Nickel
Environmental estimates (circa 2011): Supplemental data

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CAREX CANADA

1. Data for lifetime excess cancer risk estimates

Overview

The summary data used to calculate lifetime excess cancer risk and the results for nickel 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	0.0005	0.0023	
Indoor air	µg/m³	0.00085	0.0017	
Dust	µg/g	102	2300	

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.000000012	0.000000053
Indoor air	0.00000028	0.00000055
Dust	0.000067	0.00151

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	--	--	0.91

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)

	Average[1]			Maximum[2]
Exposure pathway	Health Canada	US EPA	CA OEHHA[3]	
Outdoor air	--	--	0.0105	0.048
Indoor air	--	--	0.25	0.5
Dust	--	--	--	--

[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	0.00016	0.0023	0.0005	1.0

DF = Detection frequency

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

ii. Indoor air

Indoor air 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 (2005) Location: Canada, Ottawa

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
10	0.93	0.5	2002	µg/m³	7 days	0.0002	0.0013		0.0007		
10						0.0004	0.0021		0.0010		

Notes: Values listed in the following order: Rural $PM_{2.5}$, Urban $PM_{2.5}$. Analyzed using ICP-MS (most accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 2 Author: Na (2004) Location: USA, Riverside CA

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
0			2001-	µg/m³	6 days			0.011			
12			2002					0.011			
7								0.010			
1											

Notes: Values listed in following order: Non-Smoking, Occasional Smoking, Frequent Smoking. Analyzed using XRF (less accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 3 Author: Molnar (2007) Location: Sweden, Stockholm

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
28	0.68	0.65	2003-2004	µg/m³	14 days	0.3	3.5	0.0011		0.00099	

Notes: Analyzed using XRF (less accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 4 Author: Adgate (2007) Location: USA, Minneapolis

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
235	0.49		1999	µg/m³	48 hr			0.012	0.0001		10th 0.0012 90th 0.0063

Notes: Analyzed using XRF (less accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 4 Author: Kinney (2002) Location: New York City, Los Angeles

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
38		0.09	1999	µg/m3	48 hrs			0.0316			
39		0.2						0.0126			

Notes: Values listed in following order: Winter, Summer. Analyzed using ICP-MS (most accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 4 | **Author:** Lai (2004) | **Location:** England, Oxford

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
50	0.71		1998-2000	µg/m³	48 hr			0.014		0.0086	

Notes: Elemental $PM_{2.5}$ levels
*DF = Detection frequency
**DL = Detection limit

Rank: 4 | **Author:** Sax (2006) | **Location:** New York City, Los Angeles

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
79	0.48			µg/m³	48 hr		0.00348	0.00237	0.00157		
75	1.0						0.000425	0.00656	0.00417		

Notes: Values listed in following order: New York City, Los Angeles. Analyzed using ICP-MS (most accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 5 | **Author:** Dermentzoglou (2003) | **Location:** Greece

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
6				µg/m³	2 hrs			0.0591			
6								0.0494			
6								0.0492			
6								0.0491			

Notes: Values listed in following order: Central Heating Central, Wood Burning Central, Cigarette Central, Cooking
*DF = Detection frequency
**DL = Detection limit

Rank: 5 | **Author:** Pekey (2010) | **Location:** Turkey

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
15			2006-2007	µg/m³	daily			0.002			
								0.003			
								0.003			
								0.004			
								0.0038	0.0033		
								0.0018	0.0016		
								0.005	0.004		
								0.002	0.002		

Notes: Values listed in following order: $PM_{2.5}$ Fraction S, $PM_{2.5}$ Fraction W, PM_{10} Fraction S, PM_{10} Fraction W, $PM_{2.5}$ Fraction Smoker, $PM_{2.5}$ Fraction Non-Smoker, PM_{10} Fraction Smoker, PM_{10} Fraction Non-Smoker. Analyzed using XRF (less accurate method).
*DF = Detection frequency
**DL = Detection limit

Rank: 5	Author:	Slezakova (2009)						Location:	Portugal		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
2			2006	µg/m³	28 days 12hr/day			0.00131 0.00107 0.00185 0.00176			

Notes: Values listed in following order: Site 1 PM_{10}, Site 1 $PM_{2.5}$, Site 2 PM_{10}, Site 2 $PM_{2.5}$. Analyzed using XRF (less accurate method).
*DF = Detection frequency
**DL = Detection limit

Sources for indoor air data:

- Adgate JL, Mongin SJ, Pratt GC, Zhang J, Field MP, Ramachandran G, et al. 2007. Relationship between personal, indoor, and outdoor exposures to trace elements in PM2.5. Science of the Total Environment 386: 21-32.
- Dermentzoglou M, Manoli E, Samara C. 2003. Sources and patterns of polycyclic aromatic hydrocarbons and heavy metals in fine indoor particulate matter of Greek houses. Fresenius Environmental Bulletin 12: 1511-1519.
- Kinney PL, Chillrud SN, Ramstrom S, Ross J, Spengler JD. 2002. Exposures to multiple air toxics in New York City. Environmental Health Perspectives 110: 539-546.
- Lai HK, Kendall M, Ferrier H, Lindup I, Alm S, Hanninen O, et al. 2004. Personal exposures and microenvironment concentrations of PM2.5, VOC, NO2 and CO in Oxford, UK. Atmospheric Environment 38: 6399-6410.
- Molnar P, Bellander T, Sallsten G, Boman J. 2007. Indoor and outdoor concentrations of PM2.5 trace elements at homes, preschools and schools in Stockholm, Sweden. J Enivron Monit 9: 348-357.
- Na K, Sawant AA, Cocker III DR. 2004. Trace elements in fine particulate matter within a community in western Riverside Country, CA: focus on residential sites and a local high school. Atmospheric Environment 38: 2867-2877.
- Pekey B, Bozkurt ZB, Pekey H, Dogan G, Zararsiz A, Efe N, et al. 2010. Indoor/outdoor concentrations and elemental composition of PM10/PM2.5 in urban/industrial areas of Kocaeli City, Turkey. Indoor Air 2010 20: 112-125.
- Rasmussen PE, Dugandzic R, Hassan N, Murimboh J, Gregoire DC. 2005. Challenges in quantifying airborne metal concentrations in residential environments. Canadian Journal of Analytical Sciences and Spectroscopy 51: 1-8.
- Sax SN, Bennett DH, Chillrud SN, Ross J, Kinney PL, Spengler JD. 2006. A cancer risk assessment of inner-city teenagers living in New York City and Los Angeles. Environmental Health Perspectives 114: 1558-1566.
- Slezakova K, Pereira MC, Alvim-Ferraz MC. 2009. Influence of tobacco smoke on the elemental compositions of indoor particles of different sizes. Atmospheric Environment 43: 486-493.

iii. Dust

Nickel is not expected to be carcinogenic via ingestion.

iv. Drinking water

Nickel is not expected to be carcinogenic via ingestion.

v. Food and Beverages

Nickel is not expected to be carcinogenic via ingestion.

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	Moderate	• Nickel is regularly measured in outdoor air at 15 monitoring stations across Canada using accepted protocols.
Indoor air	Low	• One recent Canadian study identified (Ontario). The reported medians are not very similar to several older US studies using the same analytical method.

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 nickel 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 nickel concentrations by province based on data at the health region level. The median concentration of nickel measured in outdoor air in 2011 at the health region level was 0.00066 $\mu g/m^3$, while the mean concentration was 0.00075 $\mu g/m^3$. Concentrations of nickel can be higher or lower than average in many locations.

i. Provincial averages of predicted nickel concentrations ($\mu g/m^3$) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	0.00082	0.00105
AB	0.00070	0.00075
SK	0.00043	0.00047
MB	0.00053	0.00064
ON	0.00063	0.00068
QC	0.00074	0.00077
NB	0.00076	0.00072
PE	0.00065	0.00065
NS	0.00086	0.00150
NL	0.00051	0.00051
YK	0.00083	0.00083
NT	0.00062	0.00062
NU	0.00065	0.00065
Canada	**0.00066**	**0.00075**

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 nickel in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m³)	Less than 0.00017	0.00017 to 0.0002	0.0002 to 0.0025	0.00025 to 0.00033	0.00033 to 0.0005	0.0005 to 0.00075	0.00075 to 0.001	0.001 to 0.00125	0.00125 to 0.0015	More than 0.0015
Compared to national average (0.0005 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	261,901 (6.0%)	37,669 (8.6%)	27,048 (6.1%)	461,226 (10.5%)	61,448 (1.4%)	928,473 (21.1%)	1,197,338 (27.2%)	342,176 (7.8%)	314,383 (7.1%)	768,395 (17.5%)
AB	--	--	--	640,961 (17.6%)	27,119 (0.7%)	2,177,181 (59.7%)	337,277 (9.3%)	247,554 (6.8%)	75,856 (2.1%)	139,309 (3.8%)
SK	--	--	--	354,832 (34.3%)	26,473 (2.6%)	406,849 (39.4%)	107,045 (10.4%)	64,928 (6.3%)	38,954 (3.8%)	34,300 (3.3%)
MB	--	--	--	342,224 (28.3%)	20,913 (1.7%)	590,771 (48.9%)	107,980 (8.9%)	78,110 (6.5%)	25,658 (21.2%)	42,612 (3.5%)
ON	--	275,504 (2.1%)	736,895 (5.7%)	5,139,286 (40.0%)	1,707,630 (13.3%)	3,443,988 (26.8%)	758,557 (5.9%)	355,163 (2.8%)	127,634 (1.0%)	307,164 (2.4%)
QC	--	--	231,244 (2.9%)	1,308,759 (16.6%)	2,991,447 (37.9%)	2,324,220 (29.4%)	488,.298 (6.1%)	255.919 (3.2%)	110,663 (1.4%)	192,451 (2.4%)
NB	--	--	--	249,379 (33.2%)	122,317 (16.3%)	277,222 (36.9%)	36,524 (4.9%)	30,162 (4.0%)	18,269 (2.4%)	17,298 (2.3%)
NS	--	--	--	268,433 (29.1%)	14,720 (1.6%)	196,915 (21.4%)	12,543 (1.4%)	11,345 (1.2%)	6,386 (0.7%)	411,385 (44.6%)
PE	--	--	--	52,502 (37.4%)	3,644 (2.6%)	60,644 (43.3%)	9,359 (6.7%)	7,001 (49.9%)	5,129 (3.7%)	1,925 (1.4%)
NL	--	--	--	206,686 (40.2%)	26,375 (5.1%)	202,871 (39.4%)	33,274 (6.5%)	19,496 (3.8%)	12,604 (2.4%)	13,230 (2.6%)
NU	--	--	--	23,309 (73.1%)	1,802 (5.6%)	3,645 (11.4%)	1,686 (5.3%)	846 (2.7%)	227 (0.7%)	391 (1.2%)
NT	--	--	--	16,865 40.7%)	1,114 (2.7%)	4,649 (11.2%)	9,356 (22.6%)	4,183 (10.1%)	2,903 (7.0%)	2,392 (5.8%)
YT	--	--	--	7,171 (21.2%)	360 (1.1%)	9,330 (27.5%)	4,340 (12.8%)	4,192 (12.4%)	3,491 10.3%)	5,013 (14.8%)
CANADA % of pop.	261,901 (0.8%)	313,173 (0.9%)	995,187 (3.0%)	9,071,633 (27.1%)	5,005,362 (15.0%)	10,626,758 (31.7%)	3,103,577 (9.3%)	1,421,075 (4.2%)	742,157 (2.2%)	1,935,865 (5.8%)

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

Health Canada CPF: No CPF										
California OEHHA CPF: 0.91	< 0.00036	0.00036 to < 0.0004	0.0004 to < 0.0005	0.0005 to < 0.0007	0.0007 to < 0.0011	0.0011 to < 0.0017	0.0017 to < 0.0022	0.0022 to < 0.0028	0.0028 to < 0.0033	> 0.0033
US EPA CPF: No CPF										

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