6. Environmental exposure

This section discusses Toronto residents' exposure to the selected contaminants by different environmental pathways. The following subsections describe the sources of environmental contaminants, routes by which people are exposed to these sources and finally the environmental levels of the contaminants.

6.1. Sources of emissions

Many of the contaminants on the selected list are found naturally, usually at low concentrations in the environment. For example, this is the case for metals, asbestos and PAHs. Toronto is geographically a small area and contaminants considered in this report are either gases (benzene, 1,3-butadiene) or are often bound to fine particles (most carcinogenic PAHs, metals). In either form, these contaminants can travel in the air hundreds or even thousands of kilometers before they settle to the ground by gravity or before they are deposited on the ground by rain or snow. Cross boundary transport is therefore a significant source of Toronto contaminants. This report focuses on man-made sources only.

6.1.1. Summary and ranking of sources

An attempt was made to rank the ten substances of interest based on the total release to the environment and the level of health impact on the population. This exercise helps the City of Toronto to identify those among the ten substances released to the environment that have the biggest impact on the health of its population. It will help the City to direct its resources to better reduce the cancer risk experienced by its population.

Since no Toronto-specific emission inventory is available, the USEPA's Toxic Release Inventory (TRI) was used in the exercise. The results provide a checklist of key potential contaminants of concern the City needs to include for the purpose of identifying emission sources and quantities in Toronto.

6.1.1.1. Ranking by emission levels

It was not possible to obtain realistic estimates for releases of selected contaminants within the City of Toronto. Environment Canada's (2001a) National Pollutant Release Inventory (NPRI) and USEPA's (2001)Toxic Release Inventory (TRI) both focus on large point sources. This will also be true for the recently announced Ontario Mandatory Monitoring and Reporting initiative (http://www.ene.gov.on.ca/envision/news/0080mb.htm). Toronto is affected primarily by emissions from mobile sources such as cars and trucks, area sources such as residential heating, and small but numerous point sources such as dry cleaning operations. ToxProbe attempted to use TRI data to estimate emission rates in Toronto by adjusting the US annual emission rates by the relative size of the relevant industrial sectors in Toronto and the USA. This process is similar to the CAREX process for occupational exposures. The outcome did not appear to be reasonable and the results of this assessment were discarded and are not reported here. ToxProbe was unable to find a shortcut, which could at least in part replace a Toronto emissions inventory. It is understood that the City is developing such an inventory and ToxProbe strongly supports this initiative. ToxProbe recommends however, that unlike the inventories being developed by the USA and senior Canadian governments, the City focus it's efforts on the small but numerous sources located in the midst of its community. These sources, although small individually, can be numerous in Toronto. Furthermore, their proximity to a large population means that they may have a greater impact on health that might be expected given their size.

This report provides the ranking results generated by the Environmental Defence Fund (EDF) based on the TRI emissions data. TRI collects a wider range of data than NPRI, and thus at present the TRI data were given preference to the NPRI data set. The ranking prepared by EDF is not directly applicable to the Toronto situation. Many sources, which dominate TRI are not present in Toronto. On the other hand, many sources relevant to Toronto are not covered. Nevertheless, the EDF ranking identifies important sources of contaminant emissions and this information should be taken into consideration when trying to identify emissions of potential concern in Toronto.

The ranking results presented in tables 6.1.1.1 to 6.1.1.3 are obtained from the Environmental Defence Fund's (EDF) *Scorecard* (http://www.scorecard.org/chemical-profiles/), which provides ranking of industrial sources as they are reported in the USEPA's 1998 Toxics Release Inventory (TRI) database (http://www.epa.gov/tri/).

TRI does not cover the following sources.

- Motor vehicles,
- Service businesses like dry cleaners or auto service stations,
- Sewage treatment plants,
- Hospitals,
- Airports,
- Agricultural application of pesticides,
- Releases from contaminated sites like landfills or abandoned industrial facilities (such as Superfund or "brownfields" sites).

These sources are therefore not covered in the Scorecard. However, mobile, residential, commercial and small industrial sources may be very important sources of emissions impacting on Toronto. Toronto does not have many large point sources of contaminants, but its high traffic density and residential density make the area sources more important. This disparity needs to be kept in mind and judgement needs to be exercised when extrapolating the USA situation to Toronto. On the other hand, it is useful to include this information, since Toronto does not have an emissions inventory and some of the sources and sectors reported may be present in Toronto.

Table 6.1.1.1 Total pounds released in the USA in 1998 (TRI, 1998 data)

Rank	Chemical Name	Pounds
14.	Chromium compounds	89,399,517
31.	Formaldehyde	23,690,003
38.	Chromium	16,198,713
41.	Asbestos (friable)	14,140,786
43.	Trichloroethylene	13,066,728
50.	Cadmium compounds	9,086,562
55.	Benzene	8,314,521
66.	Tetrachloroethylene	5,520,301
79.	1,3-butadiene	2,756,678
80.	Cadmium	2,451,587
89.	Polycyclic aromatic compounds	1,761,245

Table 6.1.1.2 pounds emitted into air in the USA in 1998 (TRI, 1998 data)

Rank	Chemical Name	Pounds
20.	Formaldehyde	13,387,351
21.	Trichloroethylene	13,064,458
29.	Benzene	7,667,403
34.	Tetrachloroethylene	5,490,057
42.	1,3-butadiene	2,739,114
53.	Polycyclic aromatic compounds	1,476,447
82.	Chromium compounds	645,072
89.	Chromium	480,535

Table 6.1.1.3 pounds emitted into water in the USA in 1998 (TRI, 1998 data)

Rank	Chemical Name	Pounds
15.	Formaldehyde	296,924
16.	Chromium compounds	218,146
42.	Chromium	37,228
57.	Benzene	19,346
71.	1,3-butadiene	8,834

6.1.1.2. *Human health-based ranking*

EDF uses a scoring system to help identify environmental releases of contaminants that are likely to pose the greatest risk to human health. The system adjusts the amount of a released contaminant by a weighting factor *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.

EDF uses benzene-equivalents to provide for a common denominator for comparing carcinogenic releases, taking into account variations in toxicity and exposure potential across chemicals. The units indicate the number of pounds of benzene that would have to be released into the air to pose the same approximate level of health risk as the reported release of a given contaminant (contaminant X). Benzene-equivalents are calculated by multiplying the reported releases of contaminant X to air or water by its media-specific toxic equivalency potential. Because chemicals undergo different environmental fate on release to air versus release to water (with subsequent differences in human exposure opportunities), this scoring system assigns the chemicals different air and water toxic equivalency potentials. To obtain a single common denominator of benzene-equivalents, water TEPs are normalized to air TEPs. Benzene was selected as a reference chemical for cancer TEPs because it has a potency value in the middle of the observed range of carcinogenic chemicals and it is a familiar chemical name to the general public. For non-cancer endpoints EDF uses toluene-equivalents, but otherwise the process is homologous to the one used for calculating cancer TEPs.

EDF's risk scoring system is based on Toxic Equivalency Potentials (TEPs), which are calculated using CalTOX (http://www.cwo.com/%7Eherd1/caltox.htm), an environmental fate and exposure model developed California Environmental Protection Agency (http://www.calepa.ca.gov). CalTOX utilizes the physical-chemical properties and the environmental media characteristics to predict the concentrations of the chemical in these media. CalTOX then estimates the total chemical dose people may receive from a release. CalTOX produces an estimate of the average daily dose that is associated with unit release of a chemical to air or to water in a model environment, expressed in milligrams of a chemical per kilogram of body weight.

In many cases, risk assessment values are available for only one of the three exposure routes CalTOX considers (ingestion, inhalation, and dermal contact). As a general rule, any available risk assessment value is applied to other routes of exposure lacking toxicity data , unless there is a clear toxicological rationale against making this assumption. This assumption of cross-route applicability is made to avoid treating chemicals as if they pose no health risk at all if exposures occur via a route that lacks data. On the other hand, potencies and even effects are often route-specific and this assumption, while justifiable for prioritizing purposes, may not be appropriate for other applications. Once CalTOX has produced estimates of the health risks posed by unit release of a chemical to air or water, these can be used to calculate TEPs for a chemical. TEPs are simply the ratio of the risk posed by a one-pound release of chemical X to the risk posed by a one-pound release of benzene or toluene. Separate TEPs are calculated for chemical releases to air and water. On the whole, the EDF's approach appears to be a well thought through approach for comparing the health impacts of different contaminants. Tables 6.1.1.2.1 and 6.1.1.2.2 contain the ranking of overall US environmental emissions according to their relative impact on human health. Note that the table entries are based on the emissions presented in the 1998 TRI database for USA. Many of the sources listed are not relevant to Toronto and some of the sources that likely have a significant impact in Toronto (area sources such as mobile, residential, commercial and small industrial) were not taken into account by TRI.

Table 6.1.1.2.1 Ranking by cancer risk scores as developed by EDF

Rank	Chemical Name	Pounds of Benzene-equivalents
4.	Chromium compounds	107,304,030
5.	Chromium	80,009,870
12.	Tetrachloroethylene	10,024,920
14.	Benzene	7,754,070
15.	Cadmium compounds	7,135,890
27.	1,3-butadiene	1,015,808
28.	Trichloroethylene	763,288
38.	Cadmium	285,516
53.	Formaldehyde	40,260

Table 6.1.1.2.2 Ranking by non-cancer risk score as developed by EDF

Rank	Chemical Name	Pounds of Toluene-equivalents
4.	Cadmium compounds	424,120,000,000
13.	Cadmium	17,171,700,000
23.	Chromium compounds	4,273,582,000
27.	Chromium	3,094,546,400
34.	Tetrachloroethylene	1,183,537,000
49.	Benzene	126,635,300
57.	Formaldehyde	63,917,200
82.	Trichloroethylene	12,865,890

6.1.2. Ambient air sources

This section summarizes the readily available information regarding the major sources of selected contaminants in the environment. One of the references consulted are the reports prepared by the USEPA, available at http://www.epa.gov/ttnchie1/le/ and titled *Locating and Estimating Air Toxic Emissions from Sources (source category or substance)*. These reports will be referred to here as L & E reports. Some of these reports are dated or do not include a summary of the relative magnitude of the sources. On the other hand, when available, they cover area sources, such as mobile and residential heating. The Environmental Defence Fund's *Scorecard* is another reference used. The limitations of the TRI-based approach used by the Scorecard have been discussed in section 6.1.1. Briefly, mobile, residential, commercial and small industrial sources are not usually covered in the TRI. On the other hand, the TRI data were available for 9 out of 10 contaminants considered in this report (Data were not available for dioxins and dibenzofurans).

Even if the quality of emissions data was perfect, it is important to realize that the amount emitted into the environment does not necessarily correlate with human health risk. This limitation is well illustrated (see in table 6.1.2.1) by Ott and Roberts (1998). Thus even though automobiles are by far the greatest source of benzene in the environment, automobiles contribute only moderately to total human benzene inhalation exposure. In contrast, cigarette smoking contributes little to the overall emissions of benzene, yet Ott and Roberts estimated that almost half of the inhaled benzene comes from cigarette smoke.

Table 6.1.2.1 Benzene emission levels *versus* contribution to total benzene inhalation exposure (%)

	Automobile	Industry	Individual Activities	Cigarettes
Emission levels	82	14	3	0.1
Contribution to exposure	18	3	34	45

From Ott and Roberts, Scientific American, February 1998, pp. 86-93.

Tables 6.1.2.2 to 6.1.2.13 provide estimates of emission levels for the chemicals considered as obtained for the L & E reports and from Scorecard website. These tables rank industrial sectors according to the total quantities of individual contaminants released into the air. Although US data were used, they help to identify sectors that may be the greatest contributors of particular contaminants. This serves as a checklist the City of Toronto can use as a guide in identifying key emission sources for the ten substances of interest.

Environment Canada (2001b) has released a quantitative inventory of environmental releases of dioxins and furans in Canada for the year 1999. The relative importance of various sources is slightly different in Ontario than the situation in the United States. In Ontario, medical waste incinerators are the most significant contributors of dioxins and furans accounting for 14 g TEQ per year. The next most important contributors are hazardous waste incinerators (7.4 g TEQ per year), followed by iron sintering (6 g TEQ per year) backyard barrel burning (5 g TEQ per year), steel manufacturing (3.66 g TEQ per year), diesel vehicle fuel combustion (3.11 g TEQ per year), base metal smelting (2.9 g TEQ per year), municipal waste incinerators (2.15 g TEQ per year), residential wood burning (0.84 g TEQ per year) and electrical power generation burning coal (0.69 g TEQ per year). Among these sources, hazardous incineration, iron sintering, backyard barrel burning and steel manufacturing may not be important for Toronto, however, diesel and wood burning may be of greater relevance.

Table 6.1.2.2 Asbestos emission levels (from TRI)

Rank	Industrial Sector	Pounds
1.	49: Electric, Gas, And Sanitary Services	13,527,639
2.	28: Chemicals And Allied Products	606,041
3.	32: Stone, Clay, And Glass Products	4,650
4.	37: Transportation Equipment	1,213
5.	26: Paper And Allied Products	758
6.	30: Rubber And Misc. Plastics Products	250
7.	29: Petroleum And Coal Products	235

Table 6.1.2.3 Major Emission sources of 1,3-butadiene in the US (L&E 1989)

Emission Sources	Emission %
Mobile sources	94.1
Other (mostly rubber production, chemical industry)	3.9

Table 6.1.2.4 1,3-butadiene emission levels (from TRI, excluding mobile sources)

Rank	Industrial Sector	Pounds
1.	28: Chemicals And Allied Products	2,521,757
2.	29: Petroleum And Coal Products	179,480
3.	37: Transportation Equipment	45,210
4.	38: Instruments and Related Products	7,667
5.	20: Food and Kindred Products	1,279
6.	51: Wholesale Trade--Nondurable Goods	953
7.	33: Primary Metal Industries	250
8.	49: Electric, Gas, and Sanitary Services	71
9.	NA: Not reported	11

Table 6.1.2.5 benzene emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	28: Chemicals And Allied Products	3,234,022
2.	29: Petroleum And Coal Products	2,996,376
3.	33: Primary Metal Industries	979,798
4.	51: Wholesale Trade—Nondurable Goods	350,097
5.	26: Paper And Allied Products	328,936
6.	49: Electric, Gas, And Sanitary Services	99,655
7.	37: Transportation Equipment	88,136
8.	36: Electronic & Other Electric Equipment	76,790
9.	20: Food And Kindred Products	65,000
10.	32: Stone, Clay, And Glass Products	51,461
11.	35: Industrial Machinery And Equipment	33,791
12.	NA: Not reported	4,313
13.	10: Metal Mining	2,203
14.	44: Water Transportation	1,865
15.	73: Business Services	786
16.	87: Engineering & Management Services	648
17.	13: Oil And Gas Extraction	284
18.	34: Fabricated Metal Products	95
19.	95: Environmental Quality And Housing	5
20.	24: Lumber And Wood Products	5

Table 6.1.2.6 Cadmium emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	49: Electric, Gas, And Sanitary Services	2,282,947
2.	33: Primary Metal Industries	160,848
3.	10: Metal Mining	7,394
4.	28: Chemicals And Allied Products	299
5.	36: Electronic & Other Electric Equipment	44
6.	32: Stone, Clay, And Glass Products	15
7.	37: Transportation Equipment	13
8.	34: Fabricated Metal Products	10
9.	29: Petroleum And Coal Products	10
10.	35: Industrial Machinery And Equipment	7

Table 6.1.2.7 Total chromium emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	10: Metal Mining	12,878,856
2.	49: Electric, Gas, And Sanitary Services	2,259,838
3.	33: Primary Metal Industries	610,282
4.	34: Fabricated Metal Products	227,986
5.	35: Industrial Machinery And Equipment	64,575
6.	32: Stone, Clay, And Glass Products	50,336
7.	37: Transportation Equipment	49,389
8.	NA: Not reported	28,186
9.	39: Miscellaneous Manufacturing Industries	16,216
10.	25: Furniture And Fixtures	2,855
11.	24: Lumber And Wood Products	2,821
12.	36: Electronic & Other Electric Equipment	2,148
13.	38: Instruments And Related Products	1,694
14.	50: Wholesale Trade--Durable Goods	755
15.	28: Chemicals And Allied Products	656
16.	31: Leather And Leather Products	521
17.	20: Food And Kindred Products	505
18.	30: Rubber And Misc. Plastics Products	293
19.	29: Petroleum And Coal Products	276
20.	51: Wholesale Trade--Nondurable Goods	255

Table 6.1.2.8 Major sources of dioxins & dibenzofurans (based on TEQ) in the US (L & E, 1997)

Emission Sources	Emission %
Municipal waste combustion	37.4
Residential coal combustion	10.9
Secondary aluminum smelters	8.8
Medical waste incineration	7.7
Utility coal combustion	7.0
Industrial wood combustion	5.2
On-road mobile sources	4.6
Forest fires	4.4
Portland cement with hazardous waste fired	3.0
Portland cement without hazardous waste fired	2.8
Wood treatment	1.8
Residential wood combustion	1.6
Sewage sludge incineration	1.2
Hazardous waste incineration	1.1
Utility residual oil combustion	0.5
Residential distillate fuel combustion	0.2
Other	1.8

Table 6.1.2.9 Formaldehyde emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	28: Chemicals And Allied Products	11,389,734
2.	24: Lumber And Wood Products	4,554,955
3.	26: Paper And Allied Products	2,393,005
4.	32: Stone, Clay, And Glass Products	2,073,233
5.	49: Electric, Gas, And Sanitary Services	1,950,565
6.	22: Textile Mill Products	413,676
7.	30: Rubber And Misc. Plastics Products	357,983
8.	29: Petroleum And Coal Products	152,319
9.	33: Primary Metal Industries	114,596
10.	37: Transportation Equipment	61,338
11.	34: Fabricated Metal Products	60,313
12.	25: Furniture And Fixtures	57,572
13.	36: Electronic & Other Electric Equipment	32,823
14.	35: Industrial Machinery And Equipment	31,998
15.	20: Food And Kindred Products	28,786
16.	23: Apparel And Other Textile Products	10,822
17.	38: Instruments And Related Products	4,951
18.	51: Wholesale Trade--Nondurable Goods	1,317
19.	73: Business Services	9
20.	NA: Not reported	8

Table 6.1.2.10 Major sources of PAHs (based on a total of 7 PAHs) in the US (L & E, 1998)

Emission Sources	Emission %
Open burning	43
Stationary external combustion	31
Metals industry	21
Coke production	2
Mobile sources	1
Waste incineration	0.1
Other	1.9

Table 6.1.2.11 *Total* PAHs emissions (From TRI)

Rank	Industrial Sector	Pounds
1.	33: Primary Metal Industries	1,448,740
2.	49: Electric, Gas, And Sanitary Services	116,249
3.	29: Petroleum And Coal Products	92,377
4.	34: Fabricated Metal Products	45,080
5.	36: Electronic & Other Electric Equipment	34,875
6.	28: Chemicals And Allied Products	22,972
7.	51: Wholesale Trade—Nondurable Goods	699
8.	20: Food And Kindred Products	250
9.	NA: Not reported	2
10.	44: Water Transportation	1

Table 6.1.2.12 Tetrachloroethylene emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	37: Transportation Equipment	1,216,939
2.	34: Fabricated Metal Products	1,082,785
3.	33: Primary Metal Industries	813,246
4.	36: Electronic & Other Electric Equipment	632,037
5.	35: Industrial Machinery And Equipment	520,215
6.	28: Chemicals And Allied Products	244,449
7.	30: Rubber And Misc. Plastics Products	211,354
8.	73: Business Services	191,995
9.	39: Miscellaneous Manufacturing Industries	89,210
10.	22: Textile Mill Products	83,943
11.	50: Wholesale Trade--Durable Goods	71,719
12.	24: Lumber And Wood Products	71,628
13.	29: Petroleum And Coal Products	71,387
14.	27: Printing And Publishing	67,633
15.	25: Furniture And Fixtures	44,200
16.	49: Electric, Gas, And Sanitary Services	26,696
17.	32: Stone, Clay, And Glass Products	22,204
18.	38: Instruments And Related Products	13,538
19.	31: Leather And Leather Products	9,670
20.	26: Paper And Allied Products	5,600
21.	51: Wholesale Trade--Nondurable Goods	5,103
22.	72: Personal Services	4,626
23.	44: Water Transportation	1,496
24.	NA: Not reported	118
25.	95: Environmental Quality And Housing	5

Table 6.1.2.13 Trichloroethylene emission levels (From TRI)

Rank	Industrial Sector	Pounds
1.	34: Fabricated Metal Products	4,822,841
2.	33: Primary Metal Industries	1,951,111
3.	37: Transportation Equipment	1,669,528
4.	35: Industrial Machinery And Equipment	1,235,170
5.	36: Electronic & Other Electric Equipment	796,798
6.	30: Rubber And Misc. Plastics Products	785,744
7.	22: Textile Mill Products	504,671
8.	39: Miscellaneous Manufacturing Industries	461,651
9.	38: Instruments And Related Products	292,416
10.	28: Chemicals And Allied Products	219,521
11.	50: Wholesale Trade--Durable Goods	61,737
12.	45: Transportation By Air	57,700
13.	32: Stone, Clay, And Glass Products	54,597
14.	25: Furniture And Fixtures	43,875
15.	29: Petroleum And Coal Products	41,705
16.	27: Printing And Publishing	32,422
17.	49: Electric, Gas, And Sanitary Services	11,287
18.	51: Wholesale Trade--Nondurable Goods	10,299
19.	73: Business Services	8,034
20.	44: Water Transportation	5,033
21.	NA: Not reported	578
22.	95: Environmental Quality And Housing	5

6.1.3. Indoor air sources

People generally spend more time indoors than outdoors, therefore the quality of indoor air is important for their well being. Certain human activities and consumer products are known sources of some common contaminants present in the indoor air. Furthermore, pollutants present in the outdoor air can also migrate into the indoor environment through openings and cracks of the buildings. This section examines the known sources of the selected contaminants in the indoor air.

6.1.3.1. Asbestos

Once widely used for structural fireproofing, asbestos may be found predominantly in heating systems and acoustic insulation, in the floor and ceiling tiles, and in shingles in many older houses. It was formerly used in consumer products, such as fireplace gloves, ironing board covers, and certain hair dryers.

6.1.3.2. Formaldehyde

Urea-formaldehyde foam insulation (UFFI), a source of formaldehyde, was widely used in home construction until the early 1980s. Although UFFI is now seldom installed, building materials used in the construction of mobile and conventional homes (subflooring, paneling), such as finishes, plywood, paneling, fiberboard, and particleboard all contain formaldehyde-based resins. Furthermore, formaldehyde-based resins are components of furniture and cabinets, permanent press fabric, draperies, and mattress ticking.

6.1.3.3. Other contaminants

1,3-butadiene, benzene, cadmium, chromium and PAHs are released indoors during cigarette smoking. Fireplaces and woodstoves may also be sources of these contaminants. Other sources of volatile organic contaminants are household products, including paints, paint strippers and other solvents, wood preservatives, aerosol sprays, cleansers and disinfectants, moth repellents and air fresheners, stored fuels and automotive products, hobby supplies, and dry-cleaned clothing.

6.1.3.4. Penetration of outdoor contaminants into indoor air

USEPA (1996) has reviewed and evaluated the contribution of fine particulates (and by extrapolation that of gases) to the indoor air. The fraction of outdoor contaminant that penetrates into the indoor air critically depends on the particle size and the air exchange rate. In Canada and the USA, where air exchange rates are about 0.5 per hour the penetration factor is estimated to be between 50% and 100%. Larger particles penetrate into the indoor environment less readily, but most contaminants are usually adsorbed on fine particulates that do penetrate into the indoor environments.

6.1.4. Exposures from contaminated soils

Toronto is a city with a strong industrial past. As a result, some of its lands are contaminated. Much of downtown Toronto and many low-lying areas were filled partly with industrial waste, which would now be considered hazardous. The industrial waste typically contains PAH-rich ashes from coal, wood and petroleum products. These products also contain other substances including benzene, ethylbenzene, toluene and xylenes. PAH-rich coal tar from coal gasification plants and from roofing operations is also often found in the fill. Some fills may be contaminated with volatile organic compounds including trichloroethylene and tetrachloroethylene. Soil contaminated with metals including cadmium and chromium is also common. The presence of fill is characterized by the large variance in the concentrations of contaminants found in adjacent spots close to each other.

In addition to the contaminated fill, soils may be contaminated directly from past or present industrial operations. In the latter situation, the area of contamination is often more clearly delineated. In Toronto, high PAH levels are found on sites that used or produced coal tar, such as past old coal gasification sites or roofing operations. Other sources may include ashes or used crankcase oil. Benzene is most often found as a component of gasoline or diesel fuel contaminations. Trichloroethylene and tetrachloroethylene are found where they have been used as solvents or degreasing agents on site. Chromium may be found on metal-finishing sites. 1,3-butadiene is a gas at room temperature and is not found in contaminated soils

Torontonians can be exposed to contaminants in the soil from direct skin contact with the soil when engaged in certain activities, such as gardening, yard work or playing on the site. Soil adhering to hands can also be ingested with food. Even when there is little outdoor contact with soil, contaminants close to the soil surface may enter the buildings as dust and contribute to skin and oral exposures indoors. Inhalation exposure may result from contaminants volatilizing in the soil and entering the buildings. It is recognized that contaminants in the soil can either adhere to homegrown produce or be taken up by the roots of the plants. This may be a significant pathway of exposure for individuals and families who grow a significant proportion of the produce they consume in the year.

Soil contamination in Toronto is highly variable, depending on the exact location. For this reason, it is not practical to provide readers with "typical" contaminant levels in soils.

6.1.5. Food exposure

Please refer to the discussion in section 6.2.1

6.2. Routes and pathways of exposure

Toronto residents can be exposed to contaminants by ingestion (oral exposure), inhalation (inhalation exposure) or absorption through the skin (dermal exposure). These routes of exposure will be discussed in more detail in this section.

6.2.1. Oral

Food purchased in the supermarket and drinking water are the most important sources from which people can be exposed to the ten contaminants through ingestion. The purchased fruit and vegetables are grown in different localities. Exposure from food sold in the supermarket will depend to some extent on the environmental conditions and farming practices where the produce originates. Food contamination may result from food treatment. For example, food prepared from grains, which were dried over an open fire, used to be the biggest source of human PAHs exposure. Food preparation is also an important source of human exposure and the highest reported concentrations of PAHs in food were found in smoked or grilled/barbecued meat. Estimates of intake of individual contaminants in the Canadian diet are presented in the later part of this report.

Home grown produce on private contaminated plots could be a bigger source of exposure than supermarket foods for some residents, because home-grown produce is mostly consumed by the families who produce it. There is a potential for ongoing and significant exposure if home-grown produce grown on contaminated soil or on land exposed to aerial deposition of the contaminants forms a major part of the family's diet. Data on the levels of contaminants in Toronto home-grown produce are not available.

Based on the concentrations reported for the selected contaminants in Toronto's drinking water (Toronto Works & Emergency Services, 2001; Kauss, P., 2001), exposure from this medium is expected to be negligible.

Ingestion of contaminated soil is also possible. Adults and older children may become exposed after working or playing in the garden by ingesting soil which was adhered to hands. Some toddlers also place soil in their mouths and ingest it (pica). This route of exposure could be very important in conditions where contaminated soil is close to the surface.

6.2.2. Inhalation

Most Torontonians spend more time indoors and as a result they tend to receive most of their exposure in this microenvironment. Furthermore, the indoor environment can be affected by products used and activities undertaken indoors, such as cigarette smoking (e.g. benzene, 1,3-butadiene, PAHs, cadmium), off-gassing from furniture, clothing, wall covering and carpets (e.g. formaldehyde, benzene, tetrachloroethylene), burning of wood in fireplaces (e.g. especially, but not only PAHs). If the building is situated on top of a contaminated site, volatile contaminants (e.g. benzene, PAHs, trichloroethylene and tetrachloroethylene) may enter the building through the cracks in the basement or through the floor and result in significant indoor air exposures. Gases and fine particles from the outdoor air enter the indoor environment. A building without any indoor sources is expected to have contaminant indoor air concentration approximately 50% to 100% of that found in the surrounding outdoor air. As a result, although indoor sources are often more important in terms of overall exposure than outdoor sources, outdoor sources may contribute significantly to the overall exposures.

6.2.3. Dermal exposure

Dermal exposure is the least studied among all exposure routes. In the residential setting, a Torontonian may be exposed dermally to the selected contaminants through skin contact with some household goods, contaminated soil or contaminated sediments in surface waters. Since swimming and bathing in Toronto waters is not common, the most likely mode of dermal exposure is through skin contact with contaminated soils. In general, inorganic contaminants such as cadmium are poorly absorbed. Dermal exposure to PAHs, benzene, trichloroethylene and tetrachloroethylene, on the other hand, is more likely and can be a health concern.

6.3. Environmental levels

6.3.1. Outdoor air levels

In general, inhalation exposures are often more important than other exposure routes because humans are often more sensitive to contaminants when inhaled than when ingested. As discussed earlier, indoor exposures usually have a larger impact than outdoor exposures, because most Torontonians spend more time indoors than outdoors. However, gases and fine particulates can penetrate into the indoor environment and most of the contaminants considered in this report (with the possible exception of asbestos) would readily do so if present in the outdoor air. As a result, the ambient air levels may significantly influence the total inhalation exposure, even though most of the exposure takes place indoors.

Relatively good ambient air concentration data are generally available, however, indoor air data are not. Table 6.3.1.1. summarizes the ambient air levels of the ten contaminants of interest in Toronto or in other urban centers. The data that best represent Toronto were used in section 7.1 to calculate the benzene and toluene TEPs. Tom Dann and his team at Environment Canada have collected most of the data under the National Air Pollution Surveillance (NAPS) program. Although a request has also been submitted to the Ontario Ministry of the Environment (MOE) for ambient air data, no data were made available. The MOE data reported are published in federal reports. For information regarding the typical indoor air levels in Canada, the reader is referred to section 6.4 on intake from environmental exposure.

Table 6.3.1.1. Ambient air levels (µg/m^3) of the Ten Contaminants

	Listed in CEPA/ CCME reports	Listed in other reports
1,3-Butadiene	0.03 (min, same for all 5 monitoring stations); 0.32 (average of the averages at 5 stations); 1.23-2.20 (range of maxima at 5 stations) Toronto (1989-1996, Envir. Canada); Min 0.03-0.05; mean 0.07-0.11; max 0.60-0.27 (2 stations in Toronto, 1990-1994, MOE)	
Asbestos[2]		0.001-0.1 ng/m^3 or 3 x 10^{-8} to 3 x 10^{-5} PCM f/mL (remote); 0.1 to 10 ng/m^3 or 3 x 10^{-6} to 3 x 10^{-4} PCM f/mL, but may range up to 100 ng/m^3 or 3 x 10^{-3} PCM f/mL (urban areas); median United States cities 2.3 ng/m^3 (7 x 10^{-5} PCM f/mL); Near industrial operations involving asbestos 50-5,000 ng/m^3 (1.5 x 10^{-3}-1.5 x 10^{-1} PCM f/mL)
Benzene	1.2-14.6, mean 4.4 (urban); 1.3-3.1, mean 2.2 (1989-1995 means, Toronto)	
Cadmium	0.00024-0.00072, mean 0.00042 (1982, Southern Ontario)	
Chromium (total)	0.003-0.009 (1987-1990, 12 Ontario cities)	
Dioxins	0.4-36.7 pg/m^3 (North American)	0.008-0.014 pg/m^3 (rural remote sites); 0.090-0.26 pg/m^3 (urban sites); July 1987 to April 1994 mean TEQ in Canada (Dann, 1995)
Formaldehyde	3.3, mean (1990-1998, 4 urban sites and 4 suburban sites; Dann)	0.14 to 0.96 (uncontaminated areas); 2 to 4 (major Canadian cities); 1.8 to 6.1 (1990 to1994 annual average at major monitoring sites in Toronto, Ottawa and Windsor)
PAHs (B[a]P)	0.0003 (1984-1986 mean, Toronto)	0.00014 (1988-1992 summer average; 0.00036 (1988-1992 winter average)
Tetrachloroethylene	1.9 (Toronto resid.; Chanin, 1987); 1.6 (Toronto resid), 0.6 (Toronto business; Bell, 1990) about 5 (Toronto; Dann)	
Trichloroethylene	0.32-2.8 (Toronto 1988-1990)	

6.3.2. Ontario background soil concentrations

As discussed in section 6.1.4, contaminant levels in soils can vary greatly, as observed even from samples collected in close proximity to each other. Although it is not practical to provide the typical soil concentrations in Toronto soils, typical background levels are useful information to have.

Table 6.3.2.1 lists the *background levels* of contaminants as provided by MOE (1998). These background levels were derived from the MOE Ontario Typical Range (OTR) sampling program (MOE, 1993). The OTR program was conducted to determine the background soil concentrations of various contaminants. The sample sites were selected from areas, which have not been affected by local point sources of air or land pollution, by local roads or highways, or by other known sources of contamination. In addition, samples were not collected in areas with unusually high natural levels of contamination. The background was determined by adding two coefficients of variation to the 98th percentile measurement. It is therefore clear, that these values do not represent *pristine conditions*.

Table 6.3.2.1 Ontario *background* concentrations in soils (µg/g)

	Concentration (µg/g)
1,3-Butadiene	-
Asbestos	-
Benzene	0.002
Cadmium	1
Chromium (VI)	2.5
Dioxins	2 pg/g (TEQ)
Formaldehyde	-
PAHs (B[a]P)	0.49
Tetrachloroethylene	0.002
Trichloroethylene	0.004

6.3.3. Toronto-area surface water, drinking water and sediment concentrations

The data for this section were selected and tabulated by Dr. Peter Kauss with input from Mr. Duncan Boyd and Mr. Aaron Todd, all from the Ontario Ministry of the Environment. The data are presented in table 6.3.3.1. Sediment data are collated from samples collected at several locations in the Toronto Harbour during the 1996-97 periods. The tributaries sampled include Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek and Rouge River in 1990-2000. WTP represents four water treatment facilities sampled during 1998-1999 as part of the Drinking Water Surveillance Program. The raw water data should reflect the conditions in Lake Ontario adjacent to Toronto. The Toronto Harbor may have higher concentrations.

Table 6.3.3.1 Concentrations of the Ten Contaminants in Water and Sediments in the Toronto Area

	Surface	Surface (Tributary)	Drinking Water (4 WTPs)	
Contaminant	Sediment (mg/kg, dry wt).	Water (?g/L)	Raw (lake Ontario) (?g/L)	Treated (?g/L)
Cadmium	median: 2.13 (0.275-4.66; n=62)	range of medians: 0.20-0.70 (0.00-16; n=1204)	median: 0.0104 (-0.01-0.064; n=10)	median 0.0152 (0.0041-0.094; n=10)
Chromium	median: 49 (7.6-107; n=62)	range of medians: 1.00-2.95 (0.00-3300; n=1230)	median: 3.49 (0.402-8.7; n=10)	median: 4.64 (0.344-7.71; n=10)
Benzene	--	range of means 0.0-0.063 (n=227)	median: 0.00 (DL=0.05; n=10)	median: 0.00 (DL=0.05; n=10)
Tetrachloroethylene	--	range of means: 0-0.301 (n=198)	median: 0.00 (0.00-0.050; n=10)	median: 0.00 (DL=0.05; n=10)
Trichlorethylene	--	range of means: 0-0.260 (n=198)	median: 0.00 (DL=0.05; n=10)	median: 0.00 (DL=0.05; n=10)
Benzo[a]pyrene	median: 0.543, (0.004-2.209; n=62)	range of means: 0-0.325 (n=194)	median: 0 ng/L (DL=5 ng/L; n=4)	median: 0 ng/L (DL=5 ng/L; n=4)
PAHs, total	median: 7.548 0.072-50.105; n=62)	range of means: 0.130-4.320 (n=194)	median: 0 ng/L (DL=5 to 20 ng/L; n=4)	median: 0 ng/L (0-10 ng/L; n=4)
Dioxins (as TEQ)	median: 6.7 ng/kg (1.3-25 ng/kg; n=3)	--	--	--
Asbestos	--	--	--	--
1,3-Butadiene	--	--	--	--
Formaldehyde	--	--	--	?

6.4. Intake from environmental exposure

Intake represents the quantity of a given contaminant, which comes into contact with the body surfaces. These surfaces may refer to the skin, the lining of the digestive tract or the lining of the respiratory tract. Uptake in contrast is the amount of the contaminant taken up past the body surfaces into the body tissues. Intake is usually expressed as the mass of a contaminant per kg of body weight per day.

For inhalation route of exposure, expressing intake per kg body weight is often not appropriate as the resulting toxic effects are more likely proportional to the concentrations of the contaminants in direct contact with the respiratory tract, rather than to the overall tissue burden. This is true for PAHs and some metals but probably does not apply to other toxicants, such as dioxins and lead, whose toxicity seems to be proportional to the total body burden regardless of the route of exposure. Regulatory agencies generally recognize this problem and often consider the weighted air concentration (given as the mass of a contaminant/m^3) instead of the intake as the measure of exposure. Daily intake or weighted air concentration can be used to estimate risk from exposure to cancer-causing contaminants. Intake depends not only on the environmental concentration, but also on the age, size and activities of exposed individual.

Tables 6.4.1 to 6.4.10 (with the exception of table 6.4.7 and 6.4.8) below are derived from CEPA and CCME reports (intakes reported in both reports are provided by Health Canada) and summarize the average intake among Canadians for the individual contaminants. Intakes for dioxins and furans are provided in table 6.4.7 and are obtained from Health Canada report on the Great Lakes (Health Canada, 1998). CEPA (2000b) has not estimated the average daily intake of formaldehyde among the Canadian population, therefore the intake values of formaldehyde are not provided in this report.

CEPA and CCME tabulate human intake from air in terms of the mass of a contaminant per kg body weight per day. CEPA uses generic Canada-wide assumptions regarding contaminant levels in different media (values seen as representative of Canada were selected), people's size, inhalation rates, volumes of water consumed and various lifestyle characteristics in order to estimate the intake. Some of the assumptions have changed from one report to another (e.g. inhalation rates), therefore caution must be exercised in conducting direct comparison of intakes between contaminants. For specific references to the tables, please refer to the appropriate CEPA or CCME reports in the reference section.

The tables prepared by CEPA and CCME make comparison between intakes from different media easier, but such comparisons must be made with caution. Contaminants often differ in their potencies, sites and types of tumors they induce, and sometimes act through different mechanism of action depending on the route of exposure. As a result, even though oral intakes are often higher than inhalation intakes, the risk from inhalation exposure may be higher than from ingesting the same amount of contaminant.

Benzene

Estimated average daily intakes of benzene from environmental media by various age groups in the general population in Canada are presented in table 6.4.1. These estimates are based on mean concentrations of benzene found in environmental media. Ambient air is the main source of exposure to benzene for the general Canadian population, with estimated intakes ranging from 1.3 to 3.0 µg/kg/d. Automotive-related activities are estimated to contribute an additional daily intake of 0.7 to 0.9 µg/kg/d while indoor air due mainly to the use of household products contributes 0.05 to 0.6 µg/kg/d. Cigarette smoking may account for 26 to 33 µg/kg/d daily intake among smokers, and passive smoking to 0.9 to 1.3 µg/kg/d.

1,3-Butadiene

Inhalation is the only route of exposure that is of concern. Indoor air can be a very important source, particularly in homes where residents smoke inside their residences. Active smoking adds a daily intake of 4.4 to 25 µg/kg/d to a relatively low daily intake of 0.01 to 0.6 µg/kg/d. Exposure to passive smoking increases the intake of nonsmokers to approximately 0.05 to 11 µg/kg/d.

Cadmium

Based on these estimates in table 6.4.4, the principal route of intake for all age groups is from ingestion of food. Intakes of cadmium by the general population via air are estimated to be roughly two to three orders of magnitude lower, although cadmium compounds are more readily absorbed by inhalation (up to 50%) than by ingestion (approximately 5%) (Nordberg *et al.*1985). The estimated intakes in drinking water and soil are also relatively small, compared to those in food. Cigarette smoking also contributes substantially to the total exposure to cadmium among smokers.

People living in the vicinity of point sources are exposed to substantially higher level of cadmium in the air, water and soil (see table 6.4.5). For example, the daily intakes of population living near to smelters from air and water are about one to two orders of magnitude higher than those of the general Canadian population. The intakes form soil are also higher. It is also possible that the intake of cadmium is elevated in populations consuming substantial quantities of food originating in the vicinity of point sources such as smelters.

Chromium

Estimates of the average total daily intake of chromium (on a body weight basis) for the general population in Canada are presented in Table 6.4.6. Based on these estimates, ingestion in food (primarily in the trivalent form) likely represents the principal route of chromium intake for all age groups, followed by drinking water, soil (particularly in infants and young children), and air. Cigarette smoking may increase total daily intake by 0.04 to 0.05 µg/kg/d.

Dioxins and Furans

Food is the major source of exposure to dioxins and furans as they tend to bioaccumulate in the food chain. As illustrated in table 6.4.7, age-specific estimates of average total exposure to dioxins and furans for Great Lakes basin residents range from 1.20 pg TEQ/kg/day in adults 20 years of age and older to 57.05 pgTEQ/kg/day in breast-fed infants under six months of age. Assuming a 70-year lifespan and being breast-fed as an infant, the daily intake for the Great Lakes Basin general population (including Torontonians), averaged over a lifetime, is estimated to be 2.60 pg TEQ/kg/day.

Since the fish in the Great Lakes contains substantial levels of dioxins and furans, individuals who eat a lot of sport fish are expected to have a high level of exposure. For example, adults 20 years of age or older, who eat an average 21.3 grams of Great Lakes sport fish per day would have a total exposure of 4.25 pg TEQ/kg/day (Health Canada, 1998). The daily intake, averaged over a lifetime, for sport fish eaters who were being breast-fed as an infant is estimated to be 4.65 pg TEQ/kg/day (Health Canada, 1998).

Note that these intake estimates include contributions only from dioxins and furans but not from co-planar polychlorinated biphenyls, which elicit a similar spectrum of toxic effects through the same mechanism of action. As a result, the total intakes of dioxin and related compounds are most likely underestimated.

PAH

Although food is the major source of exposure to B[a]P, since B[a]P is a more potent carcinogen when inhaled than ingested, the risk of stomach cancer from oral intake may not be higher than the risk of lung cancer due to inhalation exposure. In general, due to winter heating, the daily intake of B[a]P is about one order of magnitude higher in the winter than in the summer months. Because people spend more time indoors, the indoor air contributes more to the total daily intake of B[a]P. The exposure is further increased in situations where the residents supplement home heating with a fireplace and where cigarette smoking takes place in the homes.

Tetrachloroethylene

As indicated in table 6.4.9, the total daily intake of tetrachloroethylene was estimated to range from approximately 1.2 to 2.7 μg/kg bw/day in various age groups of the general population. It is evident that the time spent indoors makes the greatest contribution to the overall exposure to tetrachloroethylene, while the ingestion of drinking water (generally) makes a minor contribution. The use of household products that contain this compound and the residual tetrachloroethylene present in freshly dry-cleaned clothing are likely the predominant reason why the indoor air levels are higher than the ambient air levels (CEPA, 1993b).

Trichloroethylene

Table 6.4.10 summarizes the estimated daily intake of trichloroethylene for various age groups of the general population in Canada. Indoor air is the major source of exposure to trichloroethylene in the general population, while ambient air, drinking water and food make only minor contributions.

Table 6.4.1 Estimated intake of benzene[1] (µg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	4.4 µg/m^3	1.5	1.7	2.0	1.7	1.3
Indoor air[2]	2.25 µg/m^3 (non-smokers); 5.04 µg/m^3 (smokers)	0.5	0.05	0.6	0.5	0.4
Drinking water	1 µg/L	0.02	0.06	0.04	0.02	0.02
Food	-	0.07	0.06	0.05	0.03	0.02
Automobile-related activities	40 µg/day using auto, 10 µg/day refueling	-	-	-	0.9	0.7
Total intake	**-**	**2.1**	**2.3**	**2.7**	**3.2**	**2.4**
Active smoker	Additional 1800 µg/day	-	-	-	33	26
Passive smoker	Additional 3 µg/m^3 in indoor air assumed	1.0	1.2	1.3	1.1	0.9

[1]CEPA (1993d).
[2]Maxxam undated draft for CCME. A study of benzene exposure in residential homes. Contract no. 989-041. The corresponding average outdoor concentration was 1.46 µg/m^3.
An average daily concentration of 0.24 µg benzene/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.
An average oral intake of 3.4 x 10^{-2} µg benzene/kg/day over a lifetime corresponds to added cancer risk of one in a million.

Table 6.4.2 Estimated average intake of 1,3-butadiene[1] (µg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20-59 years	60+
Ambient air average/ urban	0.025-1.11 µg/m^3	0.001-0.004	0.002-0.08	0.001-0.06	0.001-0.04	0.001-0.03	0.001-0.03
Indoor air[2]	0.04-1.0 µg/m^3	0.01-0.24	0.02-0.52	0.02-041	0.01-0.23	0.01-0.20	0.01-0.18
Total intake	**-**	**0.01-0.28**	**0.02-0.60**	**0.02-0.47**	**0.01-0.27**	**0.01-0.23**	**0.01-0.21**

[1]CEPA (1999).
[2]homes of non-smokers
Average Toronto NAPS site 0.32 µg/m^3. In contrast MOE values (quoted in CEPA, 1999 draft) are 0.09 µg/m^3 (average of 2 Toronto sites).
An average daily concentration of 0.16 µg 1,3-butadiene/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.

Table 6.4.3 Estimated reasonable worst-case intake of 1,3-butadiene[1] (µg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20-59 years	60+
Ambient air average/ urban	0.025-14.1 µg/m^3	0.001-0.49	0.002-1.05	0.001-0.82	0.001-0.47	0.001-0.40	0.001-0.36
Indoor air[2]	0.3-19.2 µg/m^3	0.07-4.64	0.16-10.02	0.12-7.81	0.07-4.45	0.06-3.85	0.05-3.40
Total intake	**-**	**0.07-5.13**	**0.16-11.07**	**0.12-8.63**	**0.07-4.92**	**0.06-4.25**	**0.05-3.76**
Additional intake – smoker	16-75 µg/cig x 20 cigarettes				5.4-25	4.5-21	4.4-21

[1]CEPA (1999).
[2]homes of smokers
An average daily concentration of 0.16 µg 1,3-butadiene/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.

Table 6.4.4 Estimated intake of total cadmium[1] (μg/kg-day) for the general Canadian population

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	0.001-0.004 μg/m^3	0.00029-0.0011	0.00039-0.0015	0.00044-0.0018	0.00037-0.0015	0.00033-0.0013
Indoor air	(assumed = ambient air)	-	-	-	-	-
Drinking water	=0.01-0.09 μg/L	0-0.0026	=0.00015-0.0014	=0.00011-0.0010	=0.000088-0.00079	=0.000057-0.00051
Food	-	0.27-0.62	0.64	0.51	0.29	0.21
soil	0.56-1.14 μg/g	0.0028-0.0057	0.0022-0.0044	0.00073-0.0015	0.00020-0.00040	0.00016-0.00033
Cigarette smokers	0.187 μg/cig. x 20 cigarettes	-	-	-	0.066	0.053

[1]*CEPA (1994c).*
An average daily concentration of 5.6 x 10^{-4} μg cadmium/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.

Table 6.4.5 Estimated intake of total cadmium[1] (μg/kg-day) for population in the vicinity of some point sources in Canada

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	0.046 μg/m^3	0.013	0.018	0.020	0.017	0.015
Indoor air	(assumed = ambient air)	-	-	-	-	-
Drinking water	=0.5-1 μg/L	0.-0.11	0.031-0.062	0.017-0.033	0.011-.023	0.011-0.21
Food	-	0.27-0.62	0.64	0.51	0.29	0.21
soil	5.2 μg/g	0.026	0.020	0.0067	0.0018	0.0015
Cigarette smokers	0.187 μg/cig. x 20 cigarettes	-	-	-	0.066	0.053

[1]*CEPA (1994c).*
An average daily concentration of 5.6 x 10^{-4} μg cadmium/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.

Table 6.4.6 Estimated intake of total chromium[1] (µg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	0.003-0.009 µg/m^3	0.0009-0.003	0.001-0.003	0.001-0.004	0.001-0.003	0.001-0.003
Indoor air	-	-	-	-	-	-
Soil/dirt	43 µg/g	0.2	0.2	0.06	0.02	0.01
Drinking water	0.3-4.3 µg/L	0.03-0.5	0.02-0.3	0.01-0.1	0.007-0.1	0.006-0.09
Food	-	<0.9[2]; 0.03-0.04[3]	<1	<0.7	<0.4	<0.3
Total intake		**<1.6[1]; 0.3-0.7[2]**	**<1.5**	**<0.9**	**<0.5**	**<0.4**
Tobacco smoking	0.147 µg/cig x 20 cigarettes	-	-	-	0.05	0.04

[1]*CEPA (1994d).*
[2]*Not breast fed*
[3]*Breast fed*
An average daily concentration of 8.3 x 10^{-5} µg chromium (VI)/m^3 of air over a lifetime is associated with an added cancer risk of one in a million. Chromium (VI) comprises roughly 3-8% of total chromium in the ambient air (CEPA,1994d).

Table 6.4.7 Estimated average intake of dioxins and furans [1, 2] (pg TEQ/kg/day)

Route of exposure		0-6 month	7 mo – 4 yr	5-11 yr	12-19 yr	20+ yr
Air (ambient + indoor)		0.04	0.11	0.01	0.05	0.04
Soil + dust		0.01	0.01	<0.01	<0.01	<0.01
Drinking water	Not breast-fed	<0.01	<0.01	<0.01	<0.01	<0.01
	Breast-fed	0				
Food	Not breast-fed	12.51	9.41	4.59	2.20	1.16
	Breast-fed	57.00				
Total estimated intake	**Not breast-fed**	**12.56**	**9.54**	**4.69**	**2.25**	**1.20**
	Breast-fed	**57.05**				
Total estimated intake averaged over a lifetime		Including not breast-fed infants		2.29		
		Including breast-fed infants		2.60		

[1]*Health Canada (1998).*
[2]*Intakes for Canadian Great Lakes basin residents are reported as pg of 2,3,7,8-TCDD toxic equivalents (TEQ) calculated using International Toxicity Equivalency Factors.*
The tolerable daily intake of dioxins and furans is 10 pg TEQ/kg/day for cancer effects and 1-4 pg TEQ/kg/day for reproductive and developmental effects (WHO, 1998).

Table 6.4.8 Estimated average intake of B[a]P[1, 2]

Route of exposure	Assumed levels	Typical adult intake (µg/kg/d)
Toronto Ambient air	1.4×10^{-4} µg/m^3 (summer); 3.6×10^{-4} µg/m^3 (winter)	3.5×10^{-6} (summer) 9.1×10^{-5} (winter)
Indoor air	Assumed ½ of the outdoor	1.2×10^{-5} (summer) 3.2×10^{-4} (winter)
Total air		1.6×10^{-5} (summer) 4.1×10^{-4} (winter)
Drinking water	1×10^{-3} µg/L	2×10^{-5}
Food	-	0.02
Passive Cigarette smoking indoors	Additional 6.7×10^{-4} µg/m^3	Additional 1.2×10^{-4}
Operation of fireplace	3×10^{-4} µg/m^3 in 7 out of 12 months	Additional 3×10^{-5}

[1]*Typical adult air intake was calculated using methods compatible with the CEPA 1,3-butadiene report (1999). Inhalation rate was assumed to be 14.3 m^3/day, residents were assumed to spend 3 hr outdoors and the rest of the time indoors at home. Body weight was assumed to be 70.6 kg.*
[2]*Muller, P. Exposure Assessment and Risk Characterization of PAH. Unpublished report. Exposure to an average daily concentration of 4.3×10^{-5} µg B[a]P/m^3 of air containing a complex mixture of PAH over a lifetime is associated with an added cancer risk of one in a million.. Exposure to a complex PAH-mixture orally that yield a daily intake of 3.4×10^{-4} µg B[a]P/kg/day over a lifetime is associated with an added cancer risk of one in a million..*

Table 6.4.9 Estimated intake of tetrachloroethylene[1] (μg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	0.2-5 μg/m^3	0.01-0.24	0.01-0.32	0.01-037	0.01- 0.31	0.01-0.27
Indoor air	5.1 μg/m^3	1.21	1.63	1.88	1.56	1.40
Total air		1.22-1.45	1.64-1.95	1.89 - 2.25	1.57- 1.87	1.41- 1.67
Drinking water	0.1-0.9 μg/L	-	0.006-0.06	0.003-0.03	0.002-0.02	0.002-0.02
Food	0.4-12.9 ng/g	-	0.65	0.39	0.20	0.12
Total intake		**1.22-1.45**	**2.3-2.66**	**2.28-2.67**	**1.77- 2.09**	**1.53-1.81**

[1]CEPA (1993b).
Tolerable daily concentration of tetrachloroethylene = 250 μg/m^3 (WHO, 1996).
Reference dose of tetrachloroethylene = 10 μg/kg/day (USEPA, 1992c).

Table 6.4.10 Estimated intake of trichloroethylene[1] (μg/kg-day)

Route of exposure	Assumed levels	0-6 month	7 mo-4 years	5-11 years	12-19 years	20+ years
Ambient air	0.07 to 0.45 μg/m^3	0.003-0.02	0.004-0.03	0.005-0.03	0.004-0.03	0.004-0.02
Indoor air	1.4 μg/m^3	0.33	0.45	0.52	0.43	0.38
Drinking water	0.2 μg/L	0.02	0.01	0.007	0.005	0.004
Food	-	0.02	0.02-0.04	0.01-0.04	0.006-0.02	0.004-0.01
Total intake	**-**	**0.37-0.39**	**0.48-0.53**	**0.54-0.60**	**0.45- 0.49**	**0.39- 0.41**

[1]CEPA (1993a).
An average daily concentration of 1.6 μg trichloroethylene/m^3 of air over a lifetime is associated with an added cancer risk of one in a million.
An average daily oral intake of 6.7 μg trichloroethylene/kg/day over a lifetime is associated with an added cancer risk of one in a million