



## **Analysis of Samples for Odour, Volatile Sulphur Compounds, Volatile Organic Compounds and Aldehydes**

A Report to: Ministry of Environment  
Omineca-Peace Region  
Environmental Protection Division  
325-1011 4<sup>th</sup> Avenue, Prince George  
Prince George, BC  
V2L 3H9

Attention: Mrs. Mellissa Winfield-Lesk  
Environmental Quality Section Head  
Tel: (250) 565-6094  
Fax: (205) 565-6629  
E-mail: [mellissa.winfield-lesk@gov.bc.ca](mailto:mellissa.winfield-lesk@gov.bc.ca)

Submitted by: Anna H. Bokowa, M.Sc.  
Manager, Odour Assessment  
Tel: (905) 822-4120, Ext. 669  
Fax: (905) 855-0406  
E-mail: [abokowa@ortech.ca](mailto:abokowa@ortech.ca)

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## **1. INTRODUCTION**

ORTECH Environmental (ORTECH) was requested by the British Columbia Ministry of the Environment (BC MOE) to perform analysis on submitted samples. It was agreed that the samples would be analyzed for odour, volatile organic sulphur compounds (VOSC), volatile organic compounds (VOC) and aldehydes. Two batches of samples were delivered to ORTECH via courier.

The first batch of nine samples was delivered on July 31, 2008. According to the chain of the custody form provided by the BC MOE, samples were taken on July 29, 2008. During the shipment, one sample marked as VOC Sample #1 burst and was replaced with a sample identified as Odour Sample #2 for volatile organic compounds analysis. This sample, according to the BC MOE chain of the custody form, had the closest time to the burst VOC sample. Both samples for odour and VOC were collected in Tedlar bags. Therefore, it was possible to replace the burst VOC sample with odour sample bag.

The second batch of thirteen samples was delivered on August 8, 2008. However, samples were taken on August 6, 2008 according to the BC MOE chain custody form. Two samples for aldehyde analysis were missing from the shipment. One sample identified as Odour Sample #1 burst during the shipment and was not analyzed for odour. Samples for odour were not scheduled to be analyzed due to the requirement that the analysis is completed within 30 hours from the collection of the samples. However, ORTECH made a decision to analyze odour bags due to the fact that odour detected in the bags was still very strong. It should be noted that all samples were analyzed more the 48 hours from the time of their collection.

## **2. METHODOLOGY**

### **2.1 Odour Evaluations**

The odour samples were evaluated upon receipt from Prince George by the dynamic dilution olfactometer at ORTECH's odour test facility (Figure 1). This facility is a specialized room, designed to provide an odour-free environment for accurate evaluations.

The olfactometer is a binary port system operated in a non-forced choice mode. The sample bag is pressurized in a pressure vessel, and the resulting flow metered through an electronic mass flow controller at a predetermined rate. The sample is diluted with flow-controlled odorless air, and is passed to the panel members through one of two sample ports. A three-way valve allows the operator to direct the sample through either of the two ports.

Each evaluation begins at a high dilution level, which is lowered in a step-wise sequence by a factor of 1.41 at each step. At each dilution level, the panelists register their responses by entering the letter of the port at which they detect the odour. The range of dilution ratios of ORTECH's odour test facility is from 5,793 times to 1 times dilution.

The panelists' responses are processed to determine the odour detection threshold value for the sample. This is done by a regression analysis of the log of the dilution level versus the probit value of the percent of the panel responding. The point at which statistically 50% of the panel can just detect the odour is recorded as odour detection threshold value (ODTV). The odour detection threshold value is a dilution factor and therefore has no units. For convenience, however, the ODTV may be expressed in odour units (ou).

An eight-member panel was used for all evaluations. They are drawn from a pool of people who routinely participate in this type of work. They have all been tested annually for odour sensitivity and are considered to be within the normal range.

It should be noted that some samples were evaluated more than 48 hours after sampling due to shipping difficulties and therefore, the loss of odours might occurred with time.

## **2.2 Volatile Sulphur Compound Analysis**

Samples for volatile sulphur compound analysis were delivered in foil bags. Two batches of samples were delivered to ORTECH for sulphur compound analysis.

In addition to foil bags, Tedlar bags marked as VOC samples were also analyzed for sulphur compounds before sending them to the outside laboratory (AirZone Laboratory) for VOC analysis.

Both samples (foil and Tedlar) were analyzed at the ORTECH laboratory using gas chromatography with sulphur chemiluminescence detector. Tables 3A to 3C present the results for analysis.

A complete report is included in Appendix 2.

## **2.3 Volatile Organic Compound Analysis**

All delivered samples were analyzed by AirZone laboratory.

The first 3 samples, VOC #1, VOC #2 and VOC #3 were analyzed by direct injection into the GC/MSD system in Scan mode. There were no chemicals detected. 2.3 L of all samples were concentrated onto the thermal desorption tube. The tubes were analyzed by the TD/GC/MSD system in scan mode. The peaks were identified using an MS library search and verified with the petroleum 53 compound standard prepared in the AirZone laboratory. The identified peaks were estimated as toluene equivalents.

The results for each detected compound are presented in Table 4.

A report provided by AirZone is included in Appendix 2.

## **2.4 Aldehydes Analysis**

All delivered samples were analyzed at the AirZone laboratory by gas chromatography/flame ionization detection (GC/FID). All samples were extracted with 30 mL of solvent. The solvent was concentrated to 1 mL and analyzed by GC/FID.

The results are presented in Table 5.

A complete report provided by AirZone is included in Appendix 2.

### **3. TEST RESULTS**

Originally, ORTECH was advised by the BC MOE not to analyze samples after 30 hours from the sampling time. However due to the fact that the odour in the bags was still very strong, after 48 hours from the collection, ORTECH made a decision to analyze the bags for odour.

One sample was switched for VOC analysis and, therefore, only one sample was analyzed for odour from the first batch, which was delivered on July 31, 2008.

During the delivery of the second batch, one sample had burst (Sample Odour #3), therefore, only three samples were analyzed for odour.

Table 2 presents the results for odour detection threshold values.

Based on the results, the ODTV for the bag analyzed during the shipment of the first batch was in the range of 188 ou. The ODTV for the samples collected during the second batch were in the range from 477 ou to 842 ou.

As a comparison, the Ontario Ministry of the Environment guideline for odour is 1 ou. Therefore, all values recorded during both episodes indicate very high odour concentrations compared with this guideline.

Table 3A to Table 3C present the results for volatile sulphur compounds. A full report is included in Appendix 2.

Table 4 presents the results for the volatile organic compounds.

Table 5 presents the results for ketones and aldehydes.

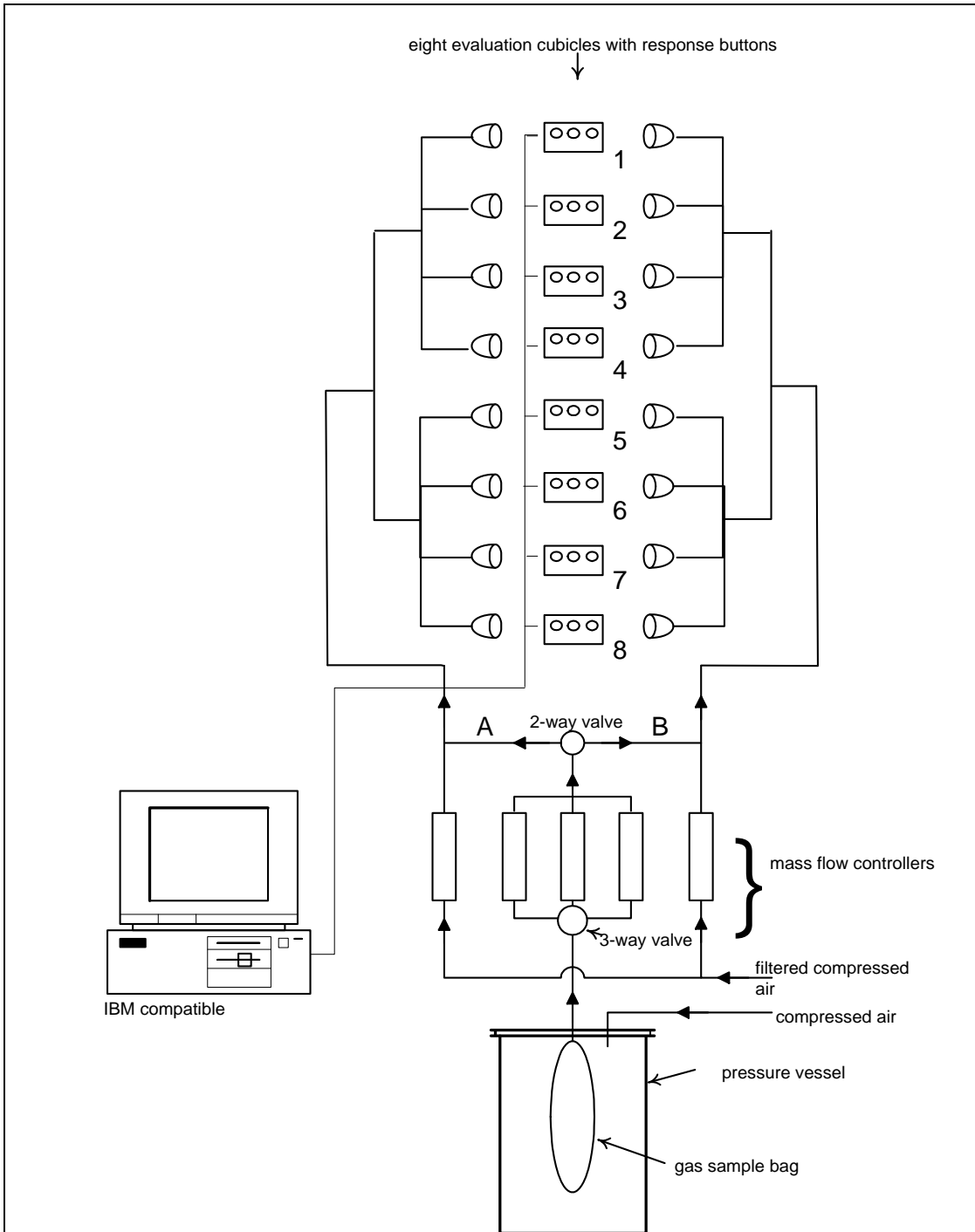


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Anna Bokowa, M.Sc.  
Manager, Odour Assessments

AB:or

Figure 1  
Odour Panel



**Table 1: Sample Identification**

Sampling Date	Delivery Date	Ortech ID (25610)	MOE Sample ID
July 29,2008	July 31,2008	C-1	TRS Sample # 1
		C-2	TRS Sample # 2
		C-3	VOC Sample # 1
		C-4	VOC Sample # 2
		C-5	Aldehyde/Ketone Field Blank # 1
		C-6	Aldehyde/Ketone Sample # 1
		C-7	Aldehyde/Ketone Sample # 2
		B-1	Odour , Sample #1
B-2	Odour, Sample #2*		
August 6, 2008	August 8, 2008	C-8	TRS Sample # 3
		C-9	TRS Sample # 4
		C-10	TRS Sample # 5
		C-11	TRS Sample # 6
		C-12	VOC Sample # 3
		C-13	VOC Sample # 4
		C-14	VOC Sample # 5
		C-15	VOC Sample # 6
		C-16	Aldehyde/Ketone Field Blank # 2
		C-17	Aldehyde/Ketone Sample # 3
		C-18	Aldehyde/Ketone Sample # 4
		C-19	Aldehyde/Ketone Sample#5
		B-3	Odour, Sample #3**
		B-4	Odour, Sample #4
B-5	Odour, Sample #5		
B-6	Odour, Sample #6		

Aldehyde/Ketone Sample #6 and Field Blank #2 were not delivered to ORTECH as marked on Ministry chain of the custody form.



**Table 2: Odour Detection Threshold Values**

ORTECH Sample ID	Description	Predilution Ratio	Raw Odour Detection Threshold Value (ODTV) ou	Net Odour Detection Threshold Value (ODTV) ou
<b>July 31/2008</b>				
25610 B-1	Sample #1	1	188	188
	Sample #2*	1	NA	NA
<b>August 8/2008</b>				
25610 B-2	Sample #3*	1	NA	NA
25610 B-3	Sample #4	1	638	638
25610 B-4	Sample #5	1	842	842
25610 B-5	Sample #6	1	477	477

Sample #2\* - not analyzed, switched for VOC analysis

Sample #3\*\* - burst during shipment, not analyzed

**Table 3A: Volatile Sulphur Analysis Results**

ORTECH ID (25610)-	C-1	C-2	C-3	C-4
Sample ID	TRS #1	TRS #2	VOC #1	VOC #2
Name <sup>2</sup>	Foil Bag	Foil Bag	Tedlar Bag	Tedlar Bag
Hydrogen Sulphide	0.02	0.02	0.01	0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<0.01	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

**Table 3B: Volatile Sulphur Analysis Results**

ORTECH ID (25610)-	C-8	C-9	C-10	C-11
Sample ID	TRS #3	TRS #4	TRS #5	TRS #6
Name <sup>2</sup>	Foil Bag	Foil Bag	Foil Bag	Foil Bag
Hydrogen Sulphide	<0.01	<0.01	<0.01	<0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<0.01	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

**Table 3C: Volatile Sulphur Analysis Results**

ORTECH ID (25610)- Sample ID	C-12 VOC #3	C-13 VOC #4	C-14 VOC #5	C-15 VOC #6
Name <sup>2</sup>	Tedlar Bag	Tedlar Bag	Tedlar Bag	Tedlar Bag
Hydrogen Sulphide	<0.01	<0.01	<0.01	<0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<b>0.02</b>	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

1. Results are reported in mole ppm. The detection limit for this method is 0.01 ppm. The method blank was <0.01 ppm for all reported analytes.
2. The concentration and identity of each sulphur compound reported is determined by the SCD response (the SCD detector is very specific for sulphur compounds ( $1 \times 10^7$  against hydrocarbons)) and the gas chromatographic retention time only and is *not confirmed* by a second method. Carbonyl sulphide (COS) co-elutes with H<sub>2</sub>S on this GC column. The H<sub>2</sub>S value in the table should be considered as the sum of H<sub>2</sub>S and COS (if present).

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**Table 4: Volatile Organic Compounds Analysis**

<i>Sample Analysis Report</i>									
Project Number:	J8096								
Client #	25610								
Report Date:	August 25, 2008								
Analysis Date:	August 8, 2008								
Analytical Method:	Thermal Desorption/Gas Chromatography/Mass Selective Detection, (TD/GC/MSD), Scan								
Unit	µg/m <sup>3</sup>								
Sample Type:	Bag								
Results	CAS#	Detection Limit	VOC-1	VOC-2	VOC-3	VOC-4	VOC-5	VOC-6	
Isobutane	000075-28-5	1	<1	<1	<1	<1	26	22	
Butane	000106-97-8	1	<1	<1	12	18	23	21	
1-Propene, 2-methyl-	000115-11-7	1	5	<1	<1	<1	3	<1	
Silane, fluorotrimethyl-	000420-56-4	1	3	3	19	21	19	13	
Butane, 2-methyl-	000078-78-4	1	<1	<1	30	10	18	19	
Trichloromonofluoromethane	000075-69-4	1	<1	<1	1	<1	3	<1	
Pentane	000109-66-0	1	3	<1	15	4	11	9	
1,2-Pentadiene	000591-95-7	1	1	<1	1	<1	15	2	
Butane, 2,2-dimethyl-	000075-83-2	1	<1	<1	2	1	15	2	
Dimethyl sulfide	000075-18-3	1	<1	<1	2	3	11	2	
Carbon disulfide	000075-15-0	1	16	8	45	<1	15	2	
Pentane, 2-methyl-	000107-83-5	1	<1	<1	16	7	6	10	
Cyclopentane	000287-92-3	1	<1	<1	4	1	11	2	
Pentane, 3-methyl-	000096-14-0	1	1	<1	11	2	28	4	
Hexane	000110-54-3	1	6	1	27	4	10	5	
Silanol, trimethyl-	001066-40-6	1	20	39	51	43	19	15	
Cyclopentane, methyl-	000096-37-7	1	3	<1	11	2	21	3	
Hexane, 2-methyl-	000591-76-4	1	<1	<1	7	2	15	2	
Cyclohexane	000110-82-7	1	<1	<1	11	2	24	3	
Hexane, 3-methyl-	000589-34-4	1	<1	<1	13	<1	17	<1	
Benzene	000071-43-2	1	<1	<1	4	<1	8	<1	
Butane, 2,2,3,3-tetramethyl-	000594-82-1	1	4	<1	2	<1	16	2	
Cyclopentane, 1,2-dimethyl-	002452-99-5	1	<1	<1	<1	<1	3	<1	
Heptane	000142-82-5	1	<1	<1	9	2	24	3	
Cyclohexane, methyl-	000108-87-2	1	<1	<1	<1	2	22	3	
Heptane, 2-methyl-	000592-27-8	1	<1	<1	<1	1	13	2	
Heptane, 4-methyl-	000589-53-7	1	10	<1	3	<1	<1	<1	
Heptane, 3-methyl-	000589-81-1	1	<1	<1	<1	<1	9	1	
Disulfide, dimethyl	000624-92-0	1	<1	<1	<1	2	3	<1	
Hexane, 2,2,5-trimethyl-	003522-94-9	1	<1	<1	2	<1	<1	<1	
Cyclohexane, 1,4-dimethyl-	000589-90-2	1	<1	<1	<1	<1	4	<1	
Cyclopentane, 1,2,4-trimethyl-	016883-48-0	1	<1	<1	1	2	11	2	
Cyclobutanone, 2,3,3-trimethyl-	028290-01-9	1	3	2	<1	<1	<1	<1	
Toluene	000108-88-3	1	3	5	26	9	8	7	
Octane	00011165-9	1	5	<1	<1	<1	23	3	
Hexane, 2,3,5-trimethyl-	001069-53-0	1	5	<1	<1	<1	<1	<1	
Heptane, 2,4-dimethyl-	002213-23-2	1	53	<1	<1	<1	1	<1	
Hexanal	000066-25-1	1	1	1	2	1	7	2	
2,4-Dimethyl-1-heptene	019549-87-2	1	29	<1	<1	<1	<1	<1	
Cyclohexan ethyl-	001678-91-7	1	<1	<1	<1	<1	2	<1	
1,1,4-Trimethyl cyclohexane	007094-27-1	1	<1	<1	<1	<1	3	<1	
Heptane, 2,3-dimethyl-	003074-71-3	1	2	<1	<1	<1	<1	<1	
Octane, 4-methyl-	002216-34-4	1	16	<1	<1	<1	5	<1	
Octane, 3-methyl-	002216-33-3	1	<1	<1	<1	<1	4	<1	
Ethylbenzene	000100-41-4	1	<1	<1	3	<1	5	2	
Nonane	000111-84-2	1	<1	<1	<1	2	11	3	

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for the Ministry of the Environment**

**Table 4 (cont'd.): Volatile Organic Compounds Results**

<i>Sample Analysis Report</i>								
Project Number:	J8096							
Client #	25610							
Report Date:	August 25, 2008							
Analysis Date:	August 8, 2008							
Analytical Method:	Thermal Desorption/Gas Chromatography/Mass Selective Detection, (TD/GC/MSD), Scan							
Unit	µg/m <sup>3</sup>							
Sample Type:	Bag							
<b>Results</b>	<b>CAS#</b>	<b>Detection Limit</b>	<b>VOC-1</b>	<b>VOC-2</b>	<b>VOC-3</b>	<b>VOC-4</b>	<b>VOC-5</b>	<b>VOC-6</b>
Benzene, 1,3-dimethyl-	000108-38-3	1	4	2	6	2	18	<1
Benzene, 1,2-dimethyl-	000095-47-6	1	<1	<1	4	1	10	1
Acetamide, N,N-dimethyl-	000127-19-5	1	<1	54	136	73	<1	<1
alpha-Pinene	000080-56-8	1	<1	12	26	29	<1	15
Camphene	000079-92-5	1	<1	<1	<1	6	9	2
Decane	000124-18-5	1	3	<1	3	1	14	2
.beta.-Pinene	000127-91-3	1	<1	<1	9	11	27	3
3-Carene	013466-78-9	1	<1	<1	18	27	20	6
Octanal	000124-13-0	1	<1	1	<1	3	11	<1
Decane, 3-methyl-	013151-34-3	1	<1	<1	8	<1	<1	<1
Benzene, 1-methyl-4-(1-methylethy	000099-87-6	1	<1	<1	7	10	23	<1
Bicyclo[3.1.0]hexane, 4-methylene	003387-41-5	1	<1	<1	23	21	4	5
Phenol	000108-95-2	1	12	16	64	48	<1	11
Nonanal	000124-19-6	1	2	4	3	4	25	5
Methylheptyl Acetate-	072218-58-7	1	<1	1	1	1	11	1
Dodecane	000112-40-3	1	<1	<1	1	2	8	2
Tridecane	000629-50-5	1	<1	<1	<1	6	3	<1
Tetradecane	000629-59-4	1	<1	<1	1	2	3	<1

**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
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**Table 5: Ketone and Aldehydes Results**

To:  
Canadian Ortech  
Att: Anna Bokowa  
2395 Speakman Drive  
Mississauga, Ontario  
L5K 1B3

<b>Sample Analysis Report</b>										
Project Number:	J8096									
Client #	25610									
Report Date:	August 25, 2008									
Analysis Date:	August 8, 2008									
Analytical Method:	Gas Chromatography/Flame Ionization Detection (GC/FID)									
Unit	µg/sample									
Sample Type:	Sep-Pak									
Results	Detection Limit	LBLK-1	LBLK-2	C5	C6	C7	C16	C17	C18	C19
Formaldehyde	0.1	0.1	0.1	<0.1	15.5	<0.1	<0.1	23.1	1.9	35.7
Acetaldehyde	0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	0.2	<0.1	0.3
Acetone	0.1	2.1	3.0	13.9	28.3	<0.1	<0.1	28.0	4.7	27.4
Acrolein	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Ethyl Ketone	0.1	<0.1	<0.1	<0.1	8.9	1.4	<0.1	10.1	1.3	9.6
Butyraldehyde	0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	0.2	0.3	0.4
Methyl n-Propyl Ketone	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Crotonaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Isobutyl Ketone	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Valeraldehyde	0.1	<0.1	<0.1	0.3	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Hexanaldehyde	0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1
Furaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tolualdehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Comment	The sample was extracted with 30 ml of solvent (ref EPA TO-5). The solvent was concentrated to 1mL and analyzed by GC/FID. Samples were corrected to Lab Blank.									

**APPENDIX 1**

**Prince George Community Odour Study Data Sheet  
(3 pages)**

**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
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**Prince George Community Odour Study Data Sheet**

Date: July 29/08

Location Description: end of Patricia.

GPS Coordinates: 53°54'46.5" N 122°43'55.6" W

Ambient H<sub>2</sub>S Level (Jerome Analyzer): 2 ppb

\*Wind Speed/Direction: 167° 4.9 m/s Temperature: 15.3°

	Time Start	Time Stop		
VOC sample # 1	10:49	10:54		
VOC sample # 2	11:01	11:06		
Odour sample # 1	10:25	10:30		
Odour sample # 2	10:37	10:42		
TRS sample # 1	10:03	10:05		
TRS sample # 2	10:12	10:14		
	Time Start	Time Stop	Pre-sample flow	Post-sample flow
Aldehyde/Ketone sample # 1	9:48	10:48	0.5526	0.6311
Aldehyde/Ketone sample # 2	10:52	11:52	0.6309	0.5432
Aldehyde/Ketone FB # 1 (if applicable)				

Comments:

→ 1<sup>st</sup> day odour sampling - one pump died before calibration  
→ only collected samples @ 1 site, b/c conditions were changing



**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
Volatile Organic Compounds and Aldehydes  
for the Ministry of the Environment**

**Prince George Community Odour Study Data Sheet**

Date: Aug 6/05  
 Location Description: end of Patricia Blvd @ dead end  
 GPS Coordinates: 53° 54' 46.5" N 122° 43' 55.6" W  
 Ambient H2S Level (Jerome Analyzer): 6 ppb @ 9:25 a      4 ppb @ 10:00  
 Wind Speed/Direction: 1.52 m/s, 89°      Temperature: 15.3      4 ppb @ 10:10

	Time Start	Time Stop		
VOC sample # 5	9:47	9:52		
VOC sample # 6	10:12	10:17		
Odour sample # 5	9:35	9:38		
Odour sample # 6	10:02	10:05		
TRS sample # 5	9:36	9:35		
TRS sample # 6	9:58	10:00		
	Time Start	Time Stop	Pre-sample flow	Post-sample flow
Aldehyde/Ketone sample # 5	9:31	10:31	0.6185 lpm	0.5406
Aldehyde/Ketone sample # 6	9:34	10:34	0.6548 lpm	0.5599
Aldehyde/Ketone FB # 2 (if applicable)				

pump  
3  
pump  
20

✓  
missing  
✓

Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
Volatile Organic Compounds and Aldehydes  
for the Ministry of the Environment**

**Prince George Community Odour Study Data Sheet**

Date: Aug. 6/08

Location Description: end of 17th @ Ft. George Park

GPS Coordinates: 53° 54' 38.3" N 122° 44' 8.0" W

Ambient H<sub>2</sub>S Level (Jerome Analyzer): 4 ppb @ 8:10

Wind Speed/Direction: 1.05 m/s @ 91° Temperature: 12.4

8 ppb @ 8:30  
11 ppb @ 8:55

	Time Start	Time Stop		
VOC sample # 3	8:37	8:42		
VOC sample # 4	8:55	9:00		
Odour sample # 3	8:26	8:29		
Odour sample # 4	8:47	8:50		
TRS sample # 3	8:28	8:30		
TRS sample # 4	8:47	8:50		
	Time Start	Time Stop	Pre-sample flow	Post-sample flow
Aldehyde/Ketone sample # 3	08:08	09:08	0.5331 lpm	0.7505 lpm
Aldehyde/Ketone sample # 4	08:17	09:17	0.6149 lpm	0.6845 lpm
Aldehyde/Ketone FB # (if applicable)				

pump 3  
pump 20

✓  
✓

missing

Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**APPENDIX 2**

**The Analysis of Tedlar and Foil Bag Samples for  
Volatile Sulphur Compounds – Ministry of the Environment, Prince George  
and AirZone Results  
(10 pages)**

## **The Analysis of Tedlar and Foil Bag Samples for Volatile Sulphur Compounds – Ministry of the Environment, Prince George**

A Report to: Ministry of the Environment  
Environmental Protection Division  
1600 Third Avenue, Prince George  
325-1011 4<sup>th</sup> Avenue  
Prince George, BC  
V2L 3H9

Attention: Mrs. Mellissa Winfield-Lesk

Submitted by: Terry Cooper  
Manager, Laboratory Services

Tel: (905) 822-4120, Ext. 407

Fax: (905) 855-0406

E-mail: [tcooper@ortech.ca](mailto:tcooper@ortech.ca)

Report No.: 25610  
5 pages

Date: September 4, 2008

**Analysis of Tedlar and Foil Bag Samples  
for Volatile Sulphur Compounds  
for the Ministry of the Environment – Prince George**

*Report #25610*

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## **1. INTRODUCTION**

ORTECH Environmental (ORTECH) received six foil bag and six Tedlar bag samples from the Ministry of the Environment that were collected at several different locations in the city of Prince George, British Columbia on July 31, 2008 and August 6, 2008. The foil and Tedlar bag samples were analyzed for volatile sulphur compounds.

## **2. ANALYTICAL PROCEDURE**

### **TRS Compounds by Gas Chromatography (GC)/Sulphur Specific Detector (SCD):**

The gas samples were analyzed for volatile sulphur compounds using an HP 5890SII GC (MII#10095) with an all Teflon sample pathway consisting of a 6' x 1/8" Teflon Chromosil 330 80/100 mesh pack column and a 6' x 1/8" Teflon Chromosil 310 80/100 mesh pack column, a gas sampling valve (GSV) fitted with a Teflon loop and a Sievers model 350B Sulphur Chemiluminescence Detector (SCD) (MII#11329). The resulting data was processed using an HP 3365 S2 Chemstation (MII# 11163).

All reported concentrations are in units of mole ppm (ppmv).

#### Method Reference:

Environment Canada Report EPS 1/RM/6

“Reference Method for Source Testing: Measurement of Releases of Total Reduced Sulphur (TRS) Compounds from Pulp and Paper Operations”.

ASTM Method D5504-01

“Standard Test Method for Determination of Sulphur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence”.

**Analysis of Tedlar and Foil Bag Samples  
for Volatile Sulphur Compounds  
for the Ministry of the Environment – Prince George**

Standard Reference Gases:

- BOC Gas Mix Cert. Std. four components at 10 ppm (mole), hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide, balance nitrogen, lot 1003675.
- BOC Gas Mix Cert. Std. two components at 10 and 5 ppm (mole) respectively; hydrogen sulphide, carbon disulphide, balance nitrogen, lot 1006010.
- Matheson Gas Mix Cert. Std. two components at 10 and 5 ppm (mole) respectively; carbonyl sulphide, carbon disulphide, balance nitrogen, lot 200-26-00602.
- BOC Gas Mix Cert. Std. five components at 10 ppm (mole); methyl mercaptan, ethyl mercaptan, isopropyl mercaptan, n-propyl mercaptan and thiophene, balance nitrogen, lot 1025128.
- BOC Gases Cert. Std. one component at 10.3 ppm (mole); t-butyl mercaptan, balance nitrogen, lot 200-36-00377.
- BOC Gases Cert. Std. one component at 9.27 ppm (mole); hydrogen sulphide, balance nitrogen, lot 1025135.

The certificates for the calibration gases used are available on request.

### 3. RESULTS

The results for the volatile sulphur compounds analysis of the Prince George Ministry of the Environment samples are reported in the following tables:

- Table 1 .....Samples analyzed on July 31, 2008
- Table 2 .....Samples analyzed on August 8, 2008

Approved by:



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Terry Cooper  
Manager, Laboratory Services



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Stephen Thorndyke, M.Eng., P.Eng.  
Principal, Emissions & Odour Assessment

**Table 1**

**Volatile Sulphur Analysis of BC MOE Samples  
Samples Analyzed on July 31, 2008  
Results Reported in Mole ppm (volume)<sup>1</sup>**

ORTECH ID (25610)-	C-1	C-2	C-3	C-4
Sample ID	TRS #1	TRS #2	VOC #1	VOC #2
Name <sup>2</sup>	Foil Bag	Foil Bag	Tedlar Bag	Tedlar Bag
Hydrogen Sulphide	0.02	0.02	0.01	0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<0.01	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

1. Results are reported in mole ppm. The detection limit for this method is 0.01 ppm. The method blank was <0.01 ppm for all reported analytes.
2. The concentration and identity of each sulphur compound reported is determined by the SCD response (the SCD detector is very specific for sulphur compounds ( $1 \times 10^7$  against hydrocarbons)) and the gas chromatographic retention time only and is *not confirmed* by a second method. Carbonyl sulphide (COS) co-elutes with H<sub>2</sub>S on this GC column. The H<sub>2</sub>S value in the table should be considered as the sum of H<sub>2</sub>S and COS (if present).



**Table 2**

**Volatile Sulphur Analysis of BC MOE Samples  
Samples Analyzed on August 8, 2008  
Results Reported in Mole ppm (volume)<sup>1</sup>**

ORTECH ID (25610)-	C-8	C-9	C-10	C-11
Sample ID	TRS #3	TRS #4	TRS #5	TRS #6
Name <sup>2</sup>	Foil Bag	Foil Bag	Foil Bag	Foil Bag
Hydrogen Sulphide	<0.01	<0.01	<0.01	<0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<0.01	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

1. Results are reported in mole ppm. The detection limit for this method is 0.01 ppm. The method blank was <0.01 ppm for all reported analytes.
2. The concentration and identity of each sulphur compound reported is determined by the SCD response (the SCD detector is very specific for sulphur compounds ( $1 \times 10^7$  against hydrocarbons)) and the gas chromatographic retention time only and is *not confirmed* by a second method. Carbonyl sulphide (COS) co-elutes with H<sub>2</sub>S on this GC column. The H<sub>2</sub>S value in the table should be considered as the sum of H<sub>2</sub>S and COS (if present).

Table 2 Continued

Volatile Sulphur Analysis of BC MOE Samples  
Samples Analyzed on August 8, 2008  
Results Reported in Mole ppm (volume)<sup>1</sup>

ORTECH ID (25610)- Sample ID	C-12 VOC #3	C-13 VOC #4	C-14 VOC #5	C-15 VOC #6
Name <sup>2</sup>	Tedlar Bag	Tedlar Bag	Tedlar Bag	Tedlar Bag
Hydrogen Sulphide	<0.01	<0.01	<0.01	<0.01
Methyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Carbon Disulphide	<0.01	<0.01	<0.01	<0.01
Ethyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Sulphide	<0.01	<b>0.02</b>	<0.01	<0.01
Isopropyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Propyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Thiophene	<0.01	<0.01	<0.01	<0.01
t-Butyl Mercaptan	<0.01	<0.01	<0.01	<0.01
Dimethyl Disulphide	<0.01	<0.01	<0.01	<0.01

- Results are reported in mole ppm. The detection limit for this method is 0.01 ppm. The method blank was <0.01 ppm for all reported analytes.
- The concentration and identity of each sulphur compound reported is determined by the SCD response (the SCD detector is very specific for sulphur compounds ( $1 \times 10^7$  against hydrocarbons)) and the gas chromatographic retention time only and is *not confirmed* by a second method. Carbonyl sulphide (COS) co-elutes with H<sub>2</sub>S on this GC column. The H<sub>2</sub>S value in the table should be considered as the sum of H<sub>2</sub>S and COS (if present).

**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
Volatile Organic Compounds and Aldehydes  
for the Ministry of the Environment**

*Appendix 2  
Report #25610-1*

To:  
Canadian Ortech Environmental Inc.  
Att: Anna Bokowa  
2395 Speakman Drive  
Mississauga, Ontario  
L5K 1B3

<i>Sample Analysis Report</i>								
Project Number:	J8096							
Client #	25610							
Report Date:	August 25, 2008							
Analysis Date:	August 8, 2008							
Analytical Method:	Thermal Desorption/Gas Chromatography/Mass Selective Detection, (TD/GC/MSD), Scan							
Unit	µg/m <sup>3</sup>							
Sample Type:	Bag							
Results	CAS#	Detection Limit	VOC-1	VOC-2	VOC-3	VOC-4	VOC-5	VOC-6
Isobutane	000075-28-5	1	<1	<1	<1	<1	26	22
Butane	000106-97-8	1	<1	<1	12	18	23	21
1-Propene, 2-methyl-	000115-11-7	1	5	<1	<1	<1	3	<1
Silane, fluorotrimethyl-	000420-56-4	1	3	3	19	21	19	13
Butane, 2-methyl-	000078-78-4	1	<1	<1	30	10	18	19
Trichloromonofluoromethane	000075-69-4	1	<1	<1	1	<1	3	<1
Pentane	000109-66-0	1	3	<1	15	4	11	9
1,2-Pentadiene	000591-95-7	1	1	<1	1	<1	15	2
Butane, 2,2-dimethyl-	000075-83-2	1	<1	<1	2	1	15	2
Dimethyl sulfide	000075-18-3	1	<1	<1	2	3	11	2
Carbon disulfide	000075-15-0	1	16	8	45	<1	15	2
Pentane, 2-methyl-	000107-83-5	1	<1	<1	16	7	6	10
Cyclopentane	000287-92-3	1	<1	<1	4	1	11	2
Pentane, 3-methyl-	000096-14-0	1	1	<1	11	2	28	4
Hexane	000110-54-3	1	6	1	27	4	10	5
Silanol, trimethyl-	001066-40-6	1	20	39	51	43	19	15
Cyclopentane, methyl-	000096-37-7	1	3	<1	11	2	21	3
Hexane, 2-methyl-	000591-76-4	1	<1	<1	7	2	15	2
Cyclohexane	000110-82-7	1	<1	<1	11	2	24	3
Hexane, 3-methyl-	000589-34-4	1	<1	<1	13	<1	17	<1
Benzene	000071-43-2	1	<1	<1	4	<1	8	<1
Butane, 2,2,3,3-tetramethyl-	000594-82-1	1	4	<1	2	<1	16	2
Cyclopentane, 1,2-dimethyl-	002452-99-5	1	<1	<1	<1	<1	3	<1
Heptane	000142-82-5	1	<1	<1	9	2	24	3
Cyclohexane, methyl-	000108-87-2	1	<1	<1	<1	2	22	3
Heptane, 2-methyl-	000592-27-8	1	<1	<1	<1	1	13	2
Heptane, 4-methyl-	000589-53-7	1	10	<1	3	<1	<1	<1
Heptane, 3-methyl-	000589-81-1	1	<1	<1	<1	<1	9	1
Disulfide, dimethyl	000624-92-0	1	<1	<1	<1	2	3	<1
Hexane, 2,2,5-trimethyl-	003522-94-9	1	<1	<1	2	<1	<1	<1
Cyclohexane, 1,4-dimethyl-	000589-90-2	1	<1	<1	<1	<1	4	<1
Cyclopentane, 1,2,4-trimethyl-	016883-48-0	1	<1	<1	1	2	11	2
Cyclobutanone, 2,3,3-trimethyl-	028290-01-9	1	3	2	<1	<1	<1	<1
Toluene	000108-88-3	1	3	5	26	9	8	7
Octane	00011165-9	1	5	<1	<1	<1	23	3
Hexane, 2,3,5-trimethyl-	001069-53-0	1	5	<1	<1	<1	<1	<1
Heptane, 2,4-dimethyl-	002213-23-2	1	53	<1	<1	<1	1	<1
Hexanal	000066-25-1	1	1	1	2	1	7	2
2,4-Dimethyl-1-heptene	019549-87-2	1	29	<1	<1	<1	<1	<1
Cyclohexan ethyl-	001678-91-7	1	<1	<1	<1	<1	2	<1
1,1,4-Trimethyl cyclohexane	007094-27-1	1	<1	<1	<1	<1	3	<1
Heptane, 2,3-dimethyl-	003074-71-3	1	2	<1	<1	<1	<1	<1

**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
Volatile Organic Compounds and Aldehydes  
for the Ministry of the Environment**

cont'd.

<b>Sample Analysis Report</b>									
Project Number:	J8096								
Client #	25610								
Report Date:	August 25, 2008								
Analysis Date:	August 8, 2008								
Analytical Method:	Thermal Desorption/Gas Chromatography/Mass Selective Detection, (TD/GC/MSD), Scan								
Unit	µg/m <sup>3</sup>								
Sample Type:	Bag								
<b>Results</b>	<b>CAS#</b>	<b>Detection Limit</b>	<b>VOC-1</b>	<b>VOC-2</b>	<b>VOC-3</b>	<b>VOC-4</b>	<b>VOC-5</b>	<b>VOC-6</b>	
Octane, 4-methyl-	002216-34-4	1	16	<1	<1	<1	5	<1	
Octane, 3-methyl-	002216-33-3	1	<1	<1	<1	<1	4	<1	
Ethylbenzene	000100-41-4	1	<1	<1	3	<1	5	2	
Nonane	000111-84-2	1	<1	<1	<1	2	11	3	
Benzene, 1,3-dimethyl-	000108-38-3	1	4	2	6	2	18	<1	
Benzene, 1,2-dimethyl-	000095-47-6	1	<1	<1	4	1	10	1	
Acetamide, N,N-dimethyl-	000127-19-5	1	<1	54	136	73	<1	<1	
alpha-Pinene	000080-56-8	1	<1	12	26	29	<1	15	
Camphene	000079-92-5	1	<1	<1	<1	6	9	2	
Decane	000124-18-5	1	3	<1	3	1	14	2	
.beta.-Pinene	000127-91-3	1	<1	<1	9	11	27	3	
3-Carene	013466-78-9	1	<1	<1	18	27	20	6	
Octanal	000124-13-0	1	<1	1	<1	3	11	<1	
Decane, 3-methyl-	013151-34-3	1	<1	<1	8	<1	<1	<1	
Benzene, 1-methyl-4-(1-methylethyl)-	000099-87-6	1	<1	<1	7	10	23	<1	
Bicyclo[3.1.0]hexane, 4-methylene	003387-41-5	1	<1	<1	23	21	4	5	
Phenol	000108-95-2	1	12	16	64	48	<1	11	
Nonanal	000124-19-6	1	2	4	3	4	25	5	
Methylheptyl Acetate-	072218-58-7	1	<1	1	1	1	11	1	
Dodecane	000112-40-3	1	<1	<1	1	2	8	2	
Tridecane	000629-50-5	1	<1	<1	<1	6	3	<1	
Tetradecane	000629-59-4	1	<1	<1	1	2	3	<1	
Comment	The first 3 samples VOC-1,2,3 were analyzed by direct injection into the GC/MSD system in Scan mode. There were no chemicals detected. 2.3 L of all samples were concentrated into the thermal desorption tube. The tubes were analyzed by the TD/GC/MSD system in Scan mode. The peaks were identified using MS library search and verified with the petroleum 53 compound standard prepared in AizoneOne Lab. The identified peaks were estimated as toluene equivalents.								
Analyst	Quang Tran, M. Sc.								
QA/QC	Philip Fellin, M.Sc.								

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**Analysis of Samples for Odour, Total Reduced Sulphur Compounds,  
Volatile Organic Compounds and Aldehydes  
for the Ministry of the Environment**

*Appendix 2  
Report #25610-1*

To:  
Canadian Ortech  
Att: Anna Bokowa  
2395 Speakman Drive  
Mississauga, Ontario  
L5K 1B3

<b>Sample Analysis Report</b>										
Project Number:	J8096									
Client #	25610									
Report Date:	August 25, 2008									
Analysis Date:	August 8, 2008									
Analytical Method:	Gas Chromatography/Flame Ionization Detection (GC/FID)									
Unit	µg/sample									
Sample Type:	Sep-Pak									
Results	Detection Limit	LBLK-1	LBLK-2	C5	C6	C7	C16	C17	C18	C19
Formaldehyde	0.1	0.1	0.1	<0.1	15.5	<0.1	<0.1	23.1	1.9	35.7
Acetaldehyde	0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	0.2	<0.1	0.3
Acetone	0.1	2.1	3.0	13.9	28.3	<0.1	<0.1	28.0	4.7	27.4
Acrolein	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Ethyl Ketone	0.1	<0.1	<0.1	<0.1	8.9	1.4	<0.1	10.1	1.3	9.6
Butyraldehyde	0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	0.2	0.3	0.4
Methyl n-Propyl Ketone	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Crotonaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Isobutyl Ketone	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Valeraldehyde	0.1	<0.1	<0.1	0.3	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Hexanaldehyde	0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1
Furaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzaldehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tolualdehyde	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Comment	The sample was extracted with 30 ml of solvent (ref EPA TO-5). The solvent was concentrated to 1mL and analyzed by GC/FID. Samples were corrected to Lab Blank.									
Analyst	Quang Tran, M. Sc.									
QA/QC	Philip Fellin, M.Sc.									

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