Chromium (Hexavalent)
Environmental estimates (circa 2011): Supplemental data

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1. Data for lifetime excess cancer risk estimates

Overview
The summary data used to calculate lifetime excess cancer risk and the results for hexavalent chromium are provided in the tables below. For more detailed information on supporting data and sources, see below for each exposure pathway.

i. Environmental Concentrations

Exposure pathway	Units	Average	Maximum	Notes
Outdoor air	µg/m³	0.00002	0.000085	Assumes 5% of total chromium measured is hexavalent
Indoor air	µg/m³			Insufficient data
Dust	µg/g	9	12.55	
Drinking water	µg/L	0.81	1.9	
Food and beverages				Insufficient data

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.00000000046	0.000000002
Indoor air	Insufficient data	
Dust	0.0000059	0.000154
Drinking water	0.000021	0.000049
Food and beverages	Insufficient data	

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation (hexavalent chromium)	320.0	42.0	510.0
Ingestion	--	--	0.42

Sources for Cancer Potency Factors:
- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment. Version 2.0.
- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors. Version 2.0.
- United States Environmental Protection Agency Integrated Risk Information System
- California Office of Environmental Health Hazard Assessment, 2009. Air Toxics Hot Spots Risk Assessment Guidelines Part II: Technical Support Document for Cancer Potency Factors, Appendix A. (Updated 2011)

iv. Lifetime Excess Cancer Risk (per million people)

Exposure pathway	Average[1]			Maximum[2]
	Health Canada	US EPA	CA OEHHA[3]	
Outdoor air	0.15	0.019	0.236	1.00
Indoor air	Insufficient data			
Dust	--	--	2.48	64.55
Drinking water	--	--	8.83	20.72
Food and beverages	Insufficient data			

[1]Lifetime excess cancer risk based on average intake x cancer potency factor from each agency
[2]Lifetime excess cancer risk based on maximum intake x highest cancer potency factor
[3]California Office of Environmental Health Hazard Assessment

Supporting data by exposure pathway

i. Outdoor air

Outdoor air concentrations are from the National Air Pollution Surveillance monitoring network operated by Environment Canada, for the year 2010.

Source	Stations (n)	Min	Max	Mean	DF
NAPS 2010 (µg/m³)	15	0.0000054	0.000085	0.00002	1.0

DF = Detection frequency

We assume hexavalent chromium is present at these levels in all outdoor air, although concentrations may vary from one location to another.

ii. Indoor air
No recent data or studies were identified.

iii. Dust

Indoor dust concentrations are based on data published in peer-reviewed literature since 2000. A ranking system was used to select data most representative of Canadian conditions circa 2011:

1. Canadian data collected in 2000 or more recently, sample duration of 24 hours or longer;

2. US studies of similar currency and sample duration;

3. Studies from northern European countries of similar currency and sample duration;

4. Canadian, US or European studies with data collected prior to 2000 and similar sample duration; and

5. Studies with sample duration of less than 24 hours regardless of country or collection date, or studies from countries not comparable to Canada.

Rank: 1	Author:		Rasmussen (2013)					Location:		Canada National	
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
1025		0.5	2001-2010	µg/g		0.04	234	9.4	7.9	8.1	25th 6.0 75th 10.9 90th 14.2 95th 17.1

Notes: Analyzed using ICP-MS (most accurate method). Sample represents a population-based urban baseline representative for Canada, not individual cities or provinces. Assumes 8% of total chromium measured is hexavalent (Zhi-Hua 2009).
*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author:		Stern (2010)					Location:		USA, New Jersey	
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
292			2006-2008	µg/g				3.9 4.6 4.25 (avg)			95th 11.7 13.4 12.55 (avg)

Notes: samples from 100 homes in Jersey City (industrial) Background: 60 samples from 20 homes, Values listed in following order: City, Background
*DF = Detection frequency
**DL = Detection limit

Sources for dust:
- Rasmussen PE, Levesque C, Chénier M, Gardner HD, Jones-Otazo, H, Petrovic S. 2013. Canadian House Dust Survey: Population-based concentrations of arsenic, cadmium, chromium, copper, nickel, lead, and zinc inside urban homes. Science of the Total Environment 443: 520-529.
- Stern AH, Yu CH, Black K, Lin L, Lioy PJ, Gochfeld M, et al. 2010. Hexavalent chromium in house dust - a comparison between an area with historic contamination from chromate production and background locations. Science of the Total Environment 408: 4993-4998.
- Zhi-Hua F, Shalat S, Chang-Ho Y, Black K, Lin L. 2009. Final Report: Characterization of Hexavalent Chromium Concentrations in Household Dust in Background Areas. UMDNJ-Robert Wood Johnson Medical School and Environmental and Occupational Health Sciences Institute. Submitted to Dr. Alan Stern, NJDEP Division of Science and Research, March 21.

iv.   Drinking water

Drinking water data are from the Ontario Drinking Water Surveillance Program (DWSP) for 2011. A review of published reports was also conducted in order to compare how well the Ontario data represented other regions in Canada.

Source	Units	DL								
Ontario DWSP 2011	(µg/L)	+/-								
Sample Type	Parameter	Mean	SD	Min	25th	50th	75th	Max	N	
Distribution (-)	Unfiltered Total	0.04	0.14	0.0	0.0	0.0	0.0	1.56	307	
Distribution (+)	Unfiltered Total	1.58	0.9	0.34	0.44	0.44	0.52	2.24	307	
Calculated mean:		0.81	0.52	--	0.22	0.22	0.26	1.9		

DL = Detection limit
SD = Standard Deviation

v. Food and Beverages

No recent data or studies were identified.

2. Data quality for lifetime excess cancer risk estimates

Only publicly available data were used to calculate these indicators. Data that are not publicly available may produce different results.

No systematic method for measuring data quality was possible, so we provide the following assessments of how well the data used may represent the actual Canadian average levels. Quality is rated higher when there are data from a number of Canadian monitors, or from Canadian studies that show results similar to other comparable studies. Quality is rated lower when data from few monitors or studies were available, and lowest when estimates are based on non-Canadian data. Others may rate data quality differently.

Exposure Pathway	Data Quality	Notes
Outdoor air	Very Low	• Total chromium is regularly measured in outdoor air at 15 monitoring stations across Canada using accepted protocols. Hexavalent chromium is not measured directly. This estimate assumes 5 percent of measured chromium is hexavalent chromium.
Indoor air	Gap	• No recent data or studies identified using appropriately accurate analytical methods.
Indoor dust	Very Low	• The recent Canadian House Dust Survey, which provides a population-based urban baseline estimate representative of Canada, measured levels of total chromium. This estimate assumes 8% of the total chromium measured in the house dust survey is the hexavalent form. • A recent US study (New Jersey) reported specifically on hexavalent chromium in sample of 100 homes. Mean levels in the New Jersey study are lower than those from the Canadian House Dust Survey.
Drinking water	Moderate	• This estimate assumes that 100 percent of total chromium in drinking water is hexavalent chromium.
Food and beverages	Gap	• No Canadian or US data on concentrations of hexavalent chromium in foods or beverages were identified.

3. Data for mapping concentrations

The maps use geographic coordinates at the census block level to represent residential locations. Concentration estimates are mapped at the health region level, which are created with aggregated census block data.

We used a model to predict annual average concentrations of hexavalent chromium in outdoor air at residential locations for 2011. These are predicted using levels measured from the National Air Pollution Surveillance (NAPS) monitors and estimated concentrations from known emitters. For more information on how these estimates were created, please see the Mapping Methods document on the [Environmental Approach](#) section of our website.

Estimates by health region

The table below shows predicted hexavalent chromium concentrations by province based on data at the health region level. The median concentration of hexavalent chromium measured in outdoor air in 2011 at the health region level was 0.00021 µg/m^3, while the mean concentration was 0.00034 µg/m^3. Concentrations of hexavalent chromium can be higher or lower than average in many locations.

i. **Provincial averages of predicted hexavalent chromium concentrations (µg/m^3) in outdoor air in 2011 based on health regions**

Province	Median	Mean
BC	0.00030	0.00076
AB	0.00017	0.00031
SK	0.00010	0.00013
MB	0.00011	0.00024
ON	0.00023	0.00033
QC	0.00020	0.00025
NB	0.00022	0.00022
PE	0.00019	0.00019
NS	0.00019	0.00021
NL	0.00021	0.00021
YK	0.00059	0.00059
NT	0.00046	0.00046
NU	0.00058	0.00058
Canada	**0.00021**	**0.00034**

Estimates by census block

The table below shows provincial populations by concentration levels (either annual average or number of times above/below the national average) based on the census block data and the associated potential lifetime excess risk given different cancer potency factors.

i. Provincial population distribution by estimated average concentration (µg/m³) of hexavalent chromium in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m³)	Less than 0.0000067	0.0000067 to 0.000008	0.000008 to 0.00001	0.00001 to 0.000013	0.000013 to 0.00002	0.00002 to 0.00003	0.00003 to 0.00004	0.00004 to 0.00005	0.00005 to 0.00006	More than 0.00006
Compared to national average (0.00002 µg/m³)*	> 3x lower	2.5 to 3x lower	2 to 2.5x lower	1.5 to 2x lower	1 to 1.5x lower	1 to 1.5x higher	1.5 to 2x higher	2 to 2.5x higher	2.5 to 3x higher	> 3.0x higher
				Below Average		Above Average				
BC	--	18,542	284,910	25,741	840,249	1,954,488	413,672	175,853	127,715	558,887
		(0.4%)	(6.5%)	(0.6%)	(19.1%)	(44.4%)	(9.4%)	(4.0%)	(2.9%)	(12.7%)
AB	--	--	--	--	1,230,138	950,243	816,033	148,595	100,984	399,264
					(33.7%)	(26.1%)	(22.4%)	(4.1%)	(2.8%)	(11.0%)
SK	1,831	74	62	368	365,101	436,960	62,786	51,515	32,744	81,940
	(0.2%)	(<0.1%)	(<0.1%)	(<0.1%)	(35.3%)	(42.3%)	(6.1%)	(5.0%)	(3.2%)	(7.9%)
MB	3,489	298	536	1,623	535,428	489,118	47,633	19,848	23,256	87,039
	(0.3%)	(<0.1%)	(<0.1%)	(0.1%)	(44.3%)	(40.5%)	(3.9%)	(1.6%)	(1.9%)	(7.2%)
ON	--	--	--	980,037	5,661,114	4,001,351	864,570	286,303	164,704	893,742
				(7.6%)	(44.0%)	(31.1%)	(6.7%)	(2.2%)	(1.3%)	(7.0%)
QC	--	--	--	359,682	3,911,702	2,377,597	542,837	222,734	117,529	370,920
				(4.6%)	(49.5%)	(30.1%)	(6.9%)	(2.8%)	(1.5%)	(4.7%)
NB	--	--	--	--	346,105	293,691	40,531	22,891	13,348	34,605
					(46.1%)	(39.1%)	(5.4%)	(3.0%)	(1.8%)	(4.6%)
NS	--	--	--	--	489,769	352,973	42,898	16,182	9,807	10,098
					(53.1%)	(38.3%)	(4.7%)	(1.8%)	(1.1%)	(1.1%)
PE	--	--	--	--	43,815	67,900	11,662	7,038	3,019	6,770
					(31.3%)	(48.4%)	(8.3%)	(5.0%)	(2.2%)	(4.8%)
NL	--	--	--	--	164,748	234,342	33,904	24,791	16,800	39,951
					(32.0%)	(45.5%)	(6.6%)	(4.8%)	(3.3%)	(7.8%)
NU	--	--	--	--	--	23,292	220	1,027	2,085	5,282
						(73.0%)	(0.7%)	(3.2%)	(6.5%)	(16.6%)
NT	--	--	--	--	816	17,561	3,604	4,931	3,073	11,477
					(2.0%)	(42.4%)	(8.7%)	(11.9%)	(7.4%)	(27.7%)
YT	--	--	--	--	8,214	8,923	1,018	1,460	2,420	11,862
					(24.2%)	(26.3%)	(3.0%)	(4.3%)	(7.1%)	(35.0%)
CANADA	5,320	18,914	285,508	1,367,451	13,597,199	11,208,439	2,881,368	983,168	617,484	2,511,837
% of pop.	(<0.1%)	(0.1%)	(0.9%)	(4.1%)	(40.6%)	(33.5%)	(8.6%)	(2.9%)	(1.8%)	(7.5%)

ASSOCIATED LIFETIME EXCESS CANCER RISK (per million people):
RED = POTENTIAL LIFETIME EXCESS RISK IS GREATER THAN 1 PER MILLION PEOPLE

Health Canada CPF: 320.0	<0.05	0.05 to <0.06	0.06 to <0.08	0.08 to <0.1	0.1 to <0.15	0.15 to <0.23	0.23 to <0.3	0.3 to <0.38	0.38 to <0.45	>0.45
California OEHHA CPF: 510.0	<0.079	0.079 to <0.094	0.094 to <0.12	0.12 to <0.16	0.16 to <0.24	0.24 to <0.35	0.35 to <0.47	0.47 to <0.59	0.59 to <0.71	>0.71
US EPA CPF: 42.0	<0.006	0.006 to <0.008	0.008 to <0.009	0.009 to <0.013	0.013 to <0.019	0.019 to <0.029	0.029 to <0.038	0.038 to <0.048	0.048 to <0.057	>0.057

*measured at National Air Pollution Surveillance (NAPS) monitors in 2011
CPF: Cancer Potency Factor