

4.0 SELECTION OF CHEMICALS OF CONCERN

Chemicals of Concern (COC) were selected from the 186 chemicals estimated to be potentially emitted from the ABTP. The same COCs were used for modelling in all the 4 scenarios but were not necessarily common to all 4 scenarios. The selection process was based on the following steps:

- I. Rank chemical species
 - a) Method 1a – Rank chemicals based on calculated Toxic Equivalents for carcinogenic effects
 - b) Method 1b - Rank chemicals based on calculated Toxic Equivalents for non-carcinogenic effects
 - c) Method 2 - Rank chemicals based on their toxicity, emissions, persistence, and bioaccumulation
- II. Compare the top 25 chemicals from each method/scenario combination.
- III. Identify chemicals that occur most frequently in the top 25 ranking chemicals in each method/scenario combination
- IV. Identify chemicals which were found to be above laboratory detection limits.
- V. Select chemicals which are important to the communities

The above process allows for a pragmatic scientific means of selecting chemicals but also considers the community's concerns for what can be released. The ranking was carried out independently for each scenario and each method.

4.1 SHORT LISTING CHEMICALS

Prioritization of chemicals was based on two different methods. The first method is a risk-based scoring system used by the Environmental Defence Fund (EDF, 2003) to identify environmental releases of chemicals that are likely to pose the greatest risk to human health. This system was developed by Drs. Edgar Hertwich and William Pease (1998, 2001), in collaboration with colleagues at the School of Public Health at the University of California at Berkeley. This system adjusts the amount of a chemical that is released using a weighting factor (a chemical's "toxic equivalency potential" or TEP), so that chemical releases can be compared on a common scale that takes into account differences in toxicity and exposure potential. This scoring system ranks carcinogens and non-carcinogens separately – Methods 1a and 1b, respectively. The amount of information required to derive TEPs may not be readily available for some chemicals. As a result, EDF has not derived TEPs for these chemicals although some of these chemicals are known to have high toxicity.

EDF has chosen benzene as the reference chemical for cancer effects because its cancer potency is in the middle of the range of carcinogenic chemicals and the general public is familiar with the chemical name "benzene". Total emissions of each chemical were converted to the amount of benzene-equivalents, which represent the amount of benzene that would have to be released into the air to pose the same

approximate level of cancer risk as the reported release of the chemical. Chemicals were ranked based on their benzene-equivalent values (or toxic equivalents for carcinogenic effects).

In the case of non-cancer effects, EDF has chosen toluene as the reference chemical. Emissions of noncarcinogens were converted to the amount of toluene-equivalents, which represent the amount of toluene that would have to be released into the air to pose the same level of non-cancer health risk as the reported release of the chemical. Non-carcinogens were ranked based on their toluene-equivalent values (or toxic equivalents for non-carcinogenic effects).

The second method ranks chemicals using four different criteria:

- toxicity,
- emissions,
- persistence, and
- bioaccumulation.

This method relies only on total emissions information and does not take into account other factors that affect the potential for human exposure, such as degradation of the chemical, dispersion of the emission and whether a pathway for exposure can be established. Detailed descriptions of both chemical ranking methods are provided in Appendix C.

The short listing of the chemicals resulted in 76 unique chemicals being identified over the 4 scenarios. It was evident that particular chemicals were consistently among the top ranking chemical species in all the scenarios no matter which ranking method was used. The number of chemicals was subsequently reduced to those which frequently occurred and had a higher potential health impact. Appendix C presents the 30 top ranking chemicals for each scenario identified using different prioritization methods. These lists are presented alphabetically as well as by the frequency of occurrence.

In reviewing these different chemicals, it is apparent that a significant number of chemicals were questionable. Many of the chemicals that had high ranking in all four scenarios were the result of air emission testing or water sampling and were found to be below the analytical detection limit. Laboratory analyses were carried out for a suite of compounds whether they were suspected to be present or not. In developing the emission inventory, chemicals below the detection limit were assigned the detect limit. This method of managing non-detected chemicals is very conservative but avoids biasing the results early in the process. It is highly unlikely that chemicals below the detection limit are actually present. This aspect was taken into consideration in the selection of the final COCs, which are above the detection limit with one exception.

4.2 SELECTION OF FINAL CHEMICALS OF CONCERN

The initial 186 chemicals were screened using objective and transparent means to identify potential COCs for air dispersion modelling. It was agreed that a select number of chemicals were to be included even though they may or may not be in the top 25, namely

- Criteria Air Contaminants (SO₂, NO_x, PM_{2.5});
- Hydrogen Sulphide;
- PCB (congeners with 4 or more chlorine substitution groups or Cl ≥ 4);
- Benzene
- Dioxins and Furans; and
- PAH's

Table 4-1 presents the COCs selected for air dispersion modelling, their individual ranks by each method used and whether the substance was detected or not.

The criteria air chemicals were included because SO₂ and NO_x have been identified as precursors to respirable particulate matter (i.e., PM_{2.5}) as ammonium sulphate and ammonium nitrate, respectively. Respirable particulate matter has been classified as Toxic under the Canadian Environmental Protection Act (CEPA). In addition, the ABTP combustion sources (i.e., boilers, flares, etc) directly release fine particulate. Since PM_{2.5} has been given a high profile, it has been included in the COCs.

Hydrogen sulphide is released in the greatest quantity from the facility; therefore it was prudent to include it in the analysis. PCBs, Dioxins and Furans were included because they were detected in the emissions (i.e., air testing or water) and are highly visible to the public. Although both substances were detected and were among the 25 top-ranking chemicals, benzene was chosen over tetrachloroethene since the public is more familiar with the chemical name "benzene" and its potential toxic effects. Benzene is classified as a human carcinogen by all credible international agencies (Health Canada, 1996; USEPA, 1998a; IARC, 1987). On the other hand, there is no consensus on the evaluation of carcinogenicity for tetrachloroethene, which ranges from "unlikely to be carcinogenic to humans" by Health Canada (1996) to "probably carcinogenic to humans" by International Agency for Research on Cancer (1995).

Polycyclic Aromatic Hydrocarbons (PAH) were found consistently at the top of virtually each chemical list sorted by whichever ranking method but review of the data indicated that PAHs, including benzo[a]pyrene (B[a]P) were below the analytical detection limits. It was decided to include total PAHs as well as B[a]P in the COC list because PAHs are products of incomplete burning, likely generated during incineration and B[a]P is the most toxic among the PAHs. Although each individual PAH may be below the detection limit, there are hundreds of PAHs emitted at the same time.

A significant portion of the PAH emission inventory was derived from the mass balance technique used on the wastewater entering and exiting the ABTP. It was assumed that the PAHs would be volatilized into the atmosphere at the open area sources, such as the Primary Clarifiers. This assumption is highly conservative since PAHs have a low vapour pressure and are not akin to volatilizing into the atmosphere.

Both the scientific literature and measurements at the plant provide supporting evidence for these characteristics for B[a]P and other PAHs. Because of low aqueous solubility and high K_{ow} , a larger fraction of the chemical tends to be adsorbed onto particles and dissolved organic matter in the water column rather than being volatilized (Awata H et al. 1998). The overall losses to the atmosphere have been found to be less than 1% (0.1 - 0.9%) in the field (Awata H et al. 1998; Fairey and Loehr, 2003). Also, the concentration of B[a]P in both the influent and effluent of the treatment plant in 2000 and 2001 were the same (0.5 $\mu\text{g/L}$), indicating that very little B[a]P volatilized into the atmosphere. These findings suggest that assuming 100% volatilization for B[a]P (and other PAHs) overestimates the total emission of B[a]P (and other PAHs) by at least two orders of magnitude.

Table 4-1 Final List of Chemicals of Concern and their Rankings

	Chemical	CAS	Ranking												Comments
			Scenario 1			Scenario 2			Scenario 3			Scenario 4			
			Method 1a	Method 1b	Method 2	Method 1a	Method 1b	Method 2	Method 1a	Method 1b	Method 2	Method 1a	Method 1b	Method 2	
1	Arsenic	7440-38-2	10	15	6	6	9	4	6	9	4				Detect
2	Benzene	71-43-2	20			24			15			14			Detect
3	Benzo[a]Pyrene	50-32-8													ND
4	Bis(2-ethylhexyl)phthalate	117-81-7		16	13		22	17	21	11	7	21	11	7	Detect
5	Cadmium	7440-43-9	2	2	3	1	1	2							Detect
6	Di-n-octyl phthalate	117-84-0		5			6			1	10		1	10	Detect
7	Hexachlorobutadiene	87-68-3	7	8	9	8	7	9	5	3	5	5	3	5	Detect
8	Hydrogen Sulphide	6/4/7783													Detect
9	Lead	7439-92-1	23	3	16	10	3	11							Detect
10	Mercury	7439-97-6		1	12		2	7		8	21		9	20	Detect
11	Nitrogen Oxides	10102-44-0		11			14			10			8		Detect
12	PM _{2.5}	N/A-PM													Detect
13	PCB's (>=4 Cl)				10			8							Detect
14	Sulphur Dioxide	7446-09-5													Detect
15	Total Dioxins and Furans (as 2,3,7,8 TCDD eq)	1746-01-6		12		23	12								Detect
16	Total PAH's	50-32-8	1		1	2		1	1		1	1		1	ND
17	Vinyl chloride	75-01-4				7	11		20	18		19	17		Detect

Method 1a – Ranked chemicals based on their calculated Toxic Equivalents for carcinogenic effects
 Method 1b – Ranked chemicals based on their calculated Toxic Equivalents for non-carcinogenic effects
 Method 2 – Ranked chemicals based on their toxicity, emissions, persistence, and bioaccumulation
 Detect Above or at Laboratory Detection Limits
 ND Below Laboratory Detection Limits
 Scenario 1 incinerator in full operation (pre 1996)
 Scenario 2 incinerator in partial operation (2000-2002)
 Scenario 3 incineration discontinued (2003-2004)
 Scenario 4 incineration discontinued and odour control measures implemented.

The estimation technique used per COC is presented in . As illustrated, direct measurements (i.e., source testing and Zorix testing) represent a significant portion of the techniques applied (~63%), while the mass balance approach represents about 27% of the cases. Generally, we should have a high degree of confidence in the source testing data and lower confidence in the mass balance. As discussed above, in the mass balance technique, 100% of the material has been assumed to volatilize into the atmosphere even though it has a low vapour pressure and/or low fugacity.

Table 4-3 Calculation Methodology for Chemicals of Concern

	<i>Chemical</i>	<i>% of Calculation Methodology</i>				
		<i>Mass Balance</i>	<i>Source Tested by Zorix</i>	<i>Engineering Estimate</i>	<i>Emission Factor</i>	<i>Source Tested</i>
1	Arsenic	-	-	-	-	100%
2	Benzene	8%	92%	-	-	-
3	Benzo[a]pyrene	80%	-	-	-	20%
4	Bis(2-ethylhexyl)phthalate	100%	-	-	-	-
5	Cadmium	-	-	-	-	100%
6	Di-n-octyl phthalate	100%	-	-	-	-
7	Total Dioxins and Furans (as 2,3,7,8 TCDD eq)					100%
8	Hexachlorobutadiene	8%	92%	-	-	-
9	Hydrogen Sulphide	-	97%	3%	-	-
10	Lead	-	-	-	-	100%
11	Mercury	80%	-	-	-	20%
12	Nitrogen Oxides	-	-	-	100%	-
13	Total PAH's	68%	-	-	-	32%
14	Particulate Matter	-	-	-	67%	33%
15	PCB's					100%
16	Sulphur Dioxide	-	97%	-	3%	-
17	Vinyl chloride	11%	89%	-	-	-

The Ontario Ambient Air Quality Criteria (AAQC)/Point-of-Impingement (POI) standards for the COC's are presented in . The AAQCs and POI standards for many of the chemical compounds emitted at the ABTP, including arsenic, B[a]P, cadmium, hydrogen sulphide, mercury and vinyl chloride, have been identified by the Ministry as requiring regulatory review (MOE, 1999). For these species and others (e.g. benzene, hexachlorobutadiene, PCBs with 4 or more chlorine substitution groups) that MOE does not have AAQC/POI standards, an appropriate health benchmark needs to be identified for assessing air quality and health impact. In keeping with the standard development process used by the Ministry (MOE, 1998), the health benchmark¹ was selected from major regulatory agencies, including United States Environmental Protection Agency (USEPA), Health Canada, World Health Organization and California

¹ Health benchmark for air exposure refers to guideline value (GV) by World Health Organization, Reference Concentration (RfC) by USEPA and California EPA, Tolerable Concentration (TC) by Health Canada for noncarcinogenic effects and concentration corresponding to an excess lifetime cancer risk of 1 E-6 (one in a million) for carcinogenic effects.

Environmental Protection Agency after a review of their scientific basis. The goal is to select a published health benchmark applicable to our study objective and one that is associated with the least level of uncertainty based on current knowledge and understanding about the substance and risk assessment methods. Only health benchmarks that have gone through a thorough scientific peer review were being considered. The selection was conducted on a chemical-by-chemical basis. The health benchmarks adopted by TPH for the COCs are also presented in where appropriate. The 24-hr health benchmarks adopted are typically three orders of magnitude below the 24 hr AAQC. Note that a range in limits is given for H₂S, as there are large variations in data.

Table 4-4 Comparison of Ontario AAQC/POI with Air Quality Health Benchmarks

	Chemical	CAS No.	Ambient Air Quality Criteria/POI (µg/m ³)				Health benchmark (µg/m ³)
			<i>POI</i> (1/2 hr)	<i>AAQC</i> (1 hr)	<i>AAQC</i> (24 hr)	<i>AAQC</i> (1 yr)	(24 hr)
1	Arsenic	7440-38-2	1		0.3		0.00066 ^d
2	Benzene	71-43-2					0.3 ^d
3	Benzo[a]pyrene ^a	50-32-8	0.0033 ^b		0.0011 ^b	0.00022 ^b	0.000012 ^{c, d}
4	Bis(2-ethylhexyl)phthalate	117-81-7	100		50		
5	Cadmium ^a	7440-43-9	5		2		0.0006 ^d
6	Di-n-octyl phthalate	117-84-0	100		120		
7	Hexachlorobutadiene	87-68-3					1.19
8	Hydrogen Sulphide ^a	7783-06-4	30	30			2-10
9	Lead	7439-92-1	6		2		
10	Mercury ^a	7439-97-6	5		2.5		0.3
11	Nitrogen Oxides	10102-44-0	500	400	200		
12	PM _{2.5}				30		30
13	PCBs with 4 or More Cl (total) ^a						0.00175 ^d
14	Sulphur Dioxide	7446-09-5	830	690	275	55	
15	Total Dioxins and Furans (as 2,3,7,8-TCDD eq)		15.0E-06		5.0E-06		
16	Total PAHs						
17	Vinyl Chloride ^a	75-01-4	3		1		0.1 ^d

Health Benchmarks provided by TPH

- ^a - These chemical species have been identified by MOE for regulatory review of their AAQCs (24 hr) and POI (1/2 hr) standards.
- ^b - Based on B[a]P only.
- ^c - Based on B[a]P as a surrogate for the toxicity of the whole PAH mixture. The risk from exposure to total PAHs in the air would be negligible if B[a]P level is found to be below this health benchmark for B[a]P.
- ^d - The health benchmark corresponds to an excess lifetime cancer risk of one in a million (or 1E-06), which meets Health Canada and MOE benchmark of negligible risk.

Table 4-4 Final Emission Rates Used for Modelling Scenarios

	Chemical	Total Emission Rate (g/s)			
		<i>Scenario #1</i>	<i>Scenario #2</i>	<i>Scenario #3</i>	<i>Scenario #4</i>
1	Arsenic	0.00010	0.00031	-	-
2	Benzene	0.076	0.022	0.020	0.0078
3	Benzo(a)pyrene	0.016	0.004	0.0041	0.0016
4	Bis(2-ethylhexyl)phthalate	0.20	0.04	0.089	0.036
5	Cadmium	0.0021	0.0028	-	-
6	Di-n-octyl phthalate	0.0073	0.0016	0.015	0.006
7	Hexachlorobutadiene	0.015	0.009	0.0090	0.0041
8	Hydrogen Sulphide	1.5	1.5	1.5	0.1
9	Lead	0.0023	0.0064	-	-
10	Mercury	0.0012	0.0045	5.7E-07	2.3E-07
11	Nitrogen Oxides	6.3	5.7	1.9	1.9
12	PM _{2.5} *	0.52	0.65	0.079	0.079
13	PCBs Greater or Equal to 4 Chlorines	0.000013	0.000014	-	-
14	Total Dioxins and Furans (as 2,3,7,8- TCDD eq).	1.07E-09	3.58E-10	-	-
15	Sulphur Dioxide	0.95	1.6	0.34	0.11
16	Total PAHs	1.2	1.2	0.089	0.034
17	Vinyl Chloride	0.018	0.020	0.0065	0.0030

*Direct particulate emissions only

- Scenario 1 incinerator in full operation (pre 1996)
- Scenario 2 incinerator in partial operation (2000-2002)
- Scenario 3 incineration discontinued (2003-2004)
- Scenario 4 incineration discontinued and odour control measures implemented.