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July 30, 2009

David White
Waste Management
2301 Carp Road
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Re: Peer Review Richmond Landfill, Napanee
RWDI Project 0925063B **Email: DWhite7@wm.com**

RWDI AIR Inc. (RWDI) was retained by Waste Management to conduct a peer review of odour modelling and analysis conducted for the Chief and Council of the Mohawks of the Bay of Quinte regarding the Richmond Landfill site by XCG. This letter presents the results of our findings.

The modelling and analysis was summarized in the following letter/document: **'Odour Modelling, Richmond Landfill Vicinity', XCG File No. 1-664-17-03 dated May 29, 2009**.

Our review has focused on the validity of the assumptions made regarding sources and modelling of the sources, the validity of the emission factors and subsequent emission rates used and how well the odour modelling represents the odour concentrations from the Richmond Landfill. We have not commented on the selection of the meteorological data used, since this is a very small factor compared with the more significant issues that we have raised in this report.

1 INTRODUCTION

At the time of the initial odour assessment of the Richmond Landfill, conducted for the Waste Management of Canada Corporation, current standard dispersion models (SCREEN3, AERMOD) were not in general use in Ontario (report was dated October of 2005, Regulation 419 requiring AERMOD modelling came into force November 30, 2005), odour legislated limits had not been formulated (Regulation 419 was amended to include odour limit in August 2007) and the current protocols for meteorological data (5 years) did not yet exist (required with AERMOD). Therefore, the input information set and subsequent assessment had limitations. The aim of the analysis provided by XCG (May 29, 2009) was to address these shortcomings. This peer review addresses the major concerns associated with the XCG analysis.

2 REVIEW

The major issues with the XCG odour modeling are discussed in the following subsections.

2.1 Selection of Landfill Sources

Only odour emissions from fresh waste placement activities were considered, without proper justification and in contradiction to actual findings at many landfill sites.

XCG Report (2.2.1)

'based on initial calculations, only odour emission estimates from fresh waste operations were considered significant in this report.'

The assumption that only working face freshly tipped waste is a significant source has not been proven. In fact, in a summary document of various landfill sources in Europe[1], it was found that landfill gas, covered waste, tipped compacted and uncovered waste can also contribute to the same extent; and in the case of capping failures and fissures, drilling and gas infrastructure, odours from these sources can exceed the contribution of freshly tipped waste by orders of magnitude. (see Attachment A). Also of paramount importance, there are no details as to how any of the odour emissions were calculated, nor were sample calculations given.

2.2 Use of Sampling Data

The significance of the sampling data was not well understood and hence these data were not utilized to substantiate emission rates used.

XCG Report (4)

'Samples collected for odour analyses were essentially "grab" samples. The number of samples collected failed to account for potential odour impact (see definition of simultaneous occurrence above) as a result of time, location, and correct meteorology.'

The samples that were taken were source samples taken in accordance with accepted protocol at that time and are for most purposes independent of meteorology. We do not expect that alternate sampling locations of the same landfill would result in significant differences, especially in light of the order of magnitude differences between different landfills or the variability in odour panel analysis results.

2.3 Determination of Emission Rates

The emission factors used were not well documented, and differed drastically for the two models for the same source.

XCG Report (5.1)

'Using a lower bound for odour emission rates for fresh waste operations as indicated in the scientific literature reviewed (0.2 OU/s/m^2), screening level dispersion was conducted.'…

When conducting an air quality assessment, the worst case upper bound is generally used. Perhaps XCG had chosen to use the lower bound in order to provide a conservative estimate of the potential impacts of the landfill on their client. However, no justification for using the lower bound is given, which makes it difficult to comment on the appropriateness of their choice.

XCG Report (5.2.1)

'The geometric mean rate of odour emission for a fresh waste operation source (67,000) OU/s as reported by Nicolas, J. et al,2008) and working face dimensions (similar to the screening level dispersion level dispersion model's dimensions) were used as inputs.'

The emissions calculated by SCREEN3 and AERMOD use different emission rates. (SCREEN3 uses 0.2 OU/s/m^2 , for fresh waste tipping, for the assumed working face of 2500m^2 this yields **500 OU/s**. For AERMOD an emission factor for fresh waste operations of **67,000 OU/s** was used, based on one study). The large discrepancy in emission factors used for virtually the same source is not justified. A paper was cited for justification of the 67,000 OU/s emission factor, however the paper was concerned with examining total off-site impacts from landfills in Belgium and does not address odour concentrations beyond 1 km.

Our own measurements taken on working face sources in Ontario landfills indicate that working face odours usually are in the 3,000 to 10,000 OU/s range. Measurements taken in Ontario by RWDI include the Trail Road landfill, Britannia St. Landfill, Eastview Landfill, Caledon Landfill etc.

2.4 SCREEN3 Modelling Results

The wrong units were reported, resulting in values 1,000,000 times the actual modelling results.

XCG Report (5.1)

'At five kilometres, the 1-hour averaging period indicated an odour concentration of approximately 7,500 OU/m^3.'

When emission rates are input as OU/s, the screening level results from SCREEN3 and AERMOD are output in µOU/m^3 by default, rather than OU/m^3, this means that the reported values in XCG's report and Attachment B are high by a factor of 10^6.

The input files for the SCREEN3 (as well as for AERMOD) were not available for review. However, RWDI has conducted a SCREEN3 modelling run based on the model inputs presented in the XCG report. The input parameters used in RWDI's SCREEN3 model are listed below in Table 1. The SCREEN3 model file can be found in RWDI Attachment B.

Odour emission factor	**0.2OU/s/m^2,**
Source dimensions	**100m x20m, at a source height of 40m**
Receptor location	**5 km from source,**
Receptor (i.e. breathing zone) height	**1.5m,**
Resulting maximum odour concentration at receptor point	**0.006005 OU/m^3**

This is an obvious error that an experienced odour team should have noticed. An error of this magnitude should have been caught.

2.5 AERMOD Modelling Receptor Grid

The receptor grid was so coarse that a very small data set contributed to the quantification of maximum odour impact.

XCG Report (5.2.2)

'…a relatively coarse receptor grid was set up with 1,000 meter spacing overlaying the TMT. The MOE specified tiered or radial receptor grid was not used in the model setup, since the modeling was not centered around the Richmond Landfill site.'

According to the MOE Guidelines for Air Dispersion Modelling[2], the area of modeling coverage varies with distance from the source, starting at 20m for an area within 200m, 500m for an area within 4800m,and 1000m or less for an area greater that 4800m from the source. Although the grid size would comply with this guideline at a distance greater than 4.8 km, the coarse grid size does not define the maximum odour levels very well, despite the addition of receptors at the border of TMT 4.5 km from the Richmond Landfill.

RECOMMENDATIONS

We do not believe that the XCG report has adequately assessed the impacts of the Richmond Landfill site on the TMT. We would be willing to review subsequent versions of the analysis after the above comments are addressed.

REFERENCES

1. Longhurst, P., ‘Principles of Landfill Odour Emissions and Control', AWE International, March 2007.
2. Ontario Ministry of the Environment, ‘Air Dispersion Modelling Guideline for Ontario’, March 2009.,PIBs # 5165e02.

Yours very truly,

RWDI AIR Inc.

Colin Welburn

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CTW/klm

Attach.

ATTACHMENT A

Attachement A

Table 1. Indicative range of odour emissions and potential sources			
Source	Indicative concentration range [ou_E/m^3]	Source of flux	Indicative surface flux rate [$ou/m^2/s$]
Landfill gas	400,000 – 1,200,000	Capping failures, / fissures, drilling, gas infrastructure	Highly variable depending on extraction and capping
Freshly tipped refuse	500 – 2,000	Exposed / tipping refuse	4 – 12
Tipped, compacted	500 – 2,000	Exposed / uncovered waste	1 – 4
Covered waste	100 – 1000	Non – extracted wastes	0-3

Odour concentrations

Work completed from a number of sites[5] gives an indication of the range of emissions that are likely to occur[6]. Typically concentrations from refuse are significantly lower than the concentration of odour from landfill gas. Table 1 shows the range of typical odour sources on an MSW landfill site alongside the concentration range that could be measured from these areas. The source of emission may vary depending on site conditions and operational factors and this in turn will influence the emission of odours from the surface, i.e. the surface flux.

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Dr Phil Longhurst is a Senior Lecturer at Cranfield University and head of the Centre for Resource Management & Efficiency, a research group focussed in effective waste management and resource recovery. His research interests include emission measurement & odour sampling and odour management plans for operational sites. He has been a member of scientific committees for the conferences on environmental odours and manages the EPSRC Odour Network.

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ATTACHMENT B

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 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Richmond Landfill Peer review at breathing zone 1.5m

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                  =        AREA
   EMISSION RATE (G/(S-M**2))  =     .200000
   SOURCE HEIGHT (M)            =     40.0000
   LENGTH OF LARGER SIDE (M)   =    100.0000
   LENGTH OF SMALLER SIDE (M)  =     20.0000
   RECEPTOR HEIGHT (M)          =      1.5000
   URBAN/RURAL OPTION           =       RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

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*** SCREEN AUTOMATED DISTANCES ***
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*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***
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DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
1.	.1286E-01	1	1.0	1.1	320.0	40.00	0.
100.	8134.	1	1.0	1.1	320.0	40.00	0.
200.	.2943E+05	1	1.0	1.1	320.0	40.00	1.
300.	.2982E+05	2	1.0	1.1	320.0	40.00	0.
400.	.2939E+05	3	1.0	1.1	320.0	40.00	0.
500.	.2892E+05	3	1.0	1.1	320.0	40.00	0.
600.	.2579E+05	3	1.0	1.1	320.0	40.00	1.
700.	.2228E+05	3	1.0	1.1	320.0	40.00	0.
800.	.2265E+05	4	1.0	1.2	320.0	40.00	0.
900.	.2245E+05	4	1.0	1.2	320.0	40.00	2.
1000.	.2163E+05	4	1.0	1.2	320.0	40.00	2.
1100.	.2044E+05	4	1.0	1.2	320.0	40.00	2.
1200.	.1921E+05	4	1.0	1.2	320.0	40.00	2.
1300.	.1802E+05	4	1.0	1.2	320.0	40.00	1.
1400.	.1690E+05	4	1.0	1.2	320.0	40.00	1.
1500.	.1585E+05	4	1.0	1.2	320.0	40.00	1.
1600.	.1488E+05	4	1.0	1.2	320.0	40.00	1.
1700.	.1398E+05	4	1.0	1.2	320.0	40.00	1.
1800.	.1315E+05	4	1.0	1.2	320.0	40.00	1.
1900.	.1240E+05	4	1.0	1.2	320.0	40.00	1.
2000.	.1195E+05	5	1.0	1.6	10000.0	40.00	0.
2100.	.1157E+05	5	1.0	1.6	10000.0	40.00	0.
2200.	.1118E+05	5	1.0	1.6	10000.0	40.00	0.
2300.	.1081E+05	5	1.0	1.6	10000.0	40.00	0.
2400.	.1045E+05	5	1.0	1.6	10000.0	40.00	0.
2500.	.1010E+05	5	1.0	1.6	10000.0	40.00	0.
2600.	9762.	5	1.0	1.6	10000.0	40.00	0.
2700.	9441.	5	1.0	1.6	10000.0	40.00	0.
2800.	9134.	5	1.0	1.6	10000.0	40.00	0.

2900.	8840.	5	1.0	1.6	10000.0	40.00	0.
3000.	8559.	5	1.0	1.6	10000.0	40.00	0.
3500.	7475.	6	1.0	2.1	10000.0	40.00	0.
4000.	6958.	6	1.0	2.1	10000.0	40.00	1.
4500.	6463.	6	1.0	2.1	10000.0	40.00	1.
5000.	6005.	6	1.0	2.1	10000.0	40.00	1.
5500.	5587.	6	1.0	2.1	10000.0	40.00	1.
6000.	5210.	6	1.0	2.1	10000.0	40.00	1.
6500.	4869.	6	1.0	2.1	10000.0	40.00	1.
7000.	4561.	6	1.0	2.1	10000.0	40.00	1.
7500.	4285.	6	1.0	2.1	10000.0	40.00	1.
8000.	4036.	6	1.0	2.1	10000.0	40.00	1.
8500.	3811.	6	1.0	2.1	10000.0	40.00	1.
9000.	3606.	6	1.0	2.1	10000.0	40.00	1.
9500.	3421.	6	1.0	2.1	10000.0	40.00	1.
10000.	3251.	6	1.0	2.1	10000.0	40.00	1.
15000.	2131.	6	1.0	2.1	10000.0	40.00	1.
20000.	1574.	6	1.0	2.1	10000.0	40.00	1.
25000.	1239.	6	1.0	2.1	10000.0	40.00	1.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

295.	.2984E+05	2	1.0	1.1	320.0	40.00	0.

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*** SUMMARY OF SCREEN MODEL RESULTS ***
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CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	.2984E+05	295.	0.

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** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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