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Re: BCELQAAC Recommendations Regarding Schedule 11 Vapour Standards

The BC Environmental Laboratory Quality Assurance Advisory Committee (BCELQAAC) is comprised of representatives of five of the Province's largest commercial environmental analytical laboratories, together with representatives from Environment Canada, BC MOE, and from one or more BC environmental consultants or other contaminated sites practitioners. Our committee forms a vital linkage between government and private sector stakeholder issues associated with environmental regulation, with a focus on analytical chemistry and methodology issues.

This letter is in response to your request for our committee's recommendations regarding the following key issues pertaining to the proposed Schedule 11 Vapour Standards;

i) Definition of "Volatile Substance",
ii) Recommendations for analytical methods for Schedule 11 Vapour Standards,
iii) Preliminary recommendations for VPHv analytical methods,
iv) Achievable detection limits and related issues,
v) Other ancillary recommendations for exclusions / changes to Schedule 11.

Our recommendations for each of the above topics are presented below.

1. Recommended Definition of "Volatile Substance"

Our response to the Ministry's request that our committee develop and recommend a definition for "volatile substance" is provided below. As a committee of analytical chemists, our recommendations are based on the physical properties of substances, rather than on toxicological exposure modelling scenarios, which are beyond our area of expertise.

The majority opinion of the BCELQAAC committee is that a "volatile substance" should be defined as a substance exhibiting:

- Henry's Law Constant > 1.0×10^{-5} atm-m^3/mol, AND
- Vapour Pressure > 0.05 Torr (@ 1 atmosphere, 25°C)

The basis for the first component of this definition originates from the US EPA Region 9, which employs a two-fold definition for volatile substances under their regulatory framework. They define a compound as being volatile if its Henry's Law constant (H') exceeds 1.0×10^{-5} atm-m^3/mole AND if its molecular weight is less than 200 grams per mole.

Our committee agrees with the Henry's Law component of the Region 9 volatility definition. The Henry's Law constant is a ratio of the vapour pressure of a chemical to its solubility in water (at a given temperature and pressure). The Henry's Law constant combines the properties of vapour pressure and water solubility to provide an estimate of the tendency of a compound to volatilize from aqueous solution to the vapour phase. This is particularly relevant to contaminated sites applications, where surface water and groundwater play important roles.

It would be overly conservative to use the 1E-05 Henry's Law constant alone as a definition of volatility. This is because many compounds with very low absolute volatility (measured by vapour pressure) will have a Henry's Law constant exceeding the recommended value if they have extremely low solubility in water. For example, all n-alkanes would be classified as volatile based on the Henry's Law constant criterion alone. Therefore, an additional qualifying measure of absolute volatility is needed in addition to the Henry's Law constant parameter. We assume that this is why the EPA Region 9 added a molecular weight cut-off of 200 grams per mole to their definition.

BCELQAAC does not agree with the use of 200 grams per mole as a volatility cut-off criterion. There is a rough correlation between the molecular weight and the vapour pressure of a substance, but the link is tenuous; there are many compounds with MWt > 200 g/mole that are very volatile. Instead, BCELQAAC recommends that the vapour pressure of a substance (at 1 atmosphere and 25°C) be used as the secondary determining factor in the Province's definition. The vapour pressure of a substance is the most direct measure of its absolute volatility. A temperature of 25°C is fairly close to the upper limit of the range of temperatures that will be experienced at most contaminated sites in BC, particularly for sub-surface conditions.

Our committee considered two alternative vapour pressure criteria to define a volatile substance:

a) Vapour Pressure >0.05 Torr (at 25°C and 1 atm) – approx equal to nC13
b) Vapour Pressure >0.001 Torr (at 25°C and 1 atm) – approx equal to nC16

All committee members agreed that any substance with a vapour pressure exceeding 0.05 Torr can unequivocally be considered to be volatile. Reasons for using 0.05 Torr as a vapour pressure cut-off include:

- It includes naphthalene (VP 0.085 Torr), identified by BC MOE as a toxicity surrogate for aromatics in the C10-19 (LEPH) range. Naphthalene is prevalent at BC sites, and is frequently found at toxicologically relevant concentrations in soil gas samples.

- It includes 1-methylnaphthalene (VP 0.067 Torr) and 2-methylnaphthalene (VP 0.055 Torr), but excludes heavier PAHs which generally pose far less vapour phase exposure risk than naphthalene, due to their much higher vapour pressures. Examples:
  - acenaphthylene: VP 0.0067 Torr, ~13x less volatile than naphthalene
  - acenaphthene; VP 0.0025 Torr, ~34x less volatile than naphthalene
  - fluorene; VP 0.0006 Torr, ~140x less volatile than naphthalene

- The 0.05 Torr criterion is very similar to the US EPA definition of Volatile Organic Compounds from the TO-15 method, which specifies 0.1 Torr as the practical vapour pressure limit for this method.

The committee also considered a more conservative vapour pressure cut-off of 0.001 Torr. Committee members agreed that substances with vapour pressures between 0.001 – 0.05 Torr can be considered to be semi-volatile under environmental conditions. Substances in this range (e.g. within the boiling point range of nC13 – nC16) are sometimes found in soil gas samples. They are typically found at significant levels only at sites contaminated with diesel; even at these sites, these substances tend to occur much

less frequently than the lighter fractions. Substances with boiling points greater than nC16 are generally not found in soil gas samples.

To evaluate the relative importance of (in soil gas samples) of substances in the 0.001 – 0.05 Torr vapour pressure range, the committee compiled, on a random basis, datasets of vapour phase chemical compound concentrations from historical databases (Refer to Appendix – Tables 1 and 2, based on Charcoal and Thermal Desorption collection, respectively). The following conclusions were drawn from a review of this data:

- Based on draft ACC / Schedule 11 values supplied to us, the vapour phase parameters that will typically be the key drivers for site remediation will be: BTEX (primarily Benzene), Hexane, Decane, Naphthalene, Perchloroethylene, Trichloroethylene, and VPHv.

- On average, the relative contribution of the nC13-nC16 fraction was approximately 2 – 4% of the Total Volatile Organic Compounds (TVOC) detected in these samples (when analyzed on a non-polar compound, which will be a requirement for the VHv parameter).

- In the worst case situations (samples contaminated only with heavy diesel or heavy fuel oil), the relative contribution of the nC13-nC16 fraction was approximately 25% of TVOC (based on the use of a non-polar GC column).

- At sites where Biphenyl or PAHs heavier than methyl-naphthalenes were detected (acenaphthylene, acenaphthene, fluorene), they were usually found at concentrations below 2.5% of the naphthalene levels seen at the same site. Further, these substances were never found at levels more than 1/3rd the corresponding naphthalene levels).

In view of the above, the majority of our committee (with one dissenting vote) recommends that a 0.05 Torr cut-off would be most appropriate criterion to use as the vapour pressure cut-off for the BC CSR volatility definition. This recommendation considers the following factors:

- A 0.05 Torr cut-off allows for more inclusive use of the methods and technologies that are typically used within the industry to collect and analyze vapour samples. Achieving unbiased sampling and consistent analysis of substances with vapour pressures as low as 0.001 Torr could be a significant challenge for some techniques.

- Use of a 0.001 Torr cut-off would necessitate the inclusion of several additional semi-volatile substances to the Schedule 11 list, some of which may substantially increase the costs of site assessments to end users, for what appears to be little or no gain in terms of additional health protection (Examples: Inorganic Mercury, Acenaphthene, Biphenyl, several semi-volatile pesticides, etc).

Ultimately the decision regarding selection of appropriate volatility definitional criteria remains the responsibility of BC MOE. We have endeavoured to provide the Ministry with as much information as possible to allow a decision to be made that will provide an appropriate and scientifically defensible level of human health protection, balanced against practicality and costs to end users. We are aware that whatever decision is made now will be reviewed again by the Ministry in 2010 as part of the scheduled omnibus update of the CSR.

Note: For any substances for which vapour pressures (@ 25°C and 1 atmosphere) cannot be determined, we recommend utilizing instead one of the following physical constants as appropriate alternative absolute volatility criteria for the definition of “volatile substance” (in priority order):

a) Boiling Point < 220°C
b) Molecular Weight < 200

2. Interim Recommendations for Analytical Methods for Schedule 11 Vapour Standards

Capabilities now exist through BC commercial laboratories, or will exist soon, to test for most compounds listed in the draft Schedule 11 Vapour Standards (based on the June 10, 2008 version provided for our consideration). BCELQAAC is now working on documenting test methods for VOCs in vapour samples, which will soon be recommended for publication within the BC Laboratory Manual. These methods will include allowable analytical options and requirements, and will guide BC labs on the selection of appropriate techniques. BCELQAAC is currently developing the following performance based methods (PBMs) for the BC Lab Manual:

- VOCs in Air by Canister – GC/MS (PBM) – based on EPA TO15
- VOCs in Air by Thermal Desorption Tube – GC/MS (PBM) – based on EPA TO17
- VOCs in Air by Solvent Desorbable Media & Miscellaneous Techniques (PBM)
- Volatile Petroleum Hydrocarbons in Air, VPHv (PBM)

All of the above methods will refer to other published reference methods for specific operational instructions. To ensure that requisite scientific rigour is met by all laboratories, these methods will also include key analytical requirements and prescribed methodological elements (e.g. applicability, QC requirements, validation requirements, reporting requirements, VPHv definition, etc).

Draft versions have already been completed for the first two methods listed above. The committee is now working on completing the remaining two PBMs. The Solvent Desorbable Media & Miscellaneous Techniques PBM will largely consist of a listing of appropriate published reference methods that may be used where appropriate. BCELQAAC will commit to completing and endorsing these four methods within the next three to four months if this is a priority for BC MOE. Please be aware that in order to meet this deadline, some funding for this initiative will likely be required.

Until the BC Lab Manual Methods have been completed and endorsed, please refer to Table 3 in the appendix to this letter for our committee's interim recommendations for laboratory analytical methods for the ACC Director's Standards and/or CSR Schedule 11 Vapour Standards. Suitable published reference methods are indicated for each volatile substance to be regulated. Laboratories should utilize these reference methods as general guidance. To ensure scientific defensibility and maintain required QA/QC, laboratories must validate and document any significant deviations from the reference methods.

3. Preliminary recommendations for VPHv analytical methods

The Ministry has indicated a desire to align the hydrocarbon vapour analytical parameters with the Province's definition of "volatile substance". Therefore, should the Ministry adopt BCELQAAC's proposed definition for "volatile substance", new methods and a new definition for VPHv (VPH-vapour) will be necessary. This will require some divergence from the definition of VPH currently used for soil and water, primarily in terms of the volatility range it captures
If the Vapour Pressure cut-off criterion of 0.05 Torr is adopted within BC MOE's final definition of volatile substance, then our preliminary recommendations for key elements of the VPHv method will be as follows:

- VPHv will be defined as including those compounds that elute on a 100% polydidimethylsiloxane GC column between the retention times of n-hexane (nC6) and n-tridecane (nC13), minus n-hexane, n-decane, and BTEX.
- VPHv may be determined using either GC-FID or GC-MS detection (specific details to be determined).
- VH_{6-13} will be the parameter that is directly measured in the laboratory.
- VPHv will be a calculated parameter, determined by subtracting the sum of n-hexane, n-decane, and BTEX, from VH_{6-13}.

4. Achievable Detection Limits and Related Issues

Draft Schedule 11 (June 10, 2008 version) contains standards for several substances at concentrations that our committee judges to be unachievable by the most current technology available to BC commercial laboratories.

Canister and thermal desorption methods are generally the most sensitive techniques in use today for analysis of VOCs in air. As a general guideline, under fairly routine conditions, these methods can typically achieve reliable detection limits of approximately 1 ug/m^3 for most stable and inert VOCs in air. Under optimum conditions (which may sometimes require analysis of only one compound at a time), these methods can occasionally achieve detection limits of 0.1 ug/m^3 for stable and inert VOCs.

BCELQAAC laboratory members have reviewed the draft Schedule 11 list, and propose that some of the most stringent standards be raised due to analytical method detection limitations, as indicated in Table 4, in the appendix to this letter. It is our understanding that the process used to derive the draft toxicity-based standards includes a significant margin of safety, typically in the region of one to two orders of magnitude. In order to permit laboratories to consistently meet the majority of these standards at reasonable costs to end-users, we propose that the most stringent standards be raised to 1 ug/m^3 in cases where the toxicity-based draft standard is greater than 0.01 ug/m^3. For substances where the toxicity-based draft standard is less than 0.01 ug/m^3, we propose that the draft standard be increased to either 100 times the original toxicity-based standard, or to a value equal to the lowest detection limit that any BC laboratory can currently achieve. In making these recommendations, we assume that eliminating the 10 to 100-fold toxicological safety factor in these cases will continue to provide adequate protection of human health.

It is important to note that no laboratory will be able to guarantee that these detection limits will be achievable in all circumstances.

BC MOE and clients of BC laboratories must realize that site-specific issues will sometimes arise that will necessitate the reporting of elevated detection limits for some compounds. Examples of such situations may include:

- Presence of unknown vapour interferences, and
- High concentrations of one or more VOCs may preclude ultra-low detection limits (DLs) for other VOCs

Some of the achievable DL estimates in Table 4 have not yet been empirically verified, and may be subject to change when additional data becomes available. For example, the DL estimates provided for triethylamine, dimethylamine, and bis(chloromethyl)ether are provided with a low degree of confidence.

5. Other Recommendations for Exclusions / Changes To Schedule 11

Based on the June 10, 2008 draft version of Schedule 11, we recommend the following additional exclusions and adjustments:

Pebulate - This is a herbicide that just marginally meets our recommended definition of "volatile substance". No BC laboratories currently have analytical capabilities for Pebulate. We also note that Pebulate was de-registered for use in Canada in 2002 and that as a thio-carbamate herbicide would not be expected to exhibit significant environmental persistence. We therefore recommend that Pebulate be excluded from Schedule 11.

Chlorothiophos - Chorothiophos (synonym Chlorthiophos) is a non-volatile pesticide. It has a boiling point of 398.2°C, a vapour pressure of 0.0000024 Torr (25°C, 1 atm), and a molecular weight of 361.24 grams/mole. We therefore recommend that Chlorothiophos be excluded as a "volatile substance" from Schedule 11.

1,4-Dichloro-2-Butene - This substance exists as two isomers (cis and trans). Consequently, the Schedule 11 standard should specifically indicate that it is applicable to the sum of these two isomers.

Thiocyanate (CHNS) – BC laboratories are not aware of any analytical methods for thiocyanate in air (thiocyanic acid). In pure form, thiocyanic acid is highly unstable, existing only at very low temperatures (below minus 40°C). It is therefore known primarily in its salt forms, which are different substances entirely (most are likely non-volatile). We could find very little additional information in the literature on the physical properties of this substance. We recommend that it be removed from Schedule 11 due to lack of analytical methods, and because in its pure form, it does not appear to be environmentally relevant.

Methyl styrene – Methyl styrene can exist as three isomers. Only the meta and para isomers are commercially relevant. We therefore recommend that the Schedule 11 standard be applied specifically to the sum of the meta and para isomers.

Xylenes – The Schedule 11 standard for xylenes should specifically indicate that it is applicable to the sum of the three meta, para, and ortho xylene isomers of the substance.

Thank you for the opportunity to provide our recommendations on these issues, and to contribute to the development of these important new environmental standards for British Columbia.

Sincerely,

Mark Hugdahl, B.Sc.
Chair, BCELQAAC

cc Steve Horvath

Appendix - Table 1: Example VOC Vapour Data by Charcoal Collection / CS2 Desorption (ug/m^3)

All Units in ug/m3	Spl1	Spl2	Spl3	Spl4	Spl5	Spl6	Spl7	Spl8	Spl9	Spl10	Spl11	Spl12	Spl13	Spl14	Spl15	Spl16
Total Volatile Organic Compounds*	4350000	1690000	1680000	998000	707000	635000	614000	517000	460000	387000	293000	282000	186000	161000	146000	130000
TVOC Fraction >C12	0.3%	0.3%	0.5%	0.1%	0.0%	0.0%	6.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	18.0%	0.0%
TVOC Fraction >C13	**0.1%**	**0.1%**	**0.2%**	**0.1%**	**0.0%**	**0.0%**	**1.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**7.2%**	**0.0%**
TVOC(6-10)	3330000	1450000	1470000	760000	516000	569000	265000	340000	320000	325000	246000	245000	85600	150000	30900	150000
TVOC(10-19)	493000	221000	107000	40800	23400	65500	348000	81800	< 100000	42400	46300	15400	< 5000	10200	114000	< 100000
CWS TVOC (C6-C8)	630000	513000	891000	588000	401000	138000	6520	146000	207000	187000	32200	159000	73600	25300	940	116000
CWS TVOC (C>8-C10)	2700000	915000	569000	185000	125000	421000	267000	203000	127000	145000	218000	87200	12100	122000	29900	32000
CWS TVOC (C>10-C12)	450000	204000	96200	39300	23100	56700	290000	67500	< 20000	35500	40900	13900	< 1000	7670	85000	< 20000
CWS TVOC (C>12-C16)	12300	4900	8500	1400	< 1000	< 400	38900	450	< 20000	< 1000	< 400	< 1000	< 1000	< 400	26300	< 20000
CWS TVOC (C>13-C16)**	**4920**	**1960**	**3400**	**560**	**< 1000**	**< 400**	**9725**	**180**	**< 20000**	**< 1000**	**< 400**	**< 1000**	**< 1000**	**< 400**	**10520**	**< 20000**
CWS TVOC (C>16-C21)	< 800	< 400	< 400	< 1000	< 1000	< 400	< 400	< 400	< 20000	< 1000	< 400	< 1000	< 1000	420	< 400	< 20000
Benzene	436	4450	55.4	23100	14900	< 8	22.5	110	< 2000	2880	54.1	2820	3700	< 8	< 8	< 2000
Ethylbenzene	924	6880	61	8730	5200	< 80	< 30	160	2770	2740	< 4	2650	465	< 30	< 5	1760
Toluene	474	101	1300	46900	28800	< 60	25	259	9400	14300	< 10	12500	5350	< 20	109	5900
meta- & para-Xylene	424	1930	914	44700	24000	< 30	< 30	250	12200	16800	< 7	14300	1990	< 30	11	7880
ortho-Xylene	613	41.5	257	13200	6720	< 200	< 50	205	4520	5760	< 4	4660	633	< 30	7.9	2450
Xylenes	104	197	117	5786	3071	< 230	< 80	46	1668	2261	< 11	1897	262	< 60	2	1033
Methyl t-butyl ether (MTBE)	< 80	< 40	< 400	< 100	< 100	< 40			< 2000	< 100	< 40	< 100	< 100	< 40	< 40	< 2000
n-Hexane (nC6)	8800	16300	8730	27300	19000	242	< 40	11800	2600	5660	< 40	5660	5560	< 40	< 40	< 2000
n-Heptane (nC7)																
n-Octane (nC8)																
1,1,1,2-Tetrachloroethane	< 20					< 8	< 8	< 8						< 8		
1,1,1-Trichloroethane	50					< 8	< 8	< 8						< 8		
1,1,2,2-Tetrachloroethane	< 20000					< 1000	< 2000	< 2000						< 700		
1,1,2-Trichloroethane	< 2000					< 3000	< 300	< 300						< 700		
1,1-Dichloroethane	160					< 8	< 8	< 20						< 8		
1,1-Dichloroethylene	5200					< 8	< 8	< 8						< 8		
1,2,4-Trimethylbenzene			1280			< 40								< 40		
1,2-Dichloroethane	< 20					< 8	< 8	< 30						< 8		
1,2-Dichloropropane	< 300					< 200	< 8	< 40						< 30		
1,3,5-Trimethylbenzene			3300			< 40								< 200		
Bromodichloromethane	< 20					< 1000	< 20	< 200						< 400		
Bromoform	< 20					< 8	< 8	< 8						< 8		
Carbon Tetrachloride	< 20					< 8	< 8	< 8						< 8		
Chlorobenzene	< 30					< 40	< 100	< 50						< 30		
Chloroethane	42					< 8	< 8	171						< 8		
Chloroform	< 300					< 300	< 8	< 200								
cis-1,2-Dichloroethylene	973000					< 8	< 8	< 60						< 8		
cis-1,3-Dichloropropylene	< 20					< 8	< 8	< 8						< 8		
Cumene						< 40								< 40		
Dibromochloromethane	< 20					< 8	< 8	< 8						< 8		
Tetrachloroethylene	8300000					< 8	< 8	< 8						< 8		
trans-1,2-Dichloroethylene	24600					< 8	< 8	< 8						< 8		
trans-1,3-Dichloropropylene	< 20					< 8	< 8	< 8						< 8		
Trichloroethylene	782000					< 8	< 8	< 8						< 8		
Trichlorofluoromethane	< 20					< 8	< 8	4450						< 8		
Vinyl Chloride	129000					< 8	< 8	< 8						< 8		

Combined average relative proportion for (C13-C16)/TVOC(C6-16): 1.9%

Compiled July 23, 2008 by ALS Environmental, Vancouver. Sorted by highest TVOC concentration.

Represents a 13 month compilation for charcoal data with significant positive hits for TVOC, where carbon sub-fraction data is also available.

For some samples in this compilation, actual air volume sampled was not available. These samples were converted to units of ug/m3 (from ug) using a "typical" air volume of 10 L.
All TVOC / VH data was analyzed using a non-polar (DB-1) boiling point GC column.

* C13-C16 fractions were estimated by review of all chromatograms with where >2% of TVOC was found in the C12-C16 fraction.

** TVOC = Total Volatile Organic Compounds, and corresponds to all detected compounds from the method (typically encompasses C1-C16).

Appendix - Table 1: Example VOC Vapour Data by Charcoal Collection / CS2 Desorption (ug/m^3)

All Units in ug/m3	Spl17	Spl18	Spl19	Spl20	Spl21	Spl22	Spl23	Spl24	Spl25	Spl26	Spl27	Spl28	Spl29	Spl30	Spl31	Spl32
Total Volatile Organic Compounds*	110000	86400	77000	63600	55800	55400	52500	33600	31600	27000	22900	22000	11100	8180	7600	6710
TVOC Fraction >C12	0.0%	49.4%	5.5%	0.0%	1.5%	0.0%	1.8%	0.0%	0.0%	2.1%	0.0%	21.8%	12.5%	2.0%	0.0%	13.3%
TVOC Fraction >C13	**0.0%**	**22.2%**	**1.7%**	**0.0%**	**0.6%**	**0.0%**	**0.7%**	**0.0%**	**0.0%**	**0.8%**	**0.0%**	**8.7%**	**3.8%**	**0.8%**	**0.0%**	**2.7%**
TVOC(6-10)	97500	< 2000	42200	31800	36300	10700	32300	32200	21700	20900	14200	4910	3000.0	3790	3300	2600
TVOC(10-19)	10000	84000	16400	< 2000	19200	< 5000	19900	< 2000	< 2000	4900	8100	16900	7700	1930	< 2000	3970
CWS TVOC (C6-C8)	45700	< 400	21100	22800	2250	10600	4920	10300	15300	6700	2210	< 300	< 400	1690	2020	850
CWS TVOC (C>8-C10)	51700	1450	20600	9120	34400	< 1000	30000	21200	6560	14000	11900	4650	2890	2340	1310	1850
CWS TVOC (C>10-C12)	10100	39300	12300	1860	17600	< 1000	15100	710	1540	4460	7900	11800	5440	1670	< 400	2930
CWS TVOC (C>12-C16)	< 400	42700	4270	< 400	810	< 1000	940	< 400	< 400	570	< 400	4800	1390	160	< 400	890
CWS TVOC (C>13-C16)**	**< 400**	**19215**	**1281**	< 400	**324**	< 1000	**376**	< 400	< 400	**228**	< 400	**1920**	**417**	**64**	< 400	**178**
CWS TVOC (C>16-C21)	< 400	< 400	< 800	< 400	< 400	< 1000	< 200	< 400	< 400	< 400	< 400	< 200	< 400	< 100	< 400	< 200
Benzene	< 8	< 8	21		< 40	594	< 4	< 8	26.2	26.8	< 8	< 4	< 7	4.2		< 4
Ethylbenzene	23	< 4	22.3		< 7	< 10	112	< 6	95.8	50.3	28.5	6.7	< 4	< 1		< 2
Toluene	623	< 20	< 30		< 20	202	< 8	< 20	28	< 20	126	< 8	< 10	< 4		< 8
meta- & para-Xylene	102	< 8	< 20		< 20	< 20	100	< 8	51.5	10.1	33.8	5.4	< 7	2.7		< 4
ortho-Xylene	34.4	< 4	< 10		< 20	< 10	91.6	< 7	28.8	< 4	17.7	3.5	< 4	< 1		3.5
Xylenes	14	< 12	< 30		< 40	< 30	19	< 15	8	< 12	5	1	< 11	< 3		< 6
Methyl t-butyl ether (MTBE)	< 40	< 40	< 80		< 40	< 100	< 20	< 40		< 40	< 40	< 20	< 40	< 10		< 20
n-Hexane (nC6)	126	< 40	447		< 40	1020	48	< 40	334	209	52	< 20	< 40	< 10		23
n-Heptane (nC7)		< 80			< 40											
n-Octane (nC8)		< 80			< 40											
1,1,1,2-Tetrachloroethane			< 20						< 8				< 7			
1,1,1-Trichloroethane			< 20						< 8				< 7			
1,1,2,2-Tetrachloroethane			< 300						< 20				< 30			
1,1,2-Trichloroethane			< 20						< 100				< 7			
1,1-Dichloroethane			< 20						< 8				< 7			
1,1-Dichloroethylene			< 20						< 8				< 7			
1,2,4-Trimethylbenzene	194	< 40			< 40		631	< 40				43	< 40			
1,2-Dichloroethane			< 20						< 8				< 7			
1,2-Dichloropropane			< 20						< 8				< 7			
1,3,5-Trimethylbenzene	480	< 80			< 40		258	< 40				24	< 40			
Bromodichloromethane			< 20						< 20				< 7			
Bromoform			< 20						< 8				< 7			
Carbon Tetrachloride			< 20						< 8				< 7			
Chlorobenzene			< 20						< 8				< 7			
Chloroethane			< 20						< 8				< 7			
Chloroform			< 30					< 20	< 70				< 7			
cis-1,2-Dichloroethylene			954						< 20				< 7			
cis-1,3-Dichloropropylene			< 20						< 8				< 7			
Cumene					< 40			< 40					< 40			
Dibromochloromethane			< 20						< 8				< 7			
Tetrachloroethylene			54200						8.9				< 7			
trans-1,2-Dichloroethylene			< 20						< 8				< 7			
trans-1,3-Dichloropropylene			< 20						< 8				< 7			
Trichloroethylene			1560						< 20				< 7			
Trichlorofluoromethane			< 20						< 8				< 7			
Vinyl Chloride			46						< 8				< 7			

Combined average relative proportion for (C13-C16)/TVOC(C6-16): 1.9%

Compiled July 23, 2008 by ALS Environmental, Vancouver. Sorted by highest TVOC concentration.

Represents a 13 month compilation for charcoal data with significant positive hits for TVOC, where carbon sub-fraction data is also available.

For some samples in this compilation, actual air volume sampled was not available. These samples were converted to units of ug/m3 (from ug) using a "typical" air volume of 10 L.
All TVOC / VH data was analyzed using a non-polar (DB-1) boiling p

* C13-C16 fractions were estimated by review of all chromatograms with where >2% of TVOC was found in the C12-C16 fraction.

** TVOC = Total Volatile Organic Compounds, and corresponds to all detected compounds from the method (typically encompasses C1-C16).

Appendix - Table 1: Example VOC Vapour Data by Charcoal Collection / CS2 Desorption (ug/m^3)

All Units in ug/m3	Spl33	Spl34	Spl35	Spl36	Spl37	Spl38	Spl39	Spl40	Spl41	Spl42	Spl43	Spl44	Spl45
Total Volatile Organic Compounds*	5240	3670	3400	2440	2250	1810	1810	1780	1760	1620	1160	790	508
TVOC Fraction >C12	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	32.3%	28.6%	0.0%	10.8%	0.0%	0.0%
TVOC Fraction >C13	**0.0%**	**0.0%**	**0.0%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**19.4%**	**17.2%**	**0.0%**	**4.8%**	**0.0%**	**0.0%**
TVOC(6-10)	3000.00	790	670	979	980	1040	901	500.00	570	945	621	488	229
TVOC(10-19)	1940	2810	2510	1360	1170	170	573	1250	1150	447	526	94	188
CWS TVOC (C6-C8)	< 300	< 200	< 200	140	< 200	371	306	89	103	486	64	193	116
CWS TVOC (C>8-C10)	2700	720	590	969	880	679	661	422	476	493	576	304	126
CWS TVOC (C>10-C12)	1910	2870	2570	1050	1310	144	421	660	640	363	355	79	160
CWS TVOC (C>12-C16)	< 200	< 200	< 200	32	< 200	< 20	< 20	575	504	< 20	125	< 20	< 20
CWS TVOC (C>13-C16)**	< 200	< 200	< 200	**13**	< 200	< 20	< 20	**345**	**302**	< 20	**56**	< 20	< 20
CWS TVOC (C>16-C21)	< 200	< 200	< 200	< 20	< 200	< 20	< 20	< 30	< 30	< 20	< 20	< 20	< 20
Benzene	< 4	< 3	3.5	1.46	4.9	1.16	1.57	1.16	1.39	1.8	0.69	1.4	1.36
Ethylbenzene	< 2	< 2	5.5	2.43	7.7	2.61	3.52	2.4	2.93	2.15	1.96	1.66	1.18
Toluene	< 8	< 6	9.7	17.8	17.8	19.4	28.9	7.5	9.9	59.5	2.01	14.3	19.3
meta- & para-Xylene	< 4	3.5	5.2	9.45	65.4	8.26	10.9	13	15.3	7.56	6.59	5.33	4.1
ortho-Xylene	< 2	< 2	2.1	5.78	110	3.44	5.02	4.26	5.11	4.65	3.72	2.13	2.08
Xylenes	< 6	< 5	1	2	18	1	2	2	2	1	1	1	1
Methyl t-butyl ether (MTBE)	< 20	< 20	< 20	< 2	< 20	< 2	< 2	< 3	< 3	< 2	< 2	< 2	< 2
n-Hexane (nC6)	< 20	< 20	< 20	2.7	< 20	< 2	3.4	< 3	< 3	2.4	2.6	< 2	3.6
n-Heptane (nC7)													
n-Octane (nC8)													
1,1,1,2-Tetrachloroethane													
1,1,1-Trichloroethane													
1,1,2,2-Tetrachloroethane													
1,1,2-Trichloroethane													
1,1-Dichloroethane													
1,1-Dichloroethylene													
1,2,4-Trimethylbenzene	< 20												
1,2-Dichloroethane													
1,2-Dichloropropane													
1,3,5-Trimethylbenzene	< 20												
Bromodichloromethane													
Bromoform													
Carbon Tetrachloride													
Chlorobenzene													
Chloroethane													
Chloroform													
cis-1,2-Dichloroethylene													
cis-1,3-Dichloropropylene													
Cumene													
Dibromochloromethane													
Tetrachloroethylene													
trans-1,2-Dichloroethylene													
trans-1,3-Dichloropropylene													
Trichloroethylene													
Trichlorofluoromethane													
Vinyl Chloride													

Combined average relative proportion for (C13-C16)/TVOC(C6-16): 1.9%

Compiled July 23, 2008 by ALS Environmental, Vancouver. Sorted by highest TVOC concentration.

Represents a 13 month compilation for charcoal data with significant positive hits for TVOC, where carbon sub-fraction data is also available.

For some samples in this compilation, actual air volume sampled was not available. These samples were converted to units of ug/m3 (from ug) using a "typical" air volume of 10 L.
All TVOC / VH data was analyzed using a non-polar (DB-1) boiling p

* C13-C16 fractions were estimated by review of all chromatograms with where >2% of TVOC was found in the C12-C16 fraction.

** TVOC = Total Volatile Organic Compounds, and corresponds to all detected compounds from the method (typically encompasses C1-C16).

Appendix - Table 2: C_{6-13} vs C_{13-16} Proportions from representative Thermal Desorption samples (ug/m^3) - High Samples

Sample ID:	806020042 (ug/m^3)	805020451 (ug/m^3)	803240080 (ug/m^3)	805230068 (ug/m^3)	806240391 (ug/m^3)	806240372 (ug/m^3)	806250783 (ug/m^3)	807030228 (ug/m^3)	807030216 (ug/m^3)	807030212 (ug/m^3)	807030193 (ug/m^3)	806160117 (ug/m^3)	806030025 (ug/m^3)
C_{6-13} (aggragate)	1,229	5,417	2,750	1,146	3,396	2,708	271	6,521	4,792	4,583	2,375	22,083	1,396
C_{13-16} (aggragate) *	104	2,500	2,125	146	25	1,167	479	333	167	167	188	500	104
Benzene	0.6	2.9	19.0	1.9	4.0	1.4	7.1	131.3	25.0	27.1	4.4	1.5	2.9
Toluene	5.0	12.3	25.0	17.9	29.2	7.3	0.9	187.5	50.0	47.9	33.3	9.2	6.0
Ethylbenzene	0.7	2.5	5.0	6.3	6.0	3.5	0.1	11.7	70.8	72.9	1.4	3.8	1.5
Xylenes	3.8	17.3	20.8	25.0	31.3	14.8	2.0	191.7	291.7	270.8	39.6	35.4	8.3
n-C10	0.4	15.6	5,833.3	5.2	-	-	0.2	10.4	229.2	12.1	8.5	0.1	-
n-C13	0.4	9.8	4.0	11.0	-	-	0.3	12.7	4.6	4.0	6.9	-	-
n-C14	0.6	1.1	0.8	0.8	-	-	-	3.8	0.1	0.4	1.0	-	-
n-C15	0.2	0.2	0.2	0.1	-	-	-	0.3	-	-	-	-	-
naphthalene	11.3	4.4	122.9	19.6	1.4	3.3	-	4.2	4.0	4.0	25.0	85.4	0.5
2-methyl naphthalene	3.3	0.9	2.7	1.8	0.1	0.5	-	0.4	0.4	0.4	1.2	4.0	-
1-methyl naphthalene	2.0	0.4	1.4	1.3	0.1	0.2	-	0.4	0.2	0.2	0.7	1.9	-
acenaphthylene	-	-	1.2	-	-	-	-	-	-	-	-	0.3	-
acenaphthene	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,3-tri chloro benzene	-	1.5	-	-	-	-	-	-	-	-	-	-	-
1,2,4,5-tetra chloro benzene	-	-	-	-	-	-	-	0.6	0.2	187.5	-	-	-
1,2,3,4-tetra chloro benzene	-	-	-	-	-	-	-	2.1	0.5	0.5	-	-	-
1,1-bi phenyl	0.3	-	1.3	0.4	0.1	-	-	0.2	0.1	-	0.3	2.6	-
di phenyl ether	-	-	-	0.1	-	-	-	-	-	-	-	-	-
4-chloro aniline	-	-	-	-	-	-	-	-	-	-	-	-	-
2,6-di chloro phenol	-	-	-	-	-	-	-	-	-	-	-	-	-
di methyl naphthalene	0.3	-	-	-	-	-	-	-	-	-	0.2	1.4	-
tri methyl phenol	-	4.6	-	-	-	-	-	-	-	-	-	-	-
cyclo hexyl benzene	-	-	7.7	-	-	-	-	-	-	-	0.3	-	-
bicyclohexyl	-	8.1	9.2	0.3	-	3.4	-	-	-	-	0.3	0.1	-
1 ethyl naphthalene	0.2	-	-	0.1	-	-	-	-	-	-	0.1	0.4	-
tetra hydro naphthalene	-	0.4	-	-	-	-	-	-	-	-	0.0	-	-
tetra hydro methyl naphthalene	0.8	9.4	10.6	0.4	-	-	-	0.1	0.2	0.1	1.3	-	-
tetra hydro di methyl naphthalene	0.5	1.6	4.6	-	-	-	-	-	-	-	0.2	-	-
2 methyl biphenyl	0.1	0.1	1.5	-	-	-	-	-	-	-	0.1	0.3	-
2 benzothiophene	-	-	-	0.4	-	-	-	-	-	-	-	-	-
heptyl cyclo hexane	-	5.4	-	0.4	0.1	2.7	-	-	1.5	0.1	0.2	0.1	-
deca hydro methanoazulene	-	-	-	312.5	-	-	-	-	0.1	0.1	1.8	-	-
di methyl ethyl methyl phenol	-	-	-	937.5	0.3	-	-	-	-	-	-	-	-
di hydro di methyl 1H indene	1.2	2.2	3.8	0.6	0.1	-	-	0.2	0.2	-	0.8	1.0	-
di methyl 1H indene	-	3.5	4.6	0.1	-	-	-	-	-	0.1	0.2	0.9	-
di hydro di methyl 1H indene	0.6	1.2	-	0.3	-	-	-	-	0.1	-	0.3	0.3	-
di hydro tri methyl 1H indene	1,479.2	6.0	6.3	-	-	-	-	-	-	-	-	-	-
hexa methyl benzene	-	-	-	-	-	-	-	-	-	-	-	1.5	-
pentyl methyl benzene	0.4	-	-	-	-	-	-	0.1	-	0.1	-	4.2	-
di methyl adamantane	-	16.9	-	-	-	31.3	-	-	-	-	-	-	2.1
tri methyl adamantane	-	-	-	-	-	1.1	1.2	-	-	-	-	-	-
tetra methyl adamantane	0.4	7.1	-	-	-	2.5	5.2	-	-	-	-	-	-
octyl di methyl acetyl	-	-	-	-	0.6	-	-	2.1	0.9	1.9	-	-	-
bis di methyl methoxy methanol	-	-	-	-	-	-	-	2.1	0.4	0.3	-	-	-
bis di methyl ethyl benzene	-	-	-	-	-	-	-	3.1	0.4	-	-	-	-
di chloro benzaldehyde	-	-	-	0.1	-	-	-	875.0	-	0.4	0.7	-	0.1
di chloro phenyl ethanone	-	-	-	0.2	-	-	-	0.9	0.4	0.5	0.9	-	-
di methyl cyclo hexanol	-	-	-	-	-	-	-	-	-	-	-	-	-

Compiled by Cantest, July 26, 2008. Quantitation based on assumed sample size of 48L.

* Note: C6-13 and C13-16 aggregate results were determined using a polar GC column. The fraction of aggregate (VH) results that exceeds nC13 is significantly lower using a non-polar column.

Appendix - Table 2: C_{6-13} vs C_{13-16} Proportions from representative Thermal Desorption samples (ug/m^3) - Medium Samples

Sample ID:	806030323 (ug/m^3)	806030318 (ug/m^3)	806030022 (ug/m^3)	805280209 (ug/m^3)	805220272 (ug/m^3)	805220268 (ug/m^3)	805130272 (ug/m^3)	805050263 (ug/m^3)	805050259 (ug/m^3)	805050196 (ug/m^3)	804280021 (ug/m^3)	803240096 (ug/m^3)	806270111 (ug/m^3)
C_{6-13} (aggragate)	4,208	1,375	1,063	813	313	10,208	354	5,438	979	2,229	3,938	375	3,021
C_{13-16} (aggragate)	2.1	10.4	2.1	9.3	18.8	45.8	16.7	25.0	6.3	25.0	20.8	6.3	6.3
Benzene	0.5	0.3	1.4	3.8	4.6	9.3	0.2	9.6	1.8	0.6	1.1	645.8	6.0
Toluene	0.9	0.6	4.0	1.3	15.8	56.3	0.4	9.2	13.0	2.6	5.2	2.7	9.0
Ethylbenzene	0.5	0.4	0.6	0.4	3.5	10.6	1.9	70.8	4.0	0.3	0.6	0.3	0.8
Xylenes	1.5	1.3	2.7	2.7	14.6	52.1	16.3	193.8	16.9	1.7	3.8	1.7	5.2
n-C10	33.1	1.1	1.1	10.4	1.3	18.9	1.0	29.6	3.6	0.1	-	0.1	2.6
n-C13	0.6	0.3	0.1	0.8	2.2	1.7	0.4	0.8	0.1	-	-	-	0.2
n-C14	0.2	-	-	-	0.1	0.4	0.2	0.3	-	-	-	-	-
n-C15	-	-	-	-	-	0.1	-	-	-	-	-	-	-
naphthalene	0.9	1.3	0.1	0.3	0.7	0.6	0.6	0.7	1.3	0.6	2.4	0.6	0.6
acenaphthylene	-	-	-	-	-	-	-	-	-	-	-	-	-
acenaphthene	-	-	-	-	-	-	-	-	-	-	-	-	-
2-methyl naphthalene	0.1	0.1	-	-	-	104.2	0.2	0.1	0.1	-	0.2	-	-
1-methyl naphthalene	-	-	-	-	-	0.1	0.1	-	-	-	0.1	-	-
1,2,3-tri chloro benzene	-	-	-	-	-	-	-	-	-	-	-	-	0.1
1,2,4,5-tetra chloro benzene	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,3,4-tetra chloro benzene	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-bi phenyl	-	-	-	-	-	0.2	-	0.2	-	-	-	-	0.1
tri methyl phenol	-	-	-	-	-	-	-	-	-	-	-	-	-
cyclo hexyl benzene	-	-	-	-	-	-	-	-	-	-	-	-	-
di phenyl ether	-	-	-	-	-	-	-	-	-	-	-	-	-
4-chloro aniline	-	-	-	-	-	-	-	-	-	-	-	-	-
2,6-di chloro phenol	-	-	-	-	-	-	-	-	-	-	-	-	-
di methyl naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-
bicyclohexyl	-	-	-	-	-	-	0.1	-	-	-	-	-	-
1 ethyl naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-
tetra hydro naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-
tetra hydro methyl naphthalene	-	-	-	-	-	-	0.2	-	-	0.1	0.5	0.1	-
tetra hydro di methyl naphthalene	-	-	-	-	-	-	-	-	-	-	-	-	-
2 methyl biphenyl	-	-	-	-	-	-	-	-	-	-	-	-	-
2 benzothiophene	-	-	-	-	-	-	-	-	-	-	-	-	-
heptyl cyclo hexane	-	-	-	-	-	-	-	-	-	-	-	-	-
deca hydro methanoazulene	-	-	-	-	-	-	0.2	-	-	-	-	-	-
di methyl ethyl methyl phenol	-	-	-	-	-	0.4	-	-	-	0.5	-	-	-
di hydro di methyl 1H indene	-	-	-	-	-	-	0.1	-	-	-	-	-	-
di methyl 1H indene	-	-	-	-	-	-	-	0.1	-	-	-	-	-
di hydro di methyl 1H indene	-	-	-	-	-	-	-	-	-	-	0.2	0.5	-
di hydro tri methyl 1H indene	-	-	-	83.3	-	-	-	-	-	-	-	-	-
hexa methyl benzene	-	-	-	-	-	-	-	-	-	-	-	-	-
pentyl methyl benzene	-	-	-	-	-	-	-	-	-	-	-	-	-
di methyl adamantane	-	-	-	-	-	0.6	-	-	-	0.1	-	0.1	-
tri methyl adamantane	-	-	-	-	-	-	-	-	-	-	-	-	-
tetra methyl adamantane	-	-	-	-	-	-	-	-	-	-	-	-	-
octyl di methyl acetyl	-	-	-	-	-	-	-	-	-	-	-	-	-
bis di methyl methoxy methanol	-	-	-	-	-	-	-	-	-	-	-	-	-
bis di methyl ethyl benzene	-	-	-	-	-	-	-	-	-	-	-	-	0.3
di chloro benzaldehyde	-	-	-	-	-	-	-	-	0.1	-	-	-	-
di chloro phenyl ethanone	-	-	-	-	-	-	0.1	-	-	-	-	-	-
di methyl cyclo hexanol	-	-	-	-	-	-	-	-	-	-	-	-	-

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* Note: C6-13 and C13-16 aggregate results were determined using a polar GC column. The fraction of aggregate (VH) results that exceeds nC13 is significantly lower using a non-polar column.

Appendix - Table 3: BCELQAAC Interim Analytical Methods Guidance for ACC / Schedule 11 listed Volatile Substances.

Substance	CAS #	BP (°C)	VP, 25C, 1atm (Torr)	MW (g/mol)	Henry's Law atm-m3/mo	TO15	TO17	Solid Adsorbent Media & Misc Methods**
acetaldehyde	75-07-0	20.1	902	44.05	6.7E-05	✓	✓	✓ NIOSH 2018, 2538, 2539, EPA TO5/TO11
acetone	67-64-1	55.5	231	58.08	4.0E-05	✓	✓	✓ NIOSH 1600, 1300, 2555; OSHA 69
acetone cyanohydrin	75-86-5	171	0.341	85.11	1.3E-05	VR*	VR	✓ NIOSH 2506
acetonitrile	75-05-8	59.6	88.8	41.05	3.4E-05	✓*	✓	✓ NIOSH 1606
acrolein (2-propenal)	107-02-8	52.6	274	56.06	1.2E-04	✓	✓	✓ NIOSH 2501, 2539; OSHA 52, EPA TO5/TO11, CARB 430 (Ashland modification)
acrylonitrile (2-propenenitrile)	107-13-1	77.3	109	53.06	1.4E-04	✓	✓	✓ NIOSH 1604
ammonia	7664-41-7	-33.33	7508	17.03	1.6E-05	X	X	✓ NIOSH 6015, 6016
benzene	71-43-2	80	94.8	78.11	5.6E-03	✓	✓	✓ NIOSH 1501, 1500
benzyl chloride (a-chlorotoluene)	100-44-7	179	1.23	126.59	4.1E-04	✓	✓	✓ NIOSH 1003
bis(2-chloroethyl)ether	111-44-4	178.5	1.55	143.01	1.7E-05	VR*	✓	✓ NIOSH 1004 (VR)
bis(2-chloroisopropyl)ether	39638-32-9	124.91	12.6	171.07	3.3E-04	VR*	✓	✓ NIOSH 1004 (VR)
bis(2-chloromethyl)ether	542-88-1	106	29.4	114.96	2.1E-04	VR*	✓	✓ OSHA 10
bis(2-chloro-1-methylethyl)ether	108-60-1	187	0.56	171.07	1.1E-04	VR*	✓	✓ NIOSH 1004 (VR)
bromobenzene	108-86-1	156	4.18	157.01	2.7E-03	✓	✓	✓ NIOSH 1003 (VR)
bromodichloromethane (BDCM)	75-27-4	90	57.4	163.83	2.1E-03	✓	✓	✓ NIOSH 1003 (VR)
bromoform (tribromomethane)	75-25-2	149.1	5.4	252.73	2.2E-02	✓	✓	✓ NIOSH 1003
bromomethane (methyl bromide)	74-83-9	3.5	1620	94.94	6.2E-03	✓	✓	✓ NIOSH 2520
1,3-butadiene	106-99-0	-4.4	2110	54.09	7.4E-02	✓	✓	✓ NIOSH 1024; OSHA 56
carbon disulfide	75-15-0	46	359	76.13	1.4E-02	✓	✓	✓ NIOSH 1600
carbon tetrachloride (tetrachloromethane)	56-23-5	76.8	115	153.82	2.8E-02	✓	✓	✓ NIOSH 1003
chlorine	7782-50-5	-34.04	5854	70.91	1.2E-02	X	X	✓ OSHA ID101; NIOSH 6011
chlorobenzene (monochlorobenzene)	108-90-7	131.7	12	112.56	3.1E-03	✓	✓	✓ NIOSH 1003
4-chlorobenzotrifluoride	98-56-6	138.5	7.63	180.56	3.5E-02	✓*	✓	✓ NIOSH 1026
2-chloro-1,3-butadiene	126-99-6	59.4	215	88.54	5.6E-02	✓*	✓	✓ NIOSH 1002; OSHA 07
1-chlorobutane	109-69-3	78.6	101	92.57	1.7E-02	✓*	✓	✓ NIOSH 1003 (VR)
1-chloro-1,1-difluoroethane (HCFC-142b)	75-68-3	-9.7	2540	100.5	5.9E-02	✓*	✓	✓ NIOSH 1026
chlorodifluoromethane	75-45-6	-40.7	7250	86.47	4.1E-02	✓	✓	✓ NIOSH 1018, 1026
chloroethane (ethyl chloride)	75-00-3	12.3	1010	64.52	1.1E-02	✓	✓	✓ NIOSH 2519
chloroform (trichloromethane)	67-66-3	61.1	197	119.38	3.7E-03	✓	✓	✓ NIOSH 1003
chloromethane (methyl chloride)	74-87-3	-24	4300	50.49	8.8E-03	✓	✓	✓ NIOSH 1001
2-chlorophenol	95-57-8	174.9	2.53	128.56	1.1E-05	VR*	✓	✓ NIOSH 2014
2-chloropropane	75-29-6	35.7	515	78.54	1.7E-02	✓*	✓	✓ NIOSH 1003 (VR)
3-chloropropene (allyl chloride)	107-05-1	45.1	368	76.53	1.1E-02	✓*	✓	✓ NIOSH 1000, 1002; OSHA 07
2-chlorotoluene	95-49-8	159	3.43	126.59	3.6E-03	✓*	✓	✓ NIOSH 1003 (VR)
crotonaldehyde	123-73-9	104	30	70.09	1.9E-05	VR*	✓	✓ EPA TO11; NIOSH 2539

cyanogen	460-19-5	-21.1	4300	52.04	5.3E-03	VR*	✓	✓ OSHA PV2104
cyanogen bromide	506-68-3	61.5	122	105.92	n/a	VR*	✓	
cyanogen chloride	506-77-4	13	1230	61.47	1.9E-03	VR*	✓	✓ OSHA CSI
n-decane	124-18-5	174.1	1.32	142.29	4.7E+00	✓	✓	✓ NIOSH 1500
1,4-dibromobenzene	106-37-6	220	0.0575	235.91	3.7E-02	✓	✓	✓ NIOSH 1003 (VR)
1,2-dibromoethane (ethylene dibromide) (EDB)	106-93-4	131.6	11.2	187.86	6.7E-04	✓	✓	✓ NIOSH 1008
dibromochloromethane (DBCM)	124-48-1	120	15.6	208.28	3.2E-02	✓	✓	✓ NIOSH 1003 (VR)
1,2-dibromo-3-chloropropane (DBCP)	96-12-8	196	0.58	236.33	6.0E-03	✓*	✓	✓ OSHA CSI, NIOSH 1003 (VR)
dibromomethane (methylene bromide)	74-95-3	97	44.4	173.84	8.2E-04	✓*	✓	✓ OSHA PV2098
1,2-dichlorobenzene	95-50-1	180	1.47	147	7.9E-02	✓	✓	✓ NIOSH 1003
1,3-dichlorobenzene	541-73-1	173	2.15	147	2.6E-03	✓	✓	✓ NIOSH 1003
1,4-dichlorobenzene	106-46-7	174	1.74	147	2.4E-03	✓	✓	✓ NIOSH 1003
1,4-dichloro-2-butene, cis + trans	7364-41-0	152.5	4.09	125	8.5E-03	✓*	✓	✓ NIOSH 1003 (VR)
dichlorodifluoromethane (freon 12)	75-71-8	-29.8	4850	120.91	3.4E-01	✓	✓	✓ NIOSH 2516
1,1-dichloroethane	75-34-3	57.4	227	98.96	5.6E-03	✓	✓	✓ NIOSH 1003
1,2-dichloroethane	107-06-2	83.5	78.9	98.96	1.2E-03	✓	✓	✓ NIOSH 1003
1,1-dichloroethene (1,1-dichloroethylene)	75-35-4	31.6	634	96.94	2.6E-02	✓	✓	✓ NIOSH 1003
1,2-dichloroethylene, cis (1,2-dichloroethene, cis)	156-59-2	55	201	96.94	4.1E-03	✓	✓	✓ NIOSH 1003
1,2-dichloroethylene, trans (1,2-dichloroethene, trans)	156-60-5	55	201	96.94	9.4E-03	✓	✓	✓ NIOSH 1003
1,2-dichloropropane (propylene dichloride)	78-87-5	95.5	53.3	112.99	2.8E-03	✓	✓	✓ NIOSH 1013
1,3-dichloropropane	142-28-9	120.9	18.2	112.99	9.8E-04	✓*	✓	✓ NIOSH 1013
1,3-dichloropropene	542-75-6	112	34	110.97	3.5E-03	✓	✓	✓ NIOSH 1013
dicyclopentadiene	77-73-6	170	2.29	132.21	6.3E-02	✓*	✓	✓ OSHA PV 2098
diethyl ether (ethyl ether)	60-29-7	34.5	538	74.12	1.2E-03	✓	✓	✓ NIOSH 1610
diisopropyl methylphosphonate (DIMP)	1445-75-6	209.75	0.277	180.19	4.4E-05	VR*	✓	✓ NIOSH 5600
dimethylamine	124-40-3	6.9	1520	45.08	9.1E-05	VR	✓	✓ NIOSH 2010; OSHA 41
n,n-dimethylaniline	121-69-7	193.45	0.7	121.18	5.7E-05	VR*	✓	✓ NIOSH 2002; OSHA 07/ PV2064;
epichlorohydrin (chloromethyl-ethylene oxide)	106-89-8	117	16.4	92.53	3.0E-05	✓	✓	✓ NIOSH 1010
1,2-epoxybutane	106-88-7	63.3	180	72.11	1.8E-04	VR*	✓	✓ NIOSH 3800
ethyl acetate	141-78-6	77.1	93.2	88.11	1.3E-04	✓	✓	✓ NIOSH 1450, 1457
ethyl acrylate	140-88-5	99.4	38.6	100.12	3.4E-04	✓*	✓	✓ NIOSH 1450, 1457; OSHA 92
ethylbenzene	100-41-4	136.1	9.6	106.17	7.9E-03	✓	✓	✓ NIOSH 1501
ethyl methacrylate (ethyl 2-methyl-2-propenoate)	97-63-2	117	20.6	114.15	5.7E-04	VR	✓	✓ NIOSH 2537
ethylene oxide	75-21-8	10.6	1310	44.05	1.5E-04	✓	✓	✓ OSHA 50; NIOSH 1614
furan	110-00-9	31.5	600	68.08	5.4E-03	✓*	✓	✓ NIOSH 1613; EPA TO9
1,3-hexachlorobutadiene	87-68-3	215	0.22	260.76	4.2E-01	✓	✓	✓ NIOSH 2543
hexachlorocyclopentadiene	77-47-4	239	0.06	272.77	1.1E+00	✓	✓	✓ NIOSH 2518, 2543, 2549
hexachloroethane	67-72-1	154.45	0.21	236.74	1.6E-01	✓	✓	✓ NIOSH 1003
hexane (n-)	110-54-3	68.7	151	86.18	1.8E+00	✓	✓	✓ NIOSH 1500
hydrogen cyanide (cyanide)	74-90-8	25.7	741.9	27.03	1.3E-04	X	X	✓ NIOSH 6010, 6017, 7904, S288

isopropylbenzene (cumene)	98-82-8	152.4	4.5	120.2	1.1E-02	✓*	✓	✓ NIOSH 1501
methacrylonitrile (2-methylprop-2-enenitrile)	126-98-7	90.3	71.2	67.09	2.5E-04	✓*	✓	✓ NIOSH 1604; OSHA 37
methyl acetate	79-20-9	92	216	74.08	1.1E-04	✓	✓	✓ NIOSH 1450, 1457, 1458
methyl acrylate	96-33-3	80.2	86.6	86.09	2.0E-04	✓	✓	✓ NIOSH 1457, 1459, 2552, 2537; OSHA 92
methylcyclohexane	108-87-2	100.9	46	98.19	4.3E-01	✓	✓	✓ NIOSH 1500
methylene chloride (dichloromethane)	75-09-2	40	435	84.93	3.3E-03	✓	✓	✓ NIOSH 1005
methyl ethyl ketone (2-butanone)	78-93-3	79.5	90.6	72.11	5.7E-05	✓	✓	✓ NIOSH 1300, 2500, 2555; OSHA 84
methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1	116.5	19.9	100.16	1.4E-04	✓	✓	✓ NIOSH 1300, 2555; OSHA 84
methyl mercaptan (methanethiol)	74-93-1	5.9	1510	48.1	3.1E-03	✓	✓	✓ NIOSH 2542
methyl methacrylate	80-62-6	100.5	38.5	100.12	3.4E-04	✓	✓	✓ NIOSH 2537
a-methylstyrene (1-methyl-1-phenylethylene)	98-83-9	165.4	1.9	118.18	2.5E-03	✓*	✓	✓ NIOSH 1501
methyl styrene, m+p (vinyl toluene, m+p)	25013-15-4	165.4	1.5	118.18	7.9E-03	✓*	✓	✓ NIOSH 1501
methyl tertbutyl ether (MTBE)	1634-04-4	55.2	250	88.15	5.9E-04	✓	✓	✓ NIOSH 1615
naphthalene	91-20-3	217.9	0.085	128.18	4.4E-04	VR	✓	✓ NIOSH 1501, 5515
nitrobenzene	98-95-3	210.8	0.245	123.11	2.4E-05	✓	✓	✓ NIOSH 2005
2-nitrotoluene	88-72-2	222	0.188	137.14	5.1E-04	VR	✓	✓ NIOSH 2005
phosphine	7803-51-2	-87.75	29300	34	2.4E-02	X	X	✓ NIOSH 6002
propylene oxide	75-56-9	35	538	58.08	7.0E-05	✓	✓	✓ NIOSH 1612
pyridine	110-86-1	115.2	20.6	79.1	1.1E-05	VR	✓	✓ NIOSH 1613
styrene	100-42-5	145	6.4	104.15	2.7E-03	✓	✓	✓ OSHA 89
1,1,1,2-tetrachloroethane	630-20-6	130.5	12	167.85	2.4E-03	✓	✓	✓ NIOSH 1019 (VR)
1,1,2,2-tetrachloroethane	79-34-5	156.5	13.3	167.85	3.7E-04	✓	✓	✓ NIOSH 1019
tetrachloroethylene (PCE) (PERC)	127-18-4	121.3	18.5	165.83	1.8E-02	✓	✓	✓ NIOSH 1003
tetrahydrofuran	109-99-9	66	162	72.11	7.1E-05	✓*	✓	✓ NIOSH 1609
toluene	108-88-3	110.6	28.4	92.14	6.6E-03	✓	✓	✓ NIOSH 1501, 1500, 4000
1,2,4-trichlorobenzene	120-82-1	213.5	0.46	181.45	5.8E-02	✓	✓	✓ NIOSH 5517
1,1,1-trichloroethane	71-55-6	74	124	133.41	1.7E-02	✓	✓	✓ NIOSH 1003
1,1,2-trichloroethane	79-00-5	113.8	23	133.41	8.2E-04	✓	✓	✓ NIOSH 1003
trichloroethylene (TCE)	79-01-6	87.2	69	131.39	9.9E-03	✓	✓	✓ NIOSH 1003, 1022
1,2,2-trichloro-1,2,2-trifluoroethane (freon 113)	76-13-1	47.7	363	187.4	2.2E+01	✓	✓	✓ NIOSH 1020
trichlorofluoromethane (freon 11)	75-69-4	23.7	803	137.37	9.7E-02	✓	✓	✓ NIOSH 1006
1,1,2-trichloropropane	598-77-6	132	3.1	147.43	3.2E-04	✓*	✓	✓ NIOSH 1003
1,2,3-trichloropropane	96-18-4	157	3.69	147.43	3.4E-04	✓*	✓	✓ NIOSH 1003
1,2,3-trichloropropene	96-19-5	142	4.4	145.42	1.8E-02	✓*	✓	✓ NIOSH 1003 (VR)
a,a,a-trichlorotoluene (benzotrichloride)	98-07-7	220.6	0.414	195.48	0.0106	✓*	✓	✓ OSHA ID 216SG
triethylamine	121-44-8	89	57.1	101.19	1.5E-04	VR	✓	✓ OSHA PV2060; NIOSH 2010
1,2,4-trimethylbenzene	95-63-6	169.3	2.1	120.2	6.2E-03	✓	✓	✓ NIOSH 1501
1,3,5-trimethylbenzene	108-67-8	164.7	2.1	120.2	8.8E-03	✓	✓	✓ NIOSH 1501
vinyl acetate (ethenyl acetate)	108-05-4	72.5	90.2	86.09	5.1E-04	✓	✓	✓ NIOSH 1453
vinyl bromide (bromoethene)	593-60-2	15.8	1030	106.95	1.2E-02	✓	✓	✓ NIOSH 1009

vinyl chloride (chloroethene)	75-01-4	-13.3	2980	62.5	2.8E-02	✓	✓	✓ NIOSH 1003, 1007
VPHv	n/a	n/a	n/a	n/a	n/a	✓	✓	✓ NIOSH 1500, 1501, 1550 (tentative)
xylenes (o-xylene + m,p-xylenes)	1330-20-7	138.5	7.99	106.17	6.6E-03	✓	✓	✓ NIOSH 1501

Key:

✓ Technique is appropriate for this substance

X Technique is not appropriate for this substance

VR Validation Required (technique may be appropriate for this substance)

* Gas phase standards may not be commercially available, but may be prepared by the laboratory

** Refer to specific method indicated

Note: Not all techniques will be sufficiently sensitive to meet in all circumstances, the most stringent ACC/Schedule 11 numerical vapour standards.

Appendix - Table 4: Recommended Detection Limit Adjusted Vapour Standards for Substances with known analytical DL Issues

Parameter	Lowest Draft Schedule 11 Standard (ug/m^3)	Recommended Minimum Standard ug/m^3	Most Sensitive Method
1,1,2,2-tetrachloroethane	0.15	1	TO15 or TO17
1,1-dichloroethene (1,1-dichloroethylene)	0.2	1	TO15 or TO17
1,3-hexachlorobutadiene	0.5	2	TO15 or TO17
1,4-dichloro-2-butene (trans + cis)	0.004	0.4	TO15 or TO17 (SIM if required)
a,a,a-trichlorotoluene (benzotrichloride)	0.002	0.2	TO15 or TO17 (SIM if required)
acrolein (2-propenal)	0.02	2	TO15 or TO17
acrylonitrile (2-propenenitrile)	0.15	1.5	TO15 or TO17
bis(2-chloroethyl)ether	0.03	2	TO17
bis(chloromethyl) ether	0.0002	1	OSHA 10 (GC-ECD, 50L)
bromodichloromethane	0.7	1	TO15 or TO17
bromoethene (vinyl bromide)	0.3	1	TO15 or TO17
chlorine	0.2	20	OSHA ID101 / NIOSH 6011
chloroform (trichloromethane)	0.45	1	TO15 or TO17
crotonaldehyde	0.015	1.5	TO17
dimethylamine	0.015	200	TO17
ethylene dibromide (1,2 dibromoethane)	0.015	1	TO15 or TO17
ethylene oxide	0.1	10	TO15 or TO17
hexachlorocyclopentadiene	0.2	2	TO15 or TO17
methacrylonitrile (2-methylprop-enenitrile)	0.7	10	TO15 or TO17
phosphine	0.3	10	NIOSH 6002
trichloroethylene (TCE)	0.1	0.5	TO15 or TO17 (SIM if required)