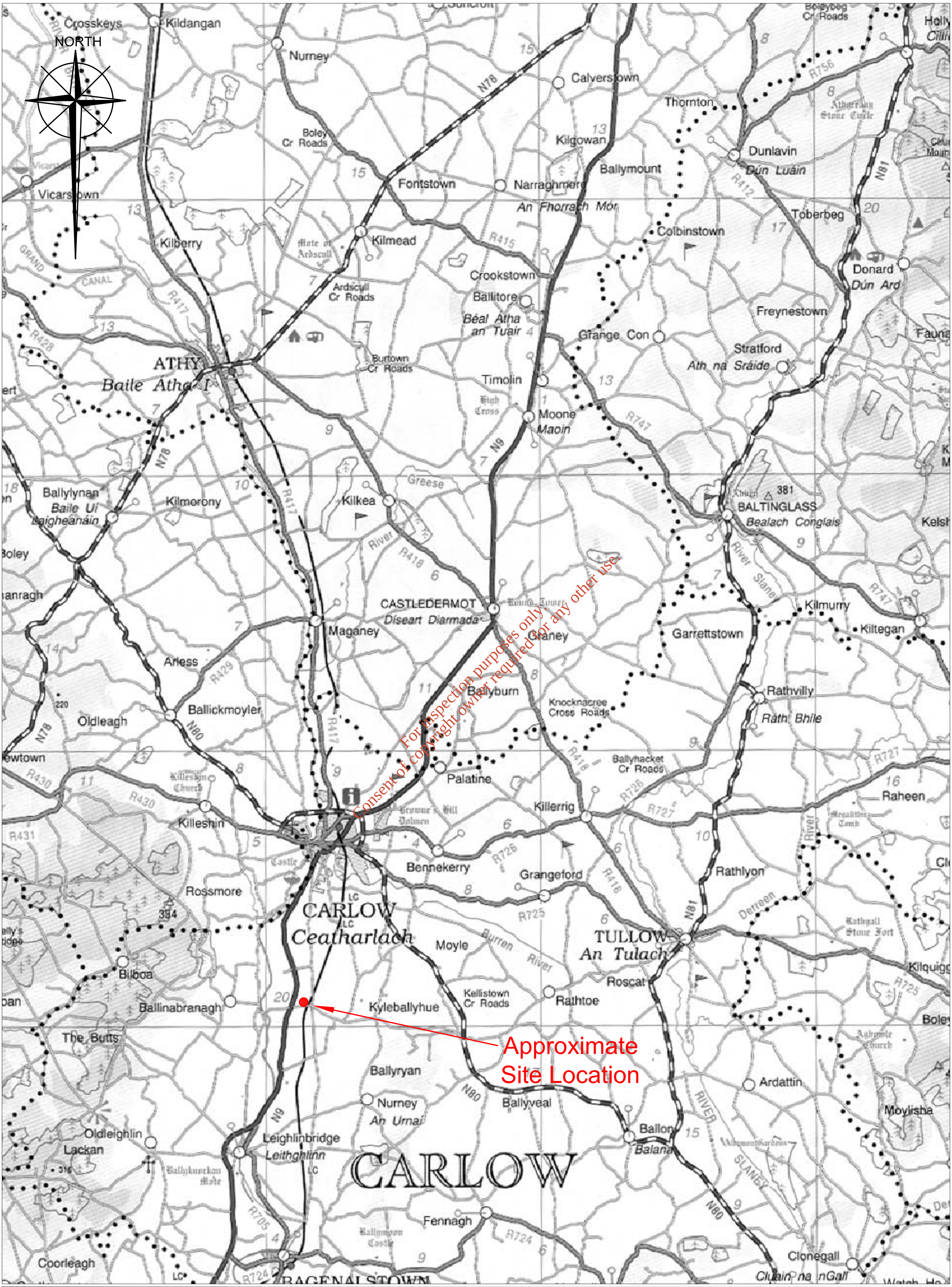
The best opportunities for avoiding damage to archaeological remains or intrusion on their setting and amenity arise when the site options for the development are being considered. Damage to the archaeological resource immediately adjacent to developments may be prevented by the selection of appropriate construction methods. Reducing adverse effects can be achieved by good design, for example by screening historic buildings or upstanding archaeological monuments or by burying archaeological sites undisturbed rather than destroying them. Offsetting adverse effects is probably best illustrated by the full investigation and recording of archaeological sites that cannot be preserved *in situ*.

Definition of Mitigation Strategies
The ideal mitigation for all archaeological sites is preservation *in situ*. This is not always a practical solution, however. Therefore a series of recommendations are offered to provide ameliorative measures when avoidance and preservation *in situ* are not possible.

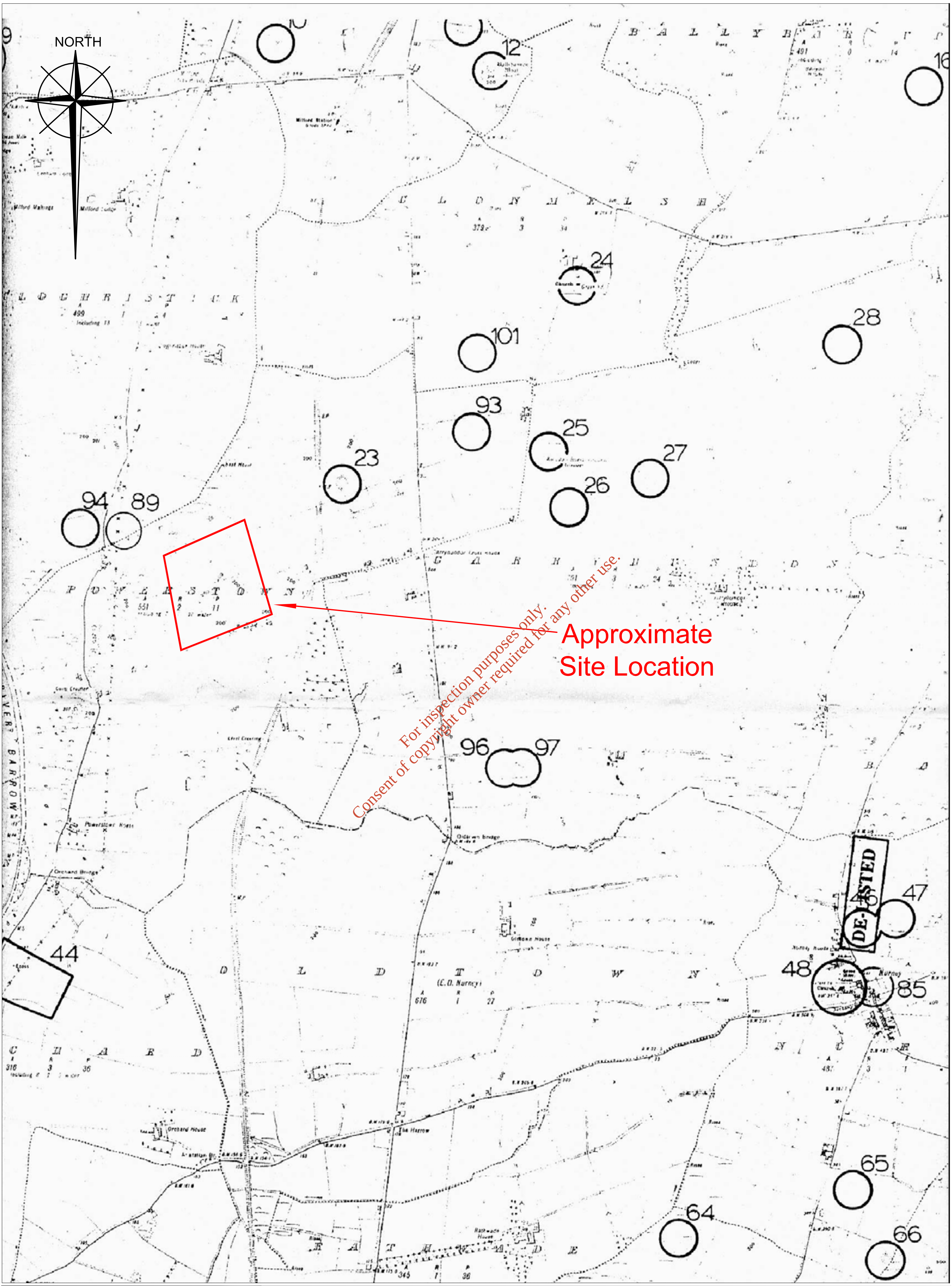
Full Archaeological Excavation
Archaeological excavation involves the scientific removal and recording of all archaeological features, deposits and objects to the level of geological strata or the base level of any given development. Full archaeological excavation is recommended where initial investigation has uncovered evidence of archaeologically significant material or structures and where avoidance of the site is not possible.

Archaeological Test Trenching
Archaeological test trenching can be defined as 'a limited programme... of intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land or underwater. If such archaeological remains are present test trenching defines their character and extent and relative quality.' (IFA 1994a, 1)

Monitoring
Archaeological monitoring can be defined as a 'formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons within a specified area or site on land or underwater, where there is possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.' (IFA 1994b, 1)

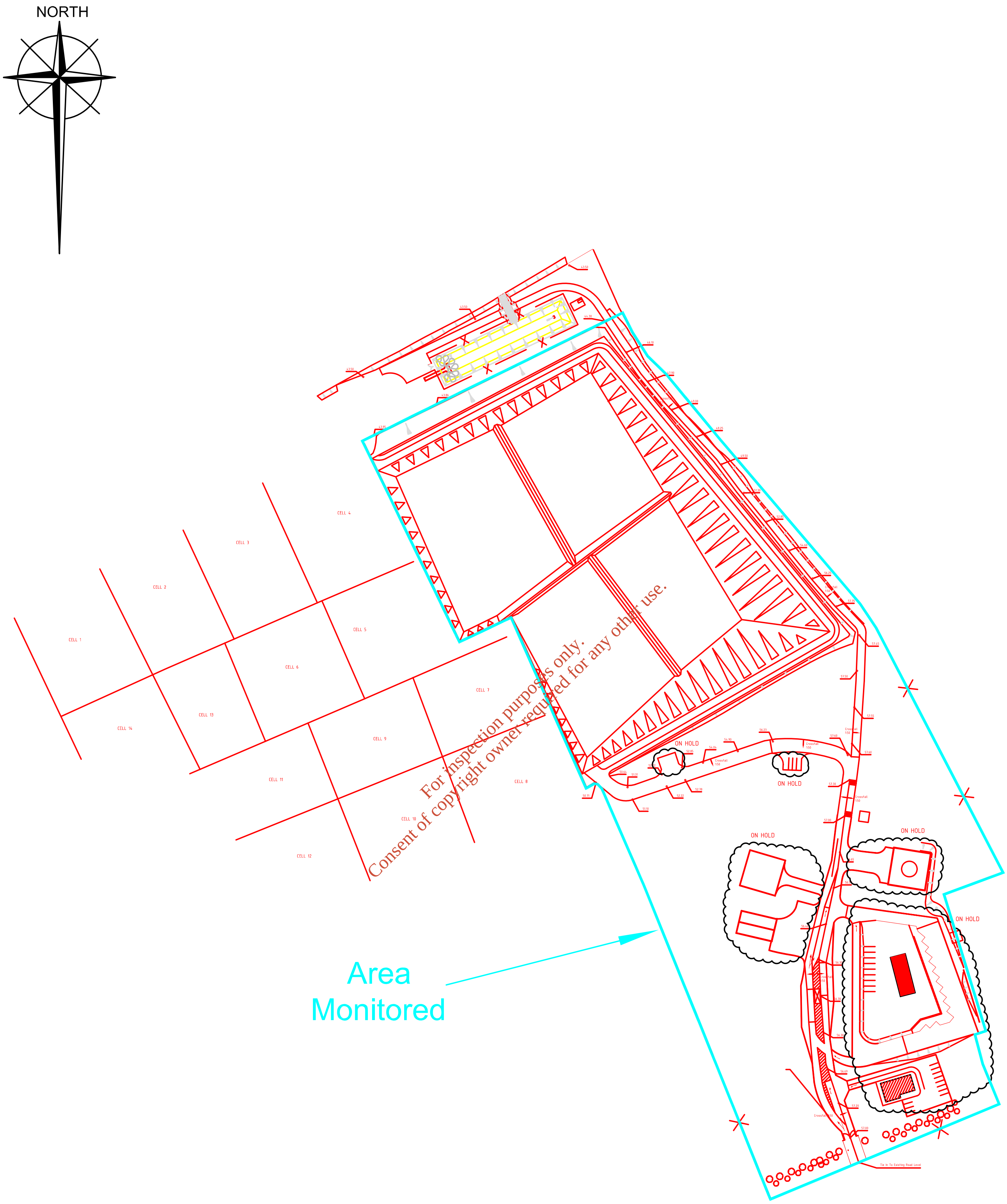


Irish Archaeological Consultancy Ltd.			
Title:	Approximate Site Location	Scale:	N.T.S.
		Date:	05/12/05
Project:	Powerstown, Carlow	Produced by:	P Higgins
		Job No:	J2330
Client:	Clare Civil Engineers	Figure No:	1



Irish Archaeological Consultancy Ltd.

Title:	RMP Map showing site of proposed development	Scale:	N.T.S.
		Date:	01/12/04
Project:	Powerstown, Carlow	Produced by:	P Higgins
		Job No:	J2330
Client:	Clare Civil Engineers	Figure No:	2



Irish Archaeological Consultancy Ltd.

Title:	Plan of proposed development site showing area monitored	Scale:	N.T.S.
		Date:	05/12/05
Project:	Powerstown, Carlow	Produced by:	P Higgins
		Job No:	J2330
Client:	Clare Civil Engineers	Figure No:	3