ASSESSMENT OF LFG VERTICAL MIGRATION

OTTAWA LANDFILL

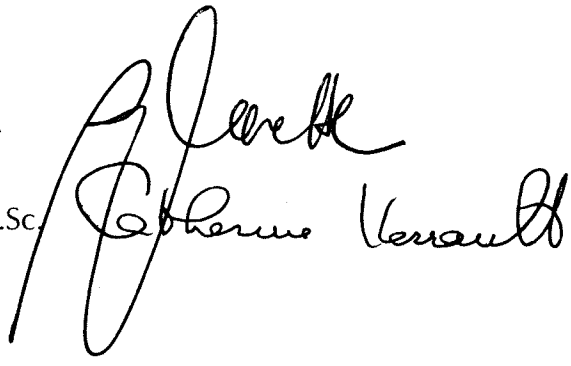
WASTE MANAGEMENT

TECHNICAL REPORT – SURVEY JUNE 2010

PROJECT N° Q122482

GENIVAR S.E.C.
1175 Lebourgneuf Boulevard, 3rd floor
Québec (Québec) G2K 0B4
Phone : (418) 780-0878
Fax : (418) 780-4182

Document prepared by Alexandre Monette, eng.
Member OIQ number: 143 579
and approved by Catherine Verrault, M.Sc., M.A.Sc.



Quebec, July 6, 2010

TABLE OF CONTENT

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF APPENDIX

1. INTRODUCTION

Waste Management of Canada Corp. has given a mandate to GENIVAR S.E.C. for the assessment of methane emission at the surface of Ottawa landfill.

According to the offer for professional services, the following tasks were performed :

- Measurement on a continuous basis of the methane concentrations in the ambient air above the surface of the landfill site and the air sparging system with the FID-GPS technology developed by the firm GENIVAR ;

- Measurement on a continuous basis of the methane concentrations in the ambient air above the ground along four (4) extra lines, located on the north and south sides of the landfill site, with the FID-GPS technology developed by the firm GENIVAR ;

- Data processing and mapping of results ;

- Technical report editing.

Field work was performed by Mr. Dave Veilleux and Mr. Alain L'italien of GENIVAR on June 15th, 2010.

2. METHODOLOGY

2.1 Location of measurements

Assessment of vertical migration of LFG was performed above the entire landfill and above the ground along four (4) extra lines located on the north and south sides of the landfill site. Location of the measurement points is shown on Figure 2-1.

This assessment was also performed above the LFG air sparging system trench (2 lines of 1 km long at a height of approximately 6 inches on each side above ground). Location of the measurement points is shown on figure 2-2.

2.2 Methodology

Methane concentrations above ground are measured and recorded on a continuous basis with a portable Flame Ionisation Detector (FID). Spatial location of the measurement points are defined and recorded by a Global Positioning System (GPS).

According to the EPA procedure, the sampling is done along the periphery of the waste cells and along a serpentine pattern spaced about 30 meters apart, at a height of approximately 6 inches above ground.

Methane concentrations are then processed and spatial coordinates are transformed from the degree, minute, second format to the NAD83MTM Zone 9 system. A map showing iso-contours of methane concentration is prepared. The iso-contours are overlaid on a map showing the landfill gas collection system general arrangement in order to be able to evaluate its efficiency and to identify areas where modifications are required to reduce emissions to the atmosphere.

2.2.1 Instrumentation

Methane concentrations are determined with a Thermo Environmental Instruments TVA 1000B portable analyser by the flame ionisation method. This instrument is used for the measurements into ambient air of small concentrations of total volatile organic

compounds, expressed as methane. The analytical range of the analyser is 0 to 50 000 ppmv with a lower detection limit at 0.5 ppmv.

Since the concentration of methane in landfill gases more than 100 times higher than non methane organic compounds and that the measured concentrations are low, the result given by the instrument is interpreted as methane alone.

Spatial co-ordinates are measured by a Garmin GPS which in DGPS mode has an accuracy of less than 1 meter.

Wind speed is checked regularly during sampling with a portable anemometer.

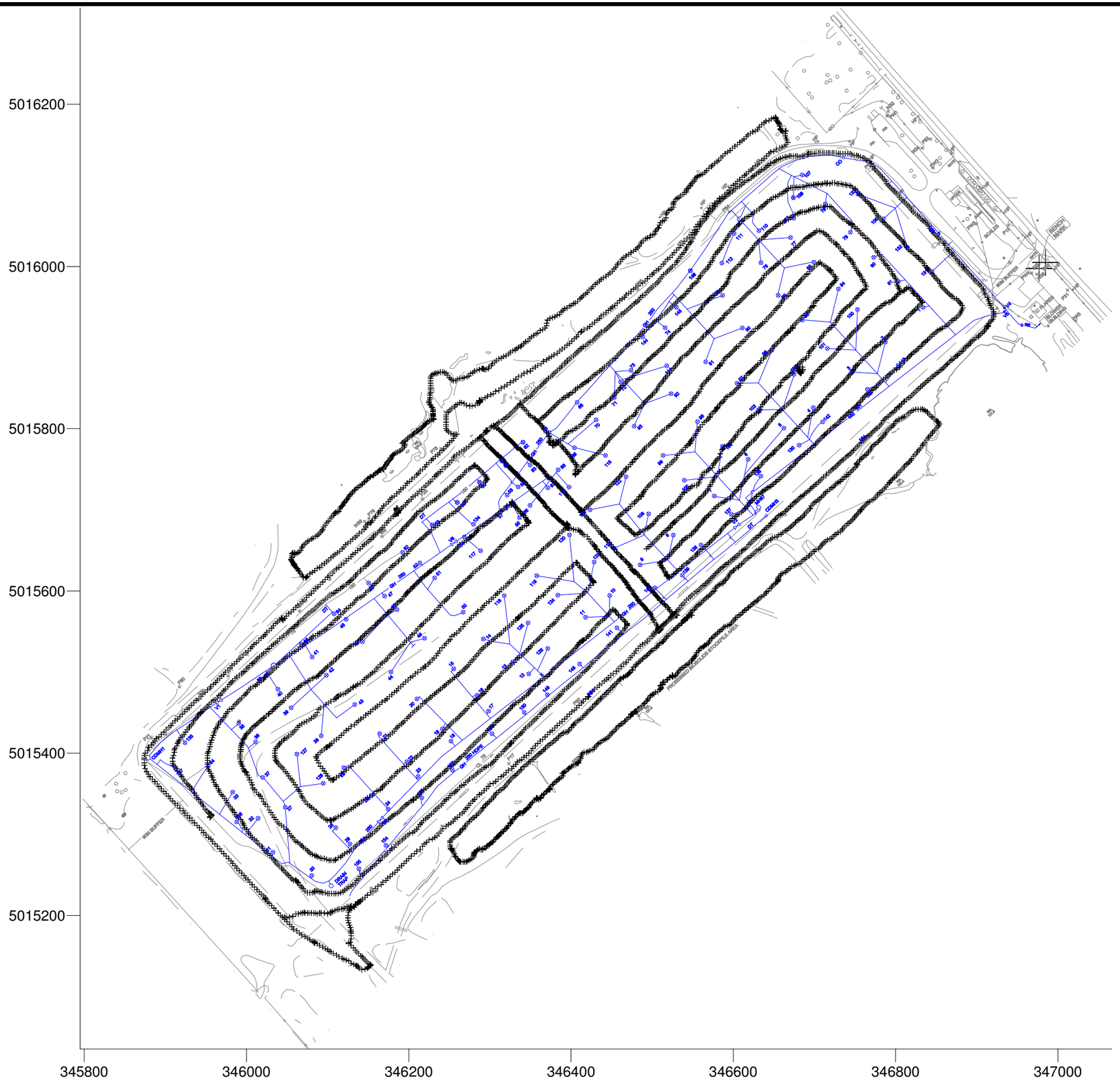
2.2.2 Instrument calibration

Accuracy of the analytical instrument is verified on a regular basis with calibration gas having a known composition. Adjustments are made if required. For the TVA 1000B, the calibration gases are composed of:

- 100 ppmv of CH_4 in air ;
- 10 000 ppmv of CH_4 in air.

2.2.3 Meteorological constraints

Average wind speed during sampling shouldn't exceed 8 km/hr with maximum peak speed at 20 km/hr.



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT®

GENIVAR

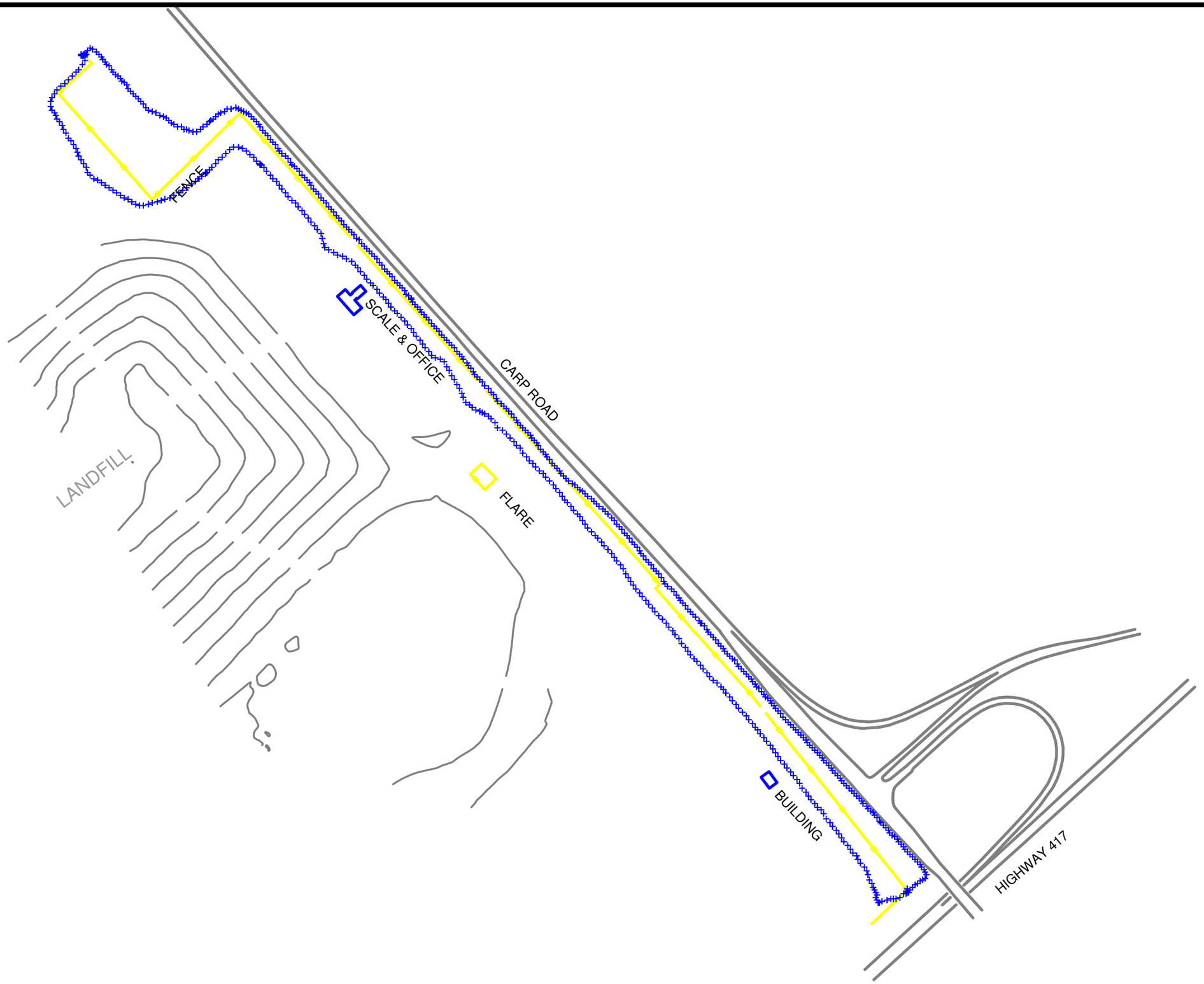
LEGEND

- MEASUREMENT POINTS
- GAS EXTRACTION WELL

FIGURE 2-1

LOCATION OF MEASUREMENT POINTS

JUNE, 2010



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT

GENIVAR

LEGEND

MEASUREMENT POINTS

EXISTING FENCE

FIGURE 2-2

LOCATION OF MEASUREMENT POINTS

JUNE, 2010

3. RESULTS

3.1 Regulations

In Ontario, owners of landfill sites need an approval if their facilities "may discharge or from which may be discharged a contaminant into any part of the natural environment other than water » (Environmental Protection Act, R.S.O. 1990, CHAPTER E.19, part II General Provisions, section 9 Approval of Director, plant or production process). However, no specific maximum acceptable concentration of methane above the surface is defined.

Under item No. 4 of Provincial Officer's Order No. 5830-6Z2PPW, WM is required to perform landfill gas emission surveys at the Ottawa landfill site in April, June, August, October and December 2010. Each report shall include also the survey results of the previous campaign and describe any actions related to the LFG collection and flaring system taken since the last survey.

US EPA has enacted operational standards in "Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills", into effect since March 12th, 1996 (40 CFR Parts 51, 52 and 60). This rule stipulates that methane concentrations measured at the surface of the landfill shall be less than 500 ppmv. EPA methodology and standard will be used for the assessment of methane emissions to the atmosphere at the Ottawa landfill.

3.2 Surface sampling results

Results show that there are 55 points (0.85%) having a methane concentration above 500 ppmv compared to 0.05% of the points for the previous survey. Table 3-1 presents the location of those points together with their concentration and table 3-2 presents the results of April 2010 survey.

Figure 3-1 presents the detailed results for this survey and figure 3-2 for April 2010. Iso-contour map of methane concentrations is shown on figure 3-3 for this sampling campaign and figure 3-4 for April 2010.

Points having a methane concentration greater than 500 ppmv are entirely concentrated on the east area of the site. The majority of these points are located on the south slope. Higher values recorded are located at three different places, which are:

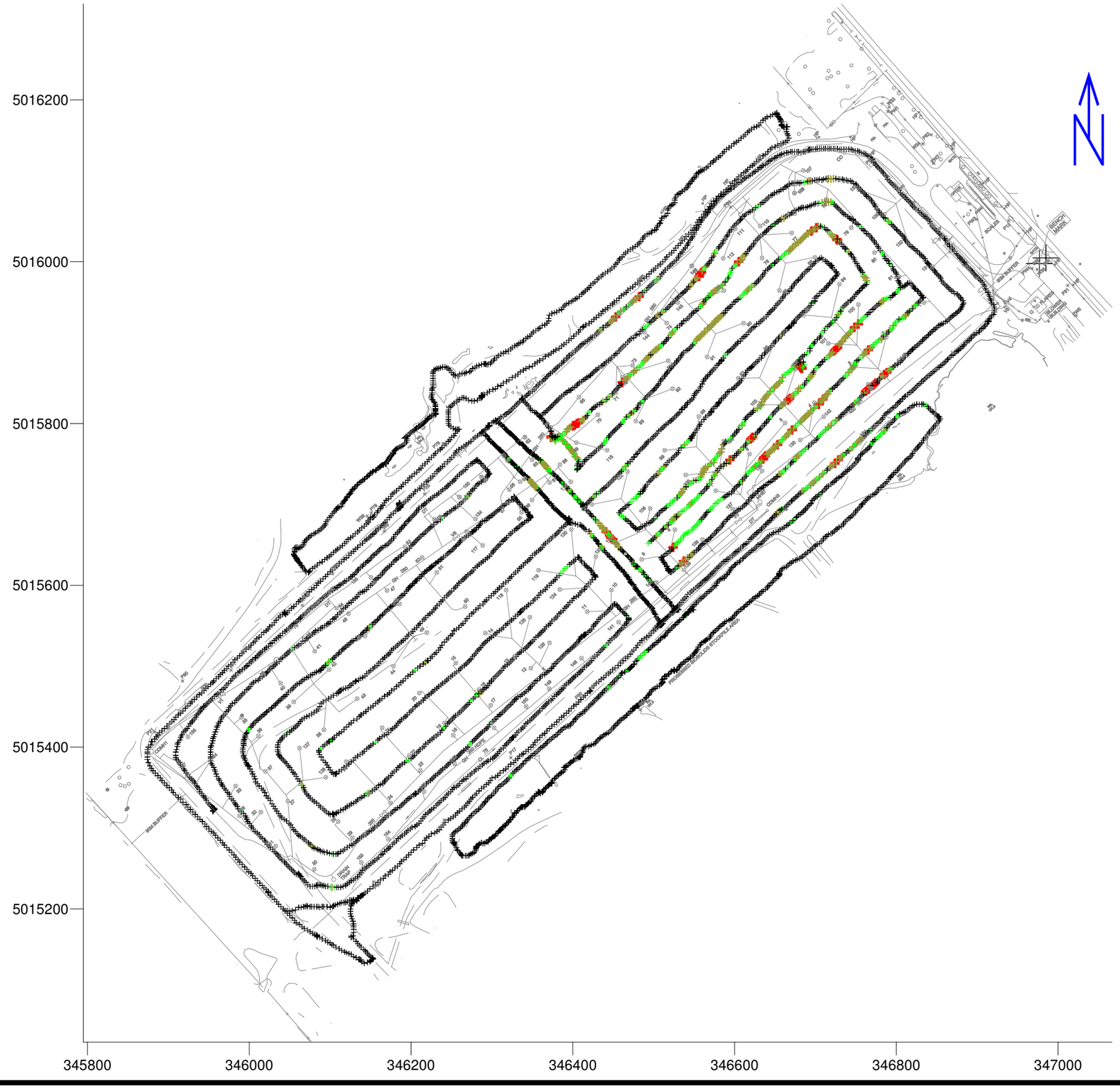
- On the north slope, near wells #62, 63, 64, 65, 69 & 70 ;
- In the middle of the site, near wells #113 & 123 ;
- On the south slope, near wells #101 & 102.

Figure 3-5 presents the methane concentrations obtained above the LFG air sparging system located along Carp Road for this survey and figure 3-6 for April 2010. As usual, no methane concentration higher than 500 ppmv was measured in June 2010.

Table 3-1: Points having a methane concentration higher than 500 ppmv June 2010		
X	***Y***	***CH_4 (ppmv)***
346373	5015784	50000
346373	5015783	34100
346727	5015894	6052
346407	5015801	3615
346682	5015869	3265
346449	5015657	3149
346447	5015659	2824
346683	5015868	2519
346681	5015871	2255
346774	5015850	2152
346683	5015869	2117
346725	5015892	1895
346681	5015870	1735
346682	5015870	1644
346441	5015666	1572
346557	5015985	1499
346405	5015800	1251
346666	5015829	1104
346668	5015831	1078
346680	5015872	1064
346704	5015824	1031
346605	5016000	965
346727	5016027	931
346753	5015923	899
346765	5015891	892
346635	5015756	813
346638	5015760	758
346524	5015647	747
346556	5015982	741
346653	5015774	733
346636	5015758	719
346772	5015848	681
346594	5015755	677
346400	5015797	670
346482	5015957	669
346726	5016028	663
346788	5015863	662
346766	5015843	657
346764	5015842	633
346537	5015630	624
346671	5015792	623
346723	5015890	602
346620	5015781	591
346724	5015751	586
346785	5015861	584
346762	5015840	584
346728	5015755	562
346622	5015783	559
346402	5015798	549
346680	5015874	546
346695	5016038	523

Table 3-1: Points having a methane concentration higher than 500 ppmv June 2010		
X	***Y***	***CH_4 (ppmv)***
346559	5015987	515
346709	5015830	514
346453	5015932	502
346461	5015851	501

Table 3-2 : Points having a methane concentration higher than 500 ppmv April 2010		
X	***Y***	***CH_4 (ppmv)***
346774	5015884	1633
346775	5015884	1182
346653	5015769	699



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT

GENIVAR

LEGEND

- 0 à 50 ppmv
- 50 à 100 ppmv
- 100 à 500 ppmv
- 500 à 50001 ppmv

FIGURE 3-1

METHANE CONCENTRATIONS
LANDFILL

JUNE, 2010

LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT

GENIVAR

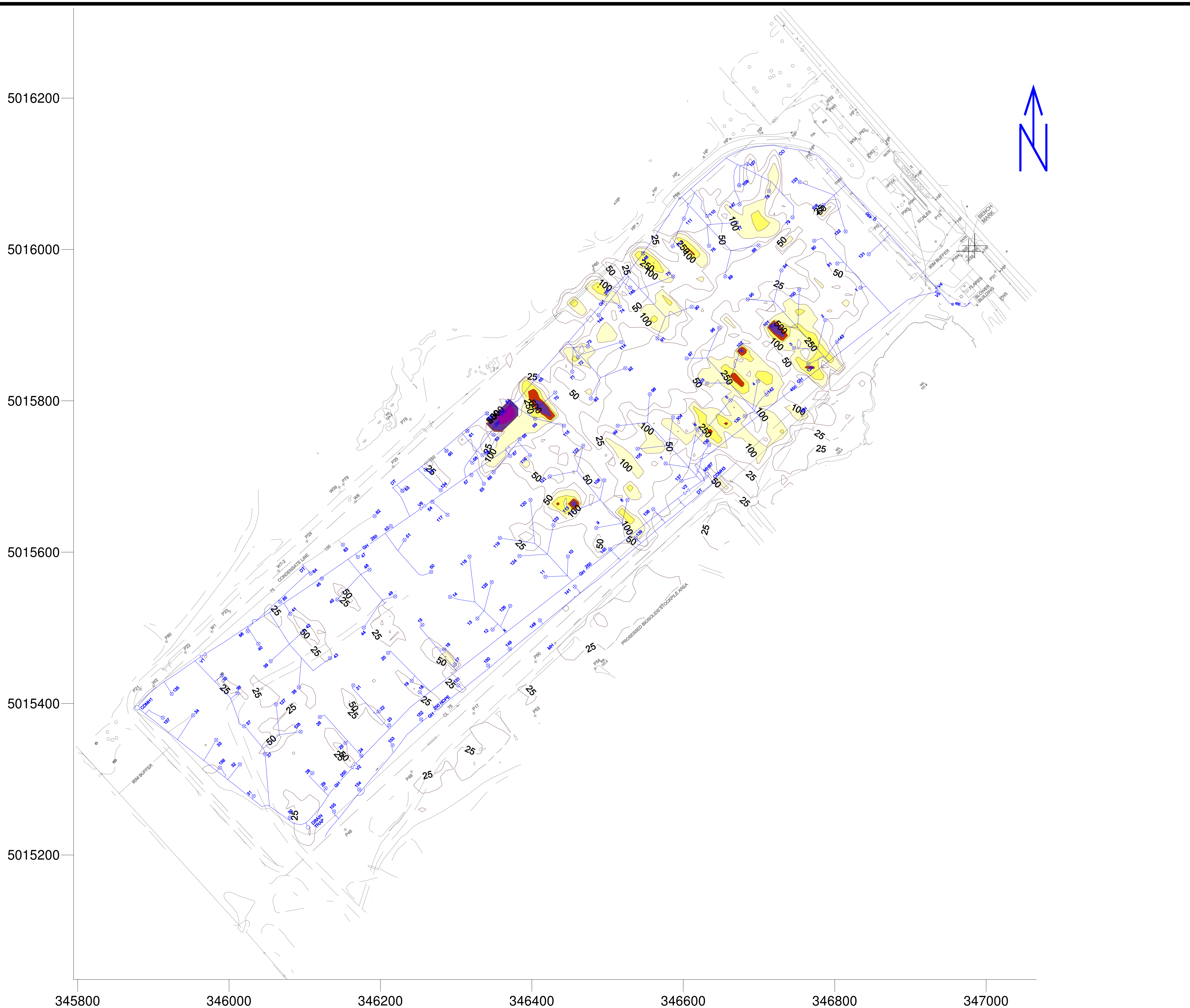
LEGEND

- 0 à 50 ppmv
- 50 à 100 ppmv
- 100 à 500 ppmv
- 500 à 50000 ppmv

FIGURE 3-2

METHANE CONCENTRATIONS
LANDFILL

APRIL, 2010



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT

GENIVAR

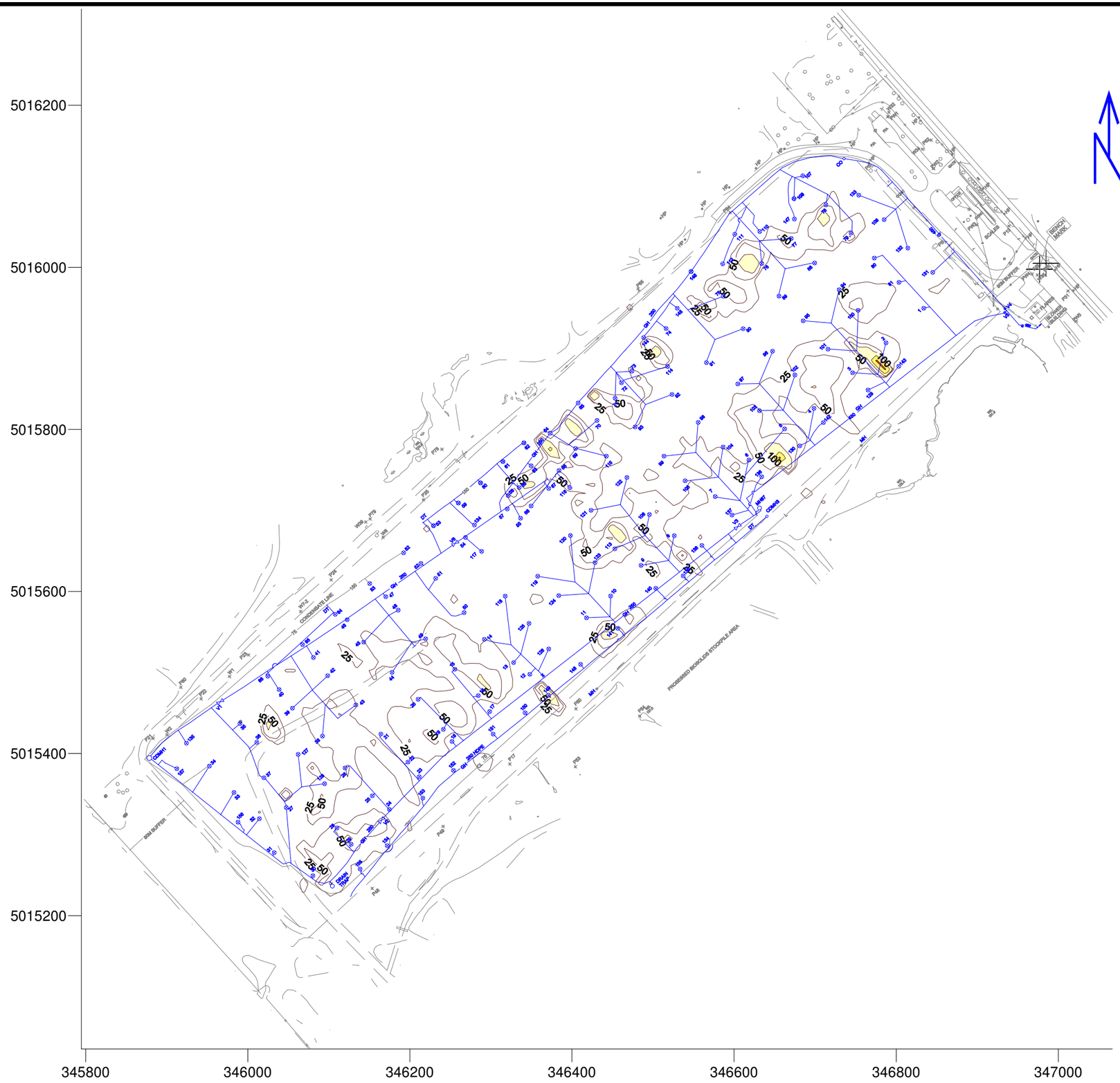
LEGEND

10000 ppmv
1000 ppmv
500 ppmv
250 ppmv
100 ppmv
50 ppmv
25 ppmv
0 ppmv

FIGURE 3-3

ISO-CONTOURS OF METHANE CONCENTRATIONS

JUNE, 2010



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT®

GENIVAR

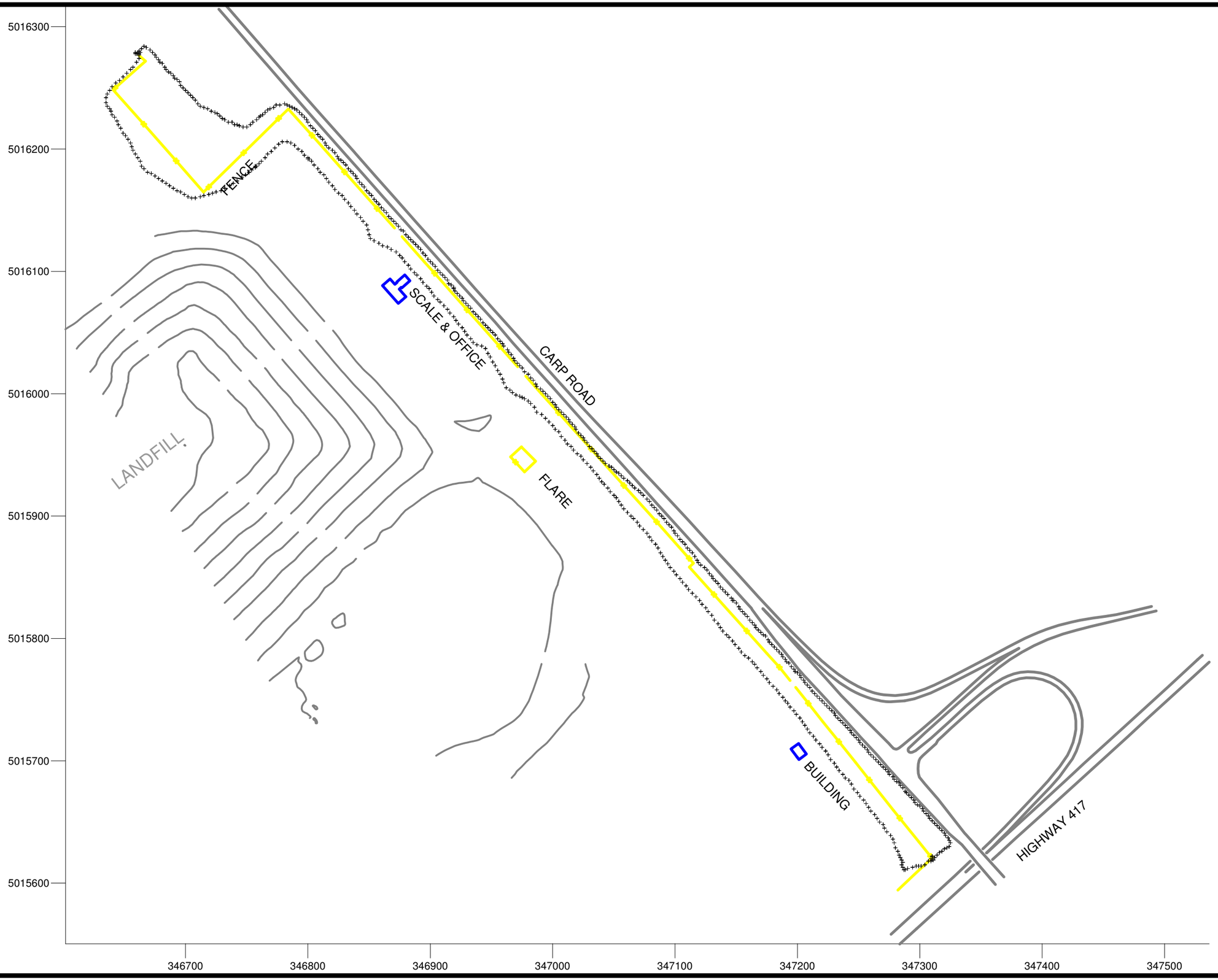
LEGEND

- 10000 ppmv
- 1000 ppmv
- 500 ppmv
- 250 ppmv
- 100 ppmv
- 50 ppmv
- 25 ppmv
- 0 ppmv

FIGURE 3-4

ISO-CONTOURS OF METHANE CONCENTRATIONS

APRIL, 2010



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT

GENIVAR

LEGEND

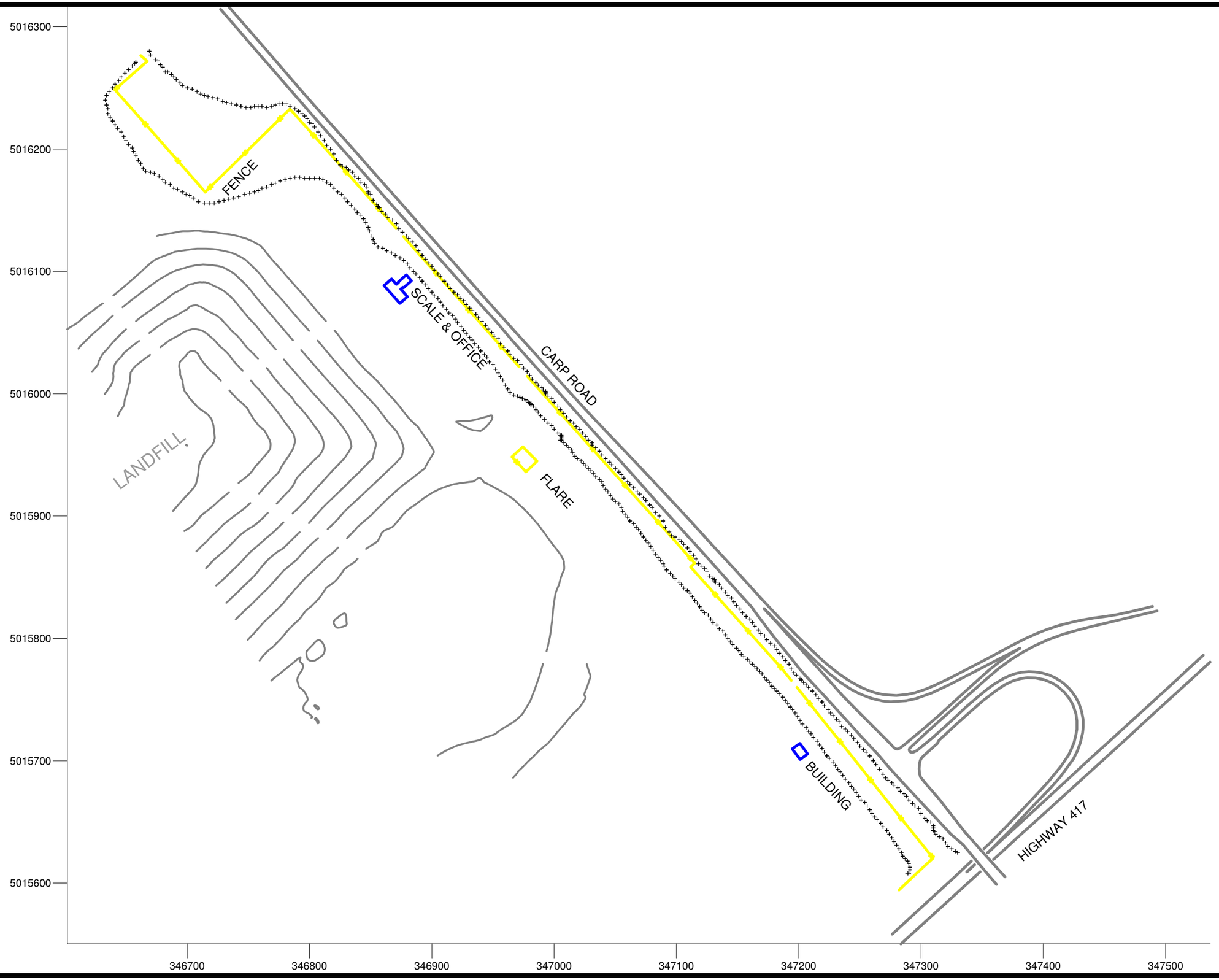
EXISTING FENCE

- 0 to 50 ppmv
- 50 to 100 ppmv
- 100 to 500 ppmv
- 500 to 50000 ppmv

FIGURE 3-5

METHANE CONCENTRATIONS
CARP ROAD

JUNE, 2010



LANDFILL GAS EMISSION
WASTE MANAGEMENT

OTTAWA LANDFILL

GPS/FID MEASUREMENT

WASTE MANAGEMENT®

GENIVAR

LEGEND

EXISTING FENCE

- 0 to 50 ppmv
- 50 to 100 ppmv
- 100 to 500 ppmv
- 500 to 50000 ppmv

FIGURE 3-6

METHANE CONCENTRATIONS
CARP ROAD

APRIL, 2010

3.3 Site configuration and well performance

Since April 2009, the landfill gas collection system at the Ottawa landfill is composed of 177 vertical extraction wells and horizontal collectors installed at the bottom of North, West and South slopes. All of these wells are connected to three (3) flaring stations (2 enclosed flares with 3 blowers and 1 candlestick flare with 1 blower) via a 450 mm header located at the bottom of the slopes.

3.4 Improvements since the previous assessment

Since the last survey, the LFG system have been maintained and calibrated on a regular basis. No LFG wells have been installed since April 2009.

3.5 Wind speed

Sampling was done when the winds were under specifications described at 2.2.3. The average velocity of the wind was between 4 and 6 km/hr and the gust of the wind was 10 km/h.

4. INTERPRETATION OF RESULTS

The results indicate that the methane emissions to the atmosphere are higher than the last survey. The results shown on Figure 3-3 indicate that high emissions are mainly located at the three following areas:

- On the north slope, near wells #62, 63, 64, 65, 69 & 70 ;
- In the middle of the site, near wells #113 & 123 ;
- On the south slope, near wells #101 & 102.

The integrity of the soil cover should be checked and modified if required and the vacuum increased at the wells located in the area of the high spots.

No high value was recorded above the ground along the four (4) extra lines located on the north and south sides of the landfill site and above the air purging system near Carp road.

APPENDIX I

STATISTICAL REPORT

Gridding Report

Wed Jun 16 08:49:35 2010
Elasped time for gridding: 0.11 seconds

Data Source

Source Data File Name: R:\GENIVAR\Q122482 (Biogaz - WM Ottawa, Surface 2010)\Juin 2010\Données brutes\Ottawa_15juin2010.xls
X Column: A
Y Column: B
Z Column: C

Data Counts

Active Data:	6459
Original Data:	7131
Excluded Data:	0
Deleted Duplicates:	672
Retained Duplicates:	222
Artificial Data:	0
Superseded Data:	0

Univariate Statistics

	X	Y	Z
Minimum:	345874	5015133	0
25%-tile:	346227	5015500	5.28
Median:	346422	5015693	11.79
75%-tile:	346610	5015862	30.81
Maximum:	346921	5016184	50000
Midrange:	346397.5	5015658.5	25000
Range:	1047	1051	50000
Interquartile Range:	383	362	25.53
Median Abs. Deviation:	192	178	7.89
Mean:	346417.03096455	5015681.9838984	51.201675181917
Trim Mean (10%):	346418.55683577	5015683.3616509	21.203793637145
Standard Deviation:	244.38027437257	237.63367301862	767.14480795519
Variance:	59721.718502414	56469.76255232	588511.15637261

Coef. of Variation:	14.982806816956
Coef. of Skewness:	56.417800340135

—

Inter-Variable Correlation

	X	Y	Z
X:	1.000	0.701	0.025
Y:		1.000	0.027
Z:			1.000

Inter-Variable Covariance

	X	Y	Z
X:	59721.718502414	40733.133955769	4690.8758329406
Y:		56469.76255232	4926.1327332743
Z:			588511.15637261

Planar Regression: Z = AX+BY+C

Fitted Parameters

—

	A	B	C
Parameter Value:	0.036874903856457	0.059187808758565	-309590.11886868
Standard Error:	0.054333018168749	0.055875563784316	267388.90156957

—

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.701	0.665
B:		1.000	0.999
C:			1.000

ANOVA Table

—

Source	df	Sum of Squares	Mean Square	F
Regression:	2	3000554.7009082	1500277.3504541	2.5501
Residual:	6456	3798193004.3098	588319.85816446	
Total:	6458	3801193559.0107		

Coefficient of Multiple Determination (R^2): 0.00078937172083637

Nearest Neighbor Statistics

	Separation	|Delta Z|
Minimum:	1	0
25%-tile:	2.2360679774998	0.19
Median:	2.2360679774998	1.05
75%-tile:	2.8284271247462	6.07
Maximum:	5	49976.39
Midrange:	3	24988.195
Range:	4	49976.39
Interquartile Range:	0.5923591472464	5.88
Median Abs. Deviation:	0.5923591472464	0.99
Mean:	2.3761726450852	30.702100944419
Trim Mean (10%):	2.372110382105	5.6883387790198
Standard Deviation:	0.7475218074349	666.33240788779
Variance:	0.55878885259074	443998.87780155
Coef. of Variation:	0.3145906965056	21.703153445234
Coef. of Skewness:	-0.076339315191172	67.449390013021
Root Mean Square:	2.4909807891352	667.03935176566
Mean Square:	6.2049852918408	444941.49680395

Complete Spatial Randomness

Lambda:	0.0058696997538161
Clark and Evans:	0.36409601947547
Skellam:	1478.0931221069

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: Maximum Z
X Duplicate Tolerance: 0.00012
Y Duplicate Tolerance: 0.00012

Deleted Duplicates: 672
Retained Duplicates: 222
Artificial Data: 0

X	Y	Z	ID	Status
345943	5015449	6.48	4705	Retained
345943	5015449	6.02	4905	Deleted
345943	5015450	6.24	4792	Retained
345943	5015450	6.05	4896	Deleted
345943	5015450	6.06	4889	Deleted
345943	5015450	6.06	4888	Deleted
345943	5015450	6.21	4808	Deleted
345944	5015451	6.09	4869	Retained
345944	5015451	5.98	4923	Deleted
345953	5015327	10.83	3629	Retained
345953	5015327	5.54	5174	Deleted
345955	5015321	13.6	3239	Retained
345955	5015321	5.62	5124	Deleted
345955	5015321	5.7	5074	Deleted
345955	5015321	5.77	5025	Deleted
345955	5015321	5.86	4987	Deleted
345955	5015321	5.88	4980	Deleted
345955	5015321	6.72	4619	Deleted
345955	5015321	7.06	4510	Deleted
345955	5015325	5.83	4997	Retained
345955	5015325	5.62	5123	Deleted
345956	5015324	6.43	4715	Retained
345956	5015324	6.21	4809	Deleted
345957	5015324	6.23	4797	Retained
345957	5015324	5.89	4967	Deleted
345957	5015324	5.96	4931	Deleted
345957	5015324	6.16	4833	Deleted
345957	5015324	6.21	4810	Deleted

345998	5015377 Retained	14.38	3104	
345998	5015377	13.45	3258	Deleted
346022	5015493 Retained	9.15	3925	
346022	5015493	6.64	4647	Deleted
346022	5015493	6.67	4634	Deleted
346022	5015493	7.24	4473	Deleted
346022	5015493	7.24	4472	Deleted
346022	5015493	7.43	4422	Deleted
346022	5015493	7.48	4415	Deleted
346022	5015493	8.27	4192	Deleted
346022	5015493	8.46	4142	Deleted
346022	5015493	8.54	4108	Deleted
346023	5015221 Retained	4.01	6035	
346023	5015221	3.48	6668	Deleted
346023	5015221	3.69	6427	Deleted
346023	5015221	3.7	6411	Deleted
346024	5015220 Retained	4.02	6016	
346024	5015220	3.65	6474	Deleted
346024	5015220	3.83	6252	Deleted
346024	5015220	3.85	6227	Deleted
346024	5015220	3.92	6132	Deleted
346044	5015566 Retained	5.5	5196	
346044	5015566	4.28	5733	Deleted
346044	5015567 Retained	4.41	5684	
346044	5015567	3.8	6294	Deleted
346047	5015198 Retained	3.85	6229	
346047	5015198	3.21	6830	Deleted
346059	5015632 Retained	4.09	5915	
346059	5015632	3.88	6177	Deleted
346059	5015645 Retained	3.95	6097	
346059	5015645	3.74	6359	Deleted
346059	5015645	3.9	6153	Deleted
346059	5015647 Retained	4.09	5916	
346059	5015647	3.8	6293	Deleted
346059	5015647	3.83	6250	Deleted
346059	5015647	3.99	6056	Deleted

346061	5015243 Retained	8.77	4046	
346061	5015243	8.22	4210	Deleted
346070	5015617 Retained	4.41	5683	
346070	5015617	4.31	5723	Deleted
346070	5015617	4.35	5702	Deleted
346073	5015616 Retained	3.32	6793	
346073	5015616	3.23	6823	Deleted
346083	5015167 Retained	3.73	6373	
346083	5015167	3.67	6453	Deleted
346084	5015166 Retained	3.42	6724	
346084	5015166	3.41	6733	Deleted
346084	5015166	3.42	6725	Deleted
346084	5015230 Retained	26.26	1987	
346084	5015230	25.75	2028	Deleted
346086	5015396 Retained	11.42	3555	
346086	5015396	8.37	4163	Deleted
346090	5015203 Retained	3.8	6295	
346090	5015203	3.53	6621	Deleted
346090	5015203	3.8	6296	Deleted
346099	5015407 Retained	34.18	1507	
346099	5015407	31.06	1692	Deleted
346099	5015407	27.79	1896	Deleted
346099	5015407	27.37	1929	Deleted
346099	5015407	16.42	2837	Deleted
346099	5015407	13.33	3273	Deleted
346099	5015407	11.71	3512	Deleted
346103	5015410 Retained	33.42	1542	
346103	5015410	33.2	1561	Deleted
346103	5015410	23.25	2240	Deleted
346104	5015204 Retained	7.75	4319	
346104	5015204	4.85	5504	Deleted
346107	5015367 Retained	12.09	3471	

346107	5015367	9.39	3863	Deleted
346107	5015367	5.36	5289	Deleted
346126	5015166	3.74	6365	Retained
346126	5015166	3.72	6382	Deleted

More ...

Breakline Filtering

Breakline Filtering: Not In Use

Gridding Rules

Gridding Method: Triangulation with Linear Interpolation
Anisotropy Ratio: 1
Anisotropy Angle: 0

Output Grid

Grid File Name: R:\GENIVAR\Q122482 (Biogaz - WM Ottawa, Surface 2010)\Juin 2010\Données brutes\Ottawa_15juin2010.grd
Grid Size: 100 rows x 100 columns
Total Nodes: 10000
Filled Nodes: 4506
Blanked Nodes: 5494

Grid Geometry

X Minimum: 345874
X Maximum: 346921
X Spacing: 10.575757575758

Y Minimum: 5015133
Y Maximum: 5016184
Y Spacing: 10.616161616162

Grid Statistics

Z Minimum: 0.70176257697083
Z 25%-tile: 6.0009740259681
Z Median: 12.829006342631
Z 75%-tile: 30.642758984422
Z Maximum: 30566.667821382

Z Midrange: 15283.684791979
Z Range: 30565.966058805
Z Interquartile Range: 24.641784958454

Z Median Abs. Deviation:	8.3245765442877
Z Mean:	54.416896711942
Z Trim Mean (10%):	21.568958202419
Z Standard Deviation:	695.48916261859
Z Variance:	483705.17531991
Z Coef. of Variation:	12.780757533826
Z Coef. of Skewness:	36.202684785972
Z Root Mean Square:	697.61477476302
Z Mean Square:	486666.37396766