GOBIERNODECHILE

COMISION NACIONAL
DEL MEDIO AMBIENTE

"NATIONAL PROGRAM FOR THE INTEGRAL MANAGEMENT OF MERCURY IN CHILE"

December 2007

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1 OBJECTIVES.

1.1 General Objective

Identify and manage mercury in Chile to protect human health and the environment.

1.2 Specific Objectives

- Involve stakeholders in partnerships for mercury emissions reporting and risk reduction.

- Develop an inventory of mercury usage, consumption and release and a listing of mercury-contaminated sites.

2 SUMMARY

The general objective of this project is to identify and manage mercury emissions in Chile in order to protect human health and the environment.

To fulfill this general objective, the project foresees the implementation of the following activities, among others:

- Identifying the main sources of mercury emission and release in Chile.
- Monitor progress towards the established goals using the inventory and subsequent updates.

The methodology used to formulate the inventory is based on the "Toolkit for Identification and Quantification of Mercury Releases," Pilot Draft, Geneva, Switzerland, November 2005. This Toolkit was designed by the United Nations Environment Programme (UNEP), Chemical Division. An Excel spreadsheet attached to the Toolkit was used to calculate mercury releases.

The first stage in applying the Toolkit was to preparing a rough selection matrix to identify the principal mercury source categories in Chile. In the second stage subcategories and additional qualitative information were added for the purpose of identifying specific activities and sources of mercury release present in the country. The third stage consisted of collecting detailed quantitative information on the sources identified, based on:

- Field visits
- Interviews with experts and academics
- Direct information provided by companies
- Projects submitted to the Environmental Impact Assessment System (SEIA)
- Information available in Yearly Reports, Inventories and Theses
- Direct surveying
- Information from the National Clean Production Council
- Existing liquid industrial waste (LIW) monitoring data
- Data available in the "Hazardous Waste Declaration and Follow Up System" and in other management plans.

In this final stage a top-down methodology was also used, with release estimates calculated based on global emissions (national aggregate data) for the main source categories of mercury releases in the inventory. This approach enabled mercury release estimates to be calculated early in the process (Preliminary Inventory).

In the fourth stage of the process, to build the release inventory, national level releases were quantified using the same top-down approach coupled with a bottom-up approach in which information was collected from specific sources for which de-aggregated information could be obtained.

This combination of a top-down and bottom-up approach in the strategy employed to build the inventory enabled the ongoing comparison of the data, which in turn helped to validate, correct, improve and converge results as they were obtained (for those activities in which information could be de-aggregated).

The following categories were used in building the inventory:

5.1 "Extraction and use of fuels/energy sources"
5.2 "Primary (virgin) metal production"
5.3 "Production of other minerals and materials with mercury impurities"
5.5 "Consumer products with intentional use of mercury"
5.6 "Other intentional products/process uses"
5.7 "Production of recycled metals ("secondary" metal production)"
5.8 "Waste incineration"
5.9 "Waste deposition/landfilling and waste water treatment"
5.10 "Crematoria and cemeteries"

It is important to highlight that there were no activities identified as mercury emission sources for any of the four sub-categories of point 5.4 of the Toolkit, "Intentional use of mercury in industrial processes." In the case of the subcategory "Chlor-alkali production with mercury-technology," Chile's single plant no longer uses mercury in its processes; under the same category, no sources were identified for polymer production using mercury as a catalyst.

In the process of building the inventory, however, certain additional sources of mercury release that were not considered in the Toolkit had to be included. A case in point is "Forest Fires" and "Agricultural Burns," which were included under subcategory 5.1.6 "Biomass fired power and heat production." Other activities incorporated into the inventory include "Ceramic production" and "Gypsum production" under subcategory 5.3.4 "Other minerals and materials."

Emissions were estimated for intervals based on the input factors recommended in the Toolkit. Preliminary estimates indicate that mercury releases in Chile fall between 361.007 and 416.821 Kg Hg/year, neither of which are absolute values.

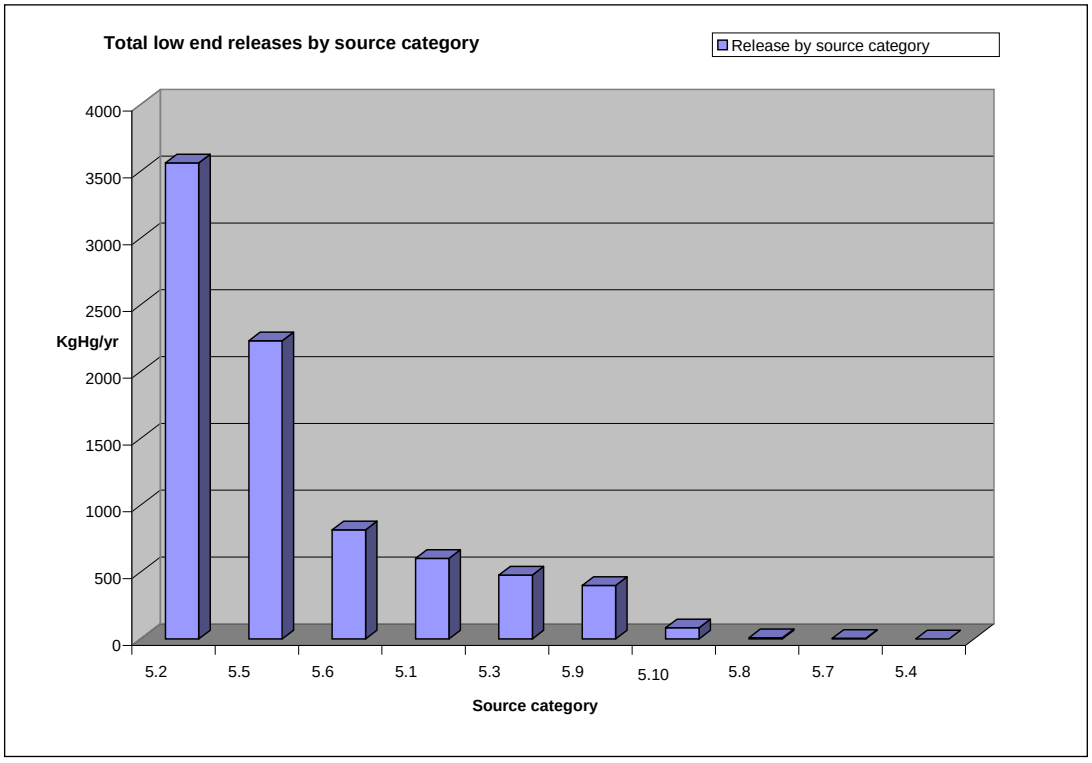
Based on the estimated results, the largest source of mercury release in the country corresponds to the category "Primary (virgin) metal production." This is due to Chile's large scale copper mining operations, specifically to the large quantity of tailing deposits coupled with the emissions from copper cathode production in seven primary smelters distributed throughout the country. Other activities that contribute mercury releases to this category include small and medium scale gold mining, which covers both natural mercury present in deposits and mercury used in the gold recovery process (amalgamation).

Comparative analysis of the results obtained, based on the input factors applied (low end and high end), indicates that five of the ten categories studied show the highest mercury releases. Because of the range obtained for the source category "Primary (virgin) metal

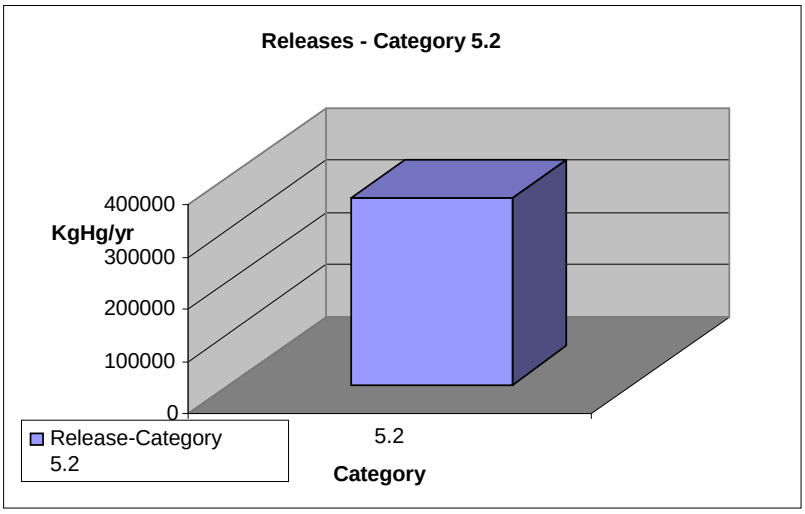
production," this item is displayed in a separate graph to facilitate comprehension (Graphs 2 and 4, low end and high end input factors, respectively).

The graphs below present the results obtained for both input factors used (Graphs 1, 2, 3 and 4):

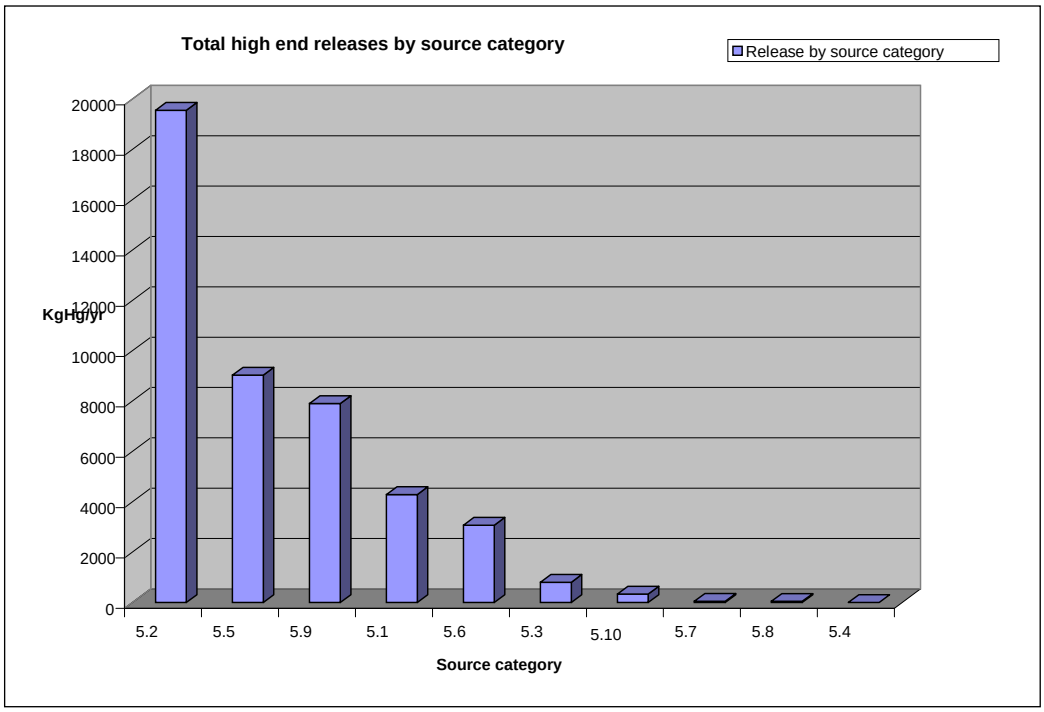
Graph 1 "Total low end release estimates by source category"



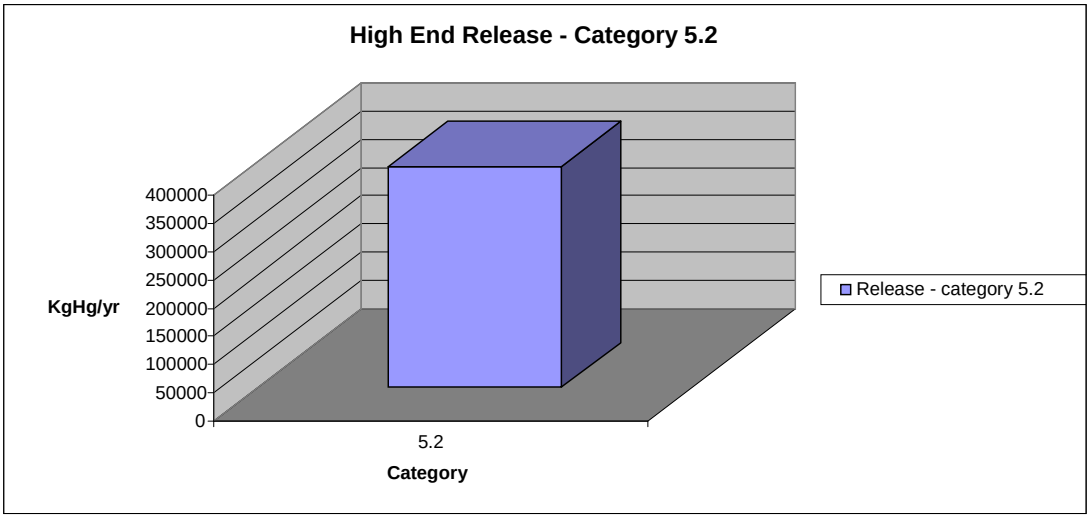
Graph 2 "Total low end release estimates for Primary (virgin) Metal Production"



Graph 3 "Total high end release estimates by source category"



Graph 4 "Total high end release estimate for Primary (virgin) Metal Production"



In regard to the different release pathways associated with the source categories studied, the main pathway identified is land, associated with the source category with the highest contribution, namely "Primary (virgin) metal production." These releases are mainly from tailing deposits generated in copper mining and gold extraction activities with and without mercury amalgamation.

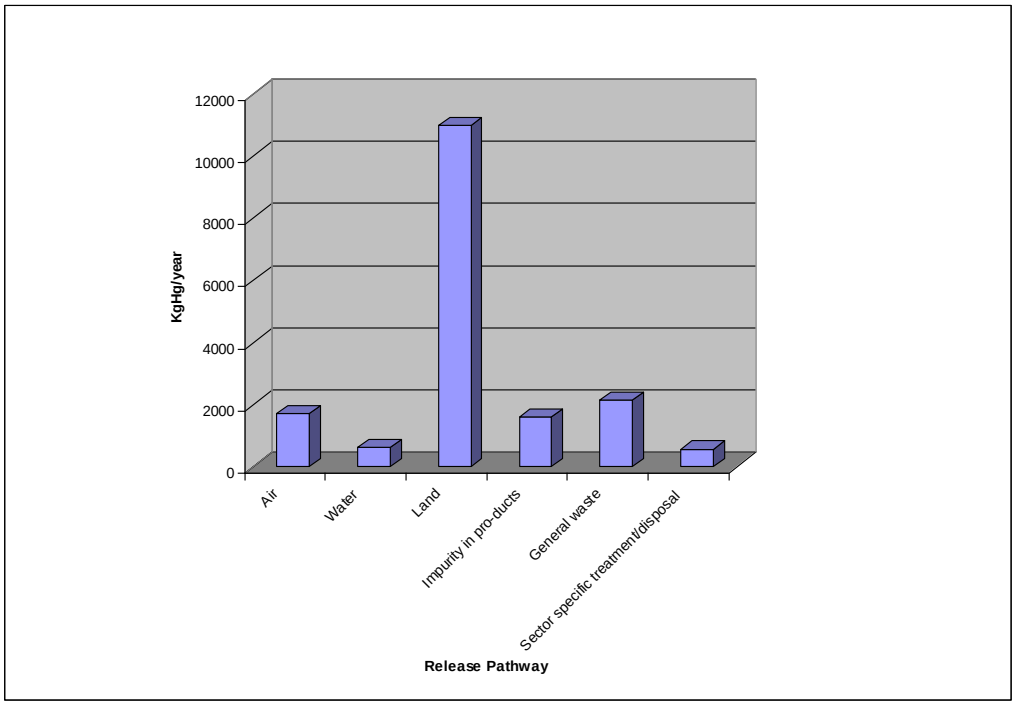
The increment in general deposits is attributed to mercury-containing waste products such as batteries, thermometers, lamps and other items that are not treated before disposal.

In regard to air releases, at the national level the industries with the highest releases are thermoelectric energy plants powered by coal, biomass, petroleum, natural gas and petroleum distillate combustion; mining smelters; and medical waste incineration.

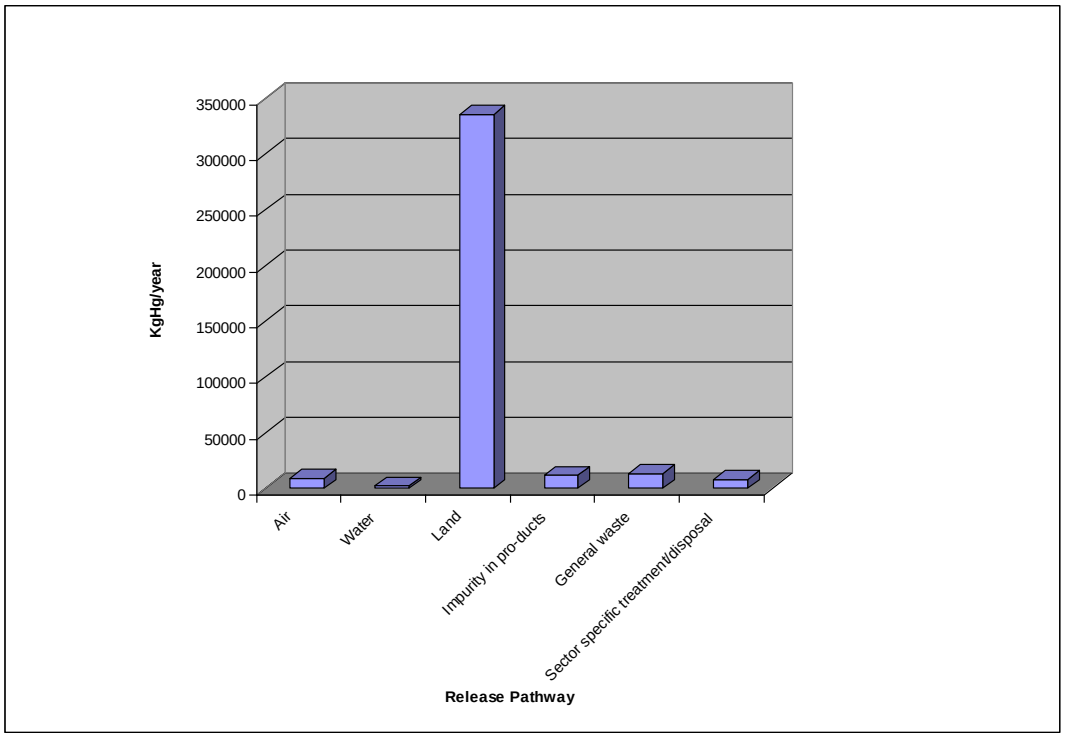
The release pathway "Product Impurity" has increased in large part because of the subcategory "Copper extraction and initial processing" and "Dental mercury-amalgam fillings."

In the graphs 5 and 6 below present the low end and high end emission estimates in all source categories and their respective subcategories by release pathway:

Graph 5 "Low end Emission Estimates by Release Pathway"



Graph 6 "High end emission estimates by release pathway"



2.1 Mercury releases by source category

The tables below present releases of mercury by source category and release pathway, as low end values in Table 1 and high end values in Table 2.

Table 1. Low End Mercury Release Estimates by Source Category and Release Pathway

			Mercury outputs calculated, Kg/y					
	Source Category	Exists (y/n)	Air	Water	Land	Products	General waste treatment	Treated waste
5.1	Extraction and use of fuels/energy sources	Y	503.09	30.96	7.74	0.00	41.28	19.29
5.2	Primary (virgin) metal production	Y	678.63	48.25	353583.46	1450.08	0.00	598.49
5.3	Production of other minerals	Y	470.84	0.00	0.00	0.00	7.88	39.99
5.4	Intentional use of mercury in industrial processes	N	0.00	0.00	0.00	0.00	0.00	0.00
5.5	Consumer products with intentional use of mercury	Y	107.04	222.98	32.53	0.00	1888.32	0.00
5.6	Other intentional products/ process uses	Y	16.27	115.07	0.00	488.02	98.80	99.20
5.7	Production of recycled metals (secondary metal production)	Y	4.05	0.00	0.00	0.00	0.45	0.00
5.8	Waste incineration	Y	8.54	0.00	0.00	0.00	0.00	0.20
5.9	Waste deposition/landfilling and waste water treatment	Y	12.08	225.91	4.01	0.00	98.07	61.16
5.10	Crematoria and cemeteries	Y	3.59	0.00	80.09	0.00	0.00	0.00
	Total		**1764.12**	**643.18**	**353707.83**	**1938.30**	**2134.80**	**818.32**

Table 2 High End Mercury Release Estimates by Source Category and Release Pathway

			Mercury outputs calculated, Kg/y					
	Source Category	Exists (y/n)	Air	Water	Land	Products	General waste treatment	Treated waste
5.1	Extraction and use of fuels/energy sources	Y	3794.89	30.96	7.74	0.00	437.17	53.71
5.2	Primary (virgin) metal production	Y	5039.08	723.81	361673.43	14944.50	0.00	8740.47
5.3	Production of other minerals	Y	790.75	0.00	0.00	0.00	7.88	0.00
5.4	Intentional use of mercury in industrial processes	N	0.00	0.00	0.00	0.00	0.00	0.00
5.5	Consumer products with intentional use of mercury	Y	619.13	636.81	406.68	0.00	7368.15	0.00
5.6	Other intentional products/ process uses	Y	65.07	456.68	0.00	1952.07	391.61	392.01
5.7	Production of recycled metals (secondary metal production)	Y	40.50	0.00	0.00	0.00	4.50	0.00
5.8	Waste incineration	Y	42.68	0.00	0.00	0.00	0.00	0.98
5.9	Waste deposition/landfilling and waste water treatment	Y	120.84	778.28	120.22	0.00	5019.60	1864.70
5.10	Crematoria and cemeteries	Y	14.35	0.00	320.34	0.00	0.00	0.00
	Total		**10527.29**	**2626.55**	**362528.41**	**16896.57**	**13228.92**	**11013.65**

Based on the results obtained for both low end and high end values, the most important categories are: "Primary (virgin) metal production;" "Consumer products with intentional use of mercury;" "Extraction and use of fuels/energy sources;" "Production of other minerals and materials with mercury impurities;" "Waste deposition/landfilling and waste water treatment" and "Other intentional products/ process uses."

2.2 Most important subcategories within each source category

The following subsections analyze each source category and the main subcategories thereunder, by their contribution to total environmental mercury releases.

Category 5.4 "Intentional use of mercury in industrial processes" was not analyzed as it does not apply to Chile.

2.2.1 Most important subcategories for source category 5.1: "Extraction and use of fuels/energy sources"

No sources under the following subcategories were identified in Chile:

i. 5.1.7 "Geothermal power production" (not carried out in Chile)
ii. 5.1.5 "Other fossil fuels – extraction and use" (associated with the production of peat and oil shale, not carried out in Chile).

The subcategories with the highest releases are:

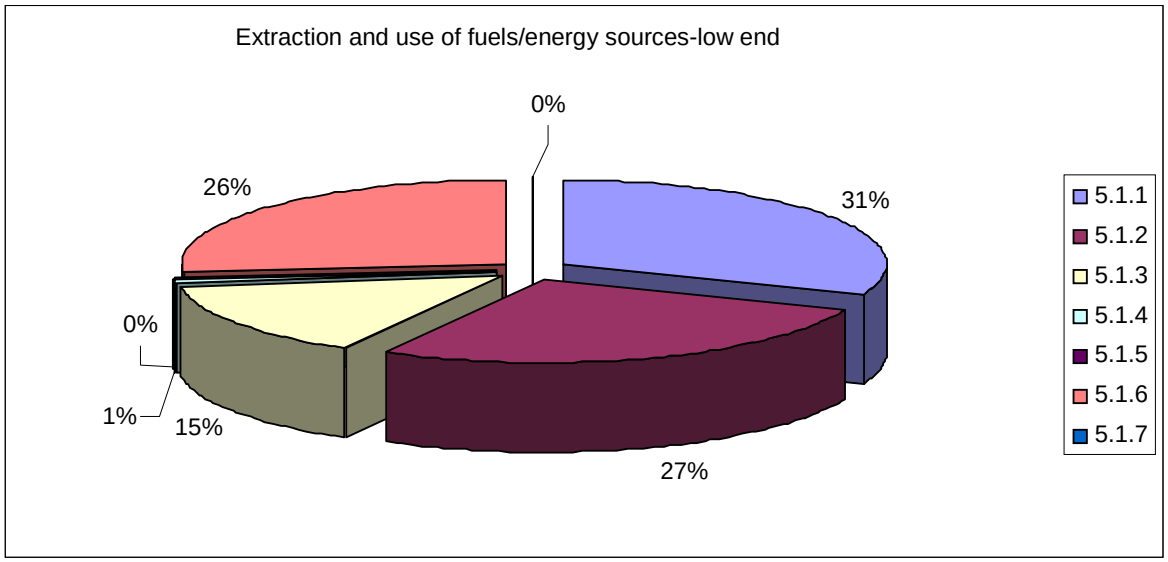
i. 5.1.1 "Coal combustion in large power plants"
ii. 5.1.2 "Other coal use" (in which information was de-aggregated by facility at the national level).

Of lesser importance is the subcategory 5.1.3 "Mineral Oils- extraction, refining and use." Extraction activities are carried out in Region XII in Chile, while refining of locally produced and imported crude oil is carried out in refineries situated in regions V, VIII and XII.

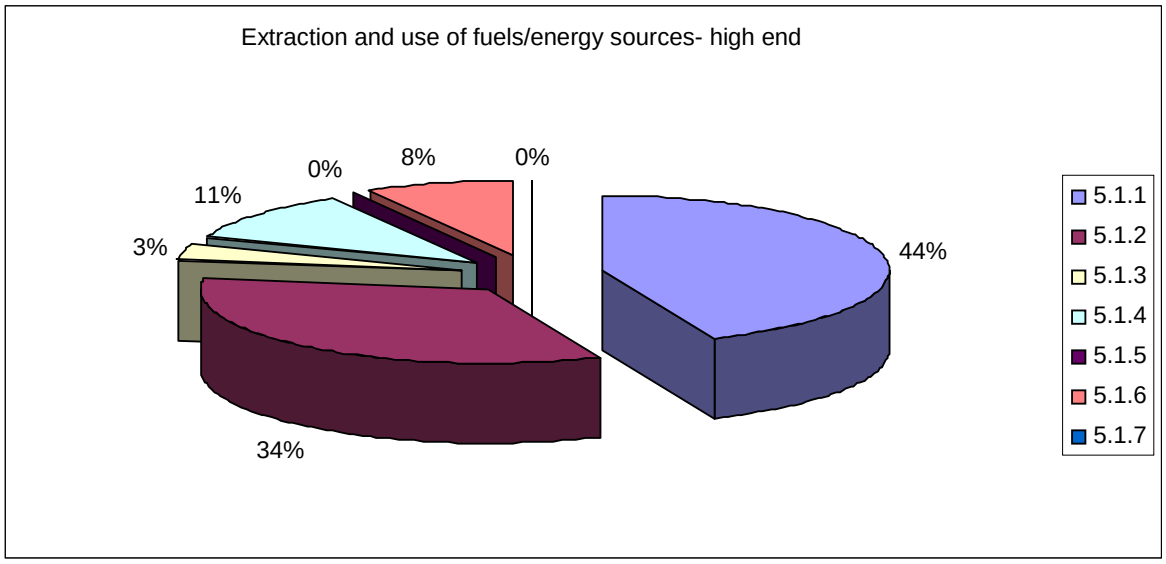
Mercury contained in fuels used in industry and in conventional modes of transportation was de-aggregated for each facility in the country.

The graphs below (7 and 8) show the percentage participation of each subcategory according to low end and high end values in each category:

Graph 7 Participation of subcategories- low end estimate



Graph 8 Participation of subcategories - high end estimate



2.2.2 Most important subcategories for source category 5.2: Primary (virgin) metal production

In this category no sources under subcategory 5.2.1 "Mercury extraction and initial processing" were identified, as there is currently no primary production of mercury in Chile.

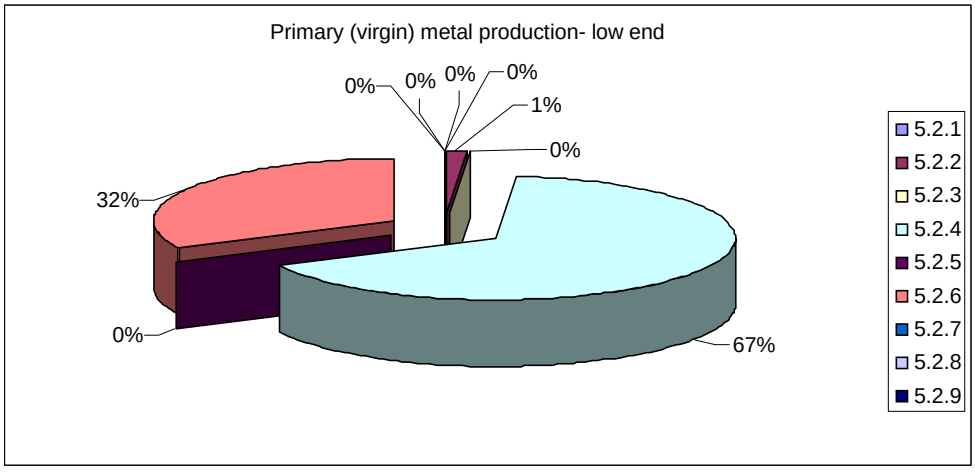
The largest releases in this category are recorded under subcategory 5.2.4 "Copper extraction and initial processing." The methodology does not include the gravel resulting from hydrometallurgical copper production; in that case mercury is not used and therefore the Toolkit does not supply factors for this process. However, mercury releases into the soil are strongly incremented in this category because of the massive amount of tailings generated in processing copper sulphate concentrates.

Another subcategory that plays a major role is 5.2.2 "Gold and silver extraction with mercury-amalgamation processes," which is carried out by small scale miners in Chile. There is a large number of these *pirquineros* in Chile using this technique, located mainly between Region III and Region IV.

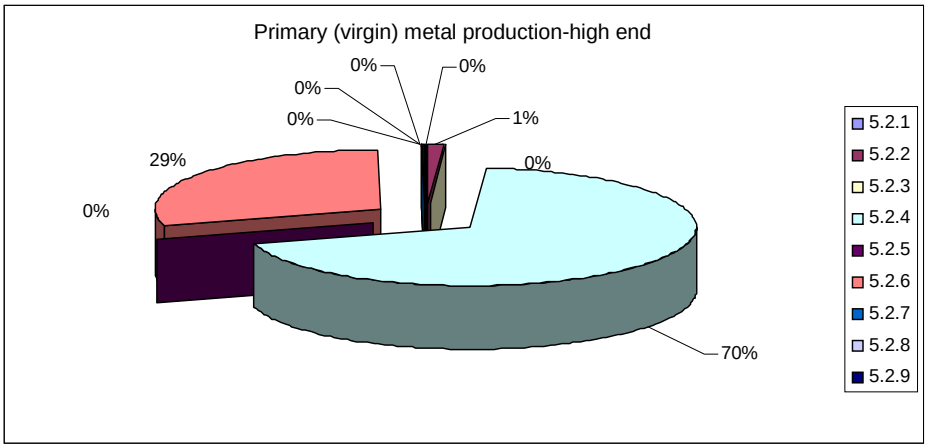
In regard to subcategory 5.2.6 "Gold extraction and initial processing by methods other than mercury amalgamation," production occurs mainly in regions II, III, IV, V, RM and XII and is usually in the form of metallic gold, gold doré and gold concentrate.

The graphs below (9 and 10) show the percentage participation of each subcategory under low end and high end values for this category:

Graph 9 Participation of each subcategory – low end estimate



Graph 10 Participation of each subcategory – high end estimate



2.2.3 Most important subcategories for source category 5.3: Production of other minerals and materials with mercury impurities.

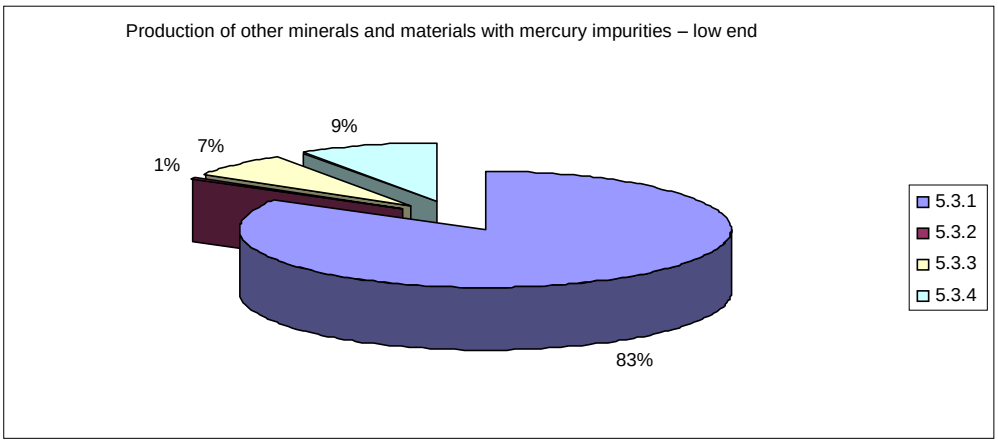
All Toolkit subcategories under this source category were identified in Chile, with the most important being subcategory 5.3.1 "Cement Production."

Chile has five cement plants located in regions II, V, RM, VII and VIII. The process of calcination accounts for the largest airborne releases of mercury.

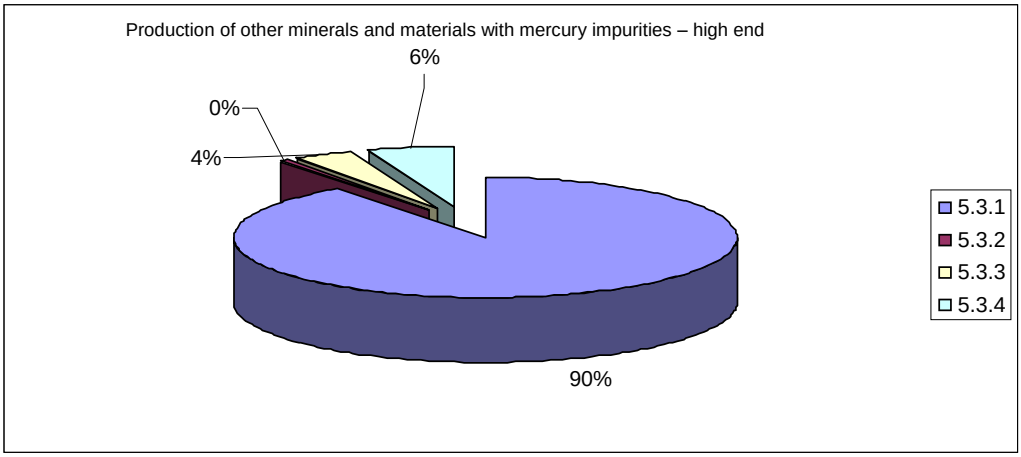
Under the emissions estimation methodology, a high end atmospheric emission factor of 0.18 ppm is used, estimated on the basis of the maximum concentration established in the "Emission Standard for waste incineration and coincineration of the Ministry Secretary General of the Presidency" and an atmospheric emission factor of 0.1 ppm, suggested in the Toolkit. This is because the values obtained using only the factors suggested in the Toolkit differ enormously from local realities.

The following graphs (11 and 12) illustrate the percentage participation of each subcategory by low end and high end estimates for this source category:

Graph 11 Participation of each subcategory - low end estimate



Graph 12 Participation of each subcategory with high end estimate



2.2.4 Most important subcategories for source category 5.5: Consumer products with intentional use of mercury

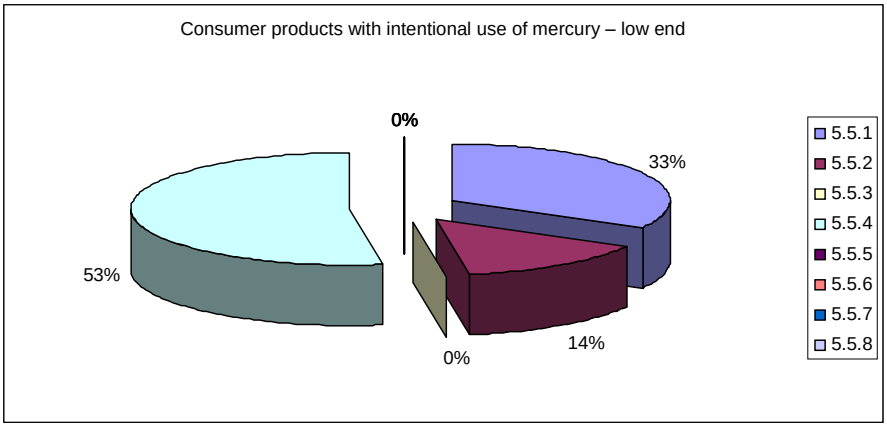
In this source category, no sources under the subcategory 5.5.5 "Biocides and pesticides" were identified, since this activity is regulated in Chile under Agriculture and Livestock Service (SAG) Resolution 996. Another subcategory not identified in Chile is 5.5.6 "Paints," as according to reports, mercury containing compounds used in paints have been replaced in Chile.

The largest subcategories under this source category are 5.5.1 "Thermometers with mercury" and 5.5.4 "Batteries with mercury," with no production of either reported in Chile. However, a large number of these goods are imported into the country, according to the National Customs Service. In addition, companies that handle hazardous waste in the

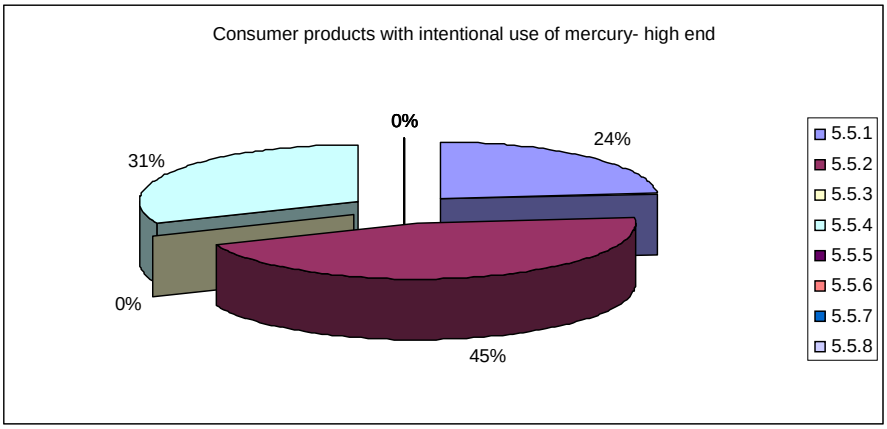
country report the disposal of approximately 3% of batteries with mercury consumed each year.

Graphs 13 and 14 show the contribution of each subcategory according to low end and high end estimates for this source category:

Graph 13 Participation of each subcategory – low end estimate



Graph 14 Subcategory participation with high end estimate



2.2.5 Most important subcategories for Source Category 5.6: Other intentional products/process uses of mercury.

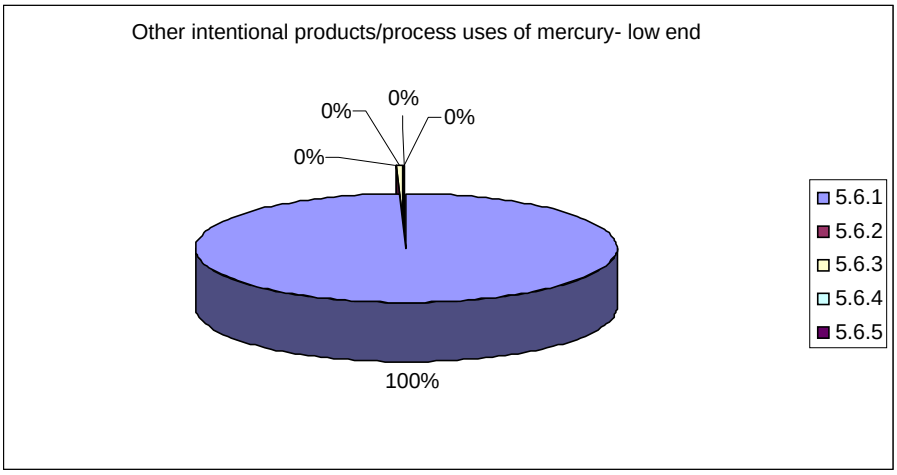
Under this source category the subcategory 5.6.4 "Ethnic, cultural, ritualistic uses" was not identified, as no activities of this kind associated with mercury use were reported in Chile. The same is true for subcategory 5.6.5 "Miscellaneous product uses, mercury metal uses, and other sources."

The most important subcategories in this case were reported for 5.6.1 "Dental mercury-amalgam fillings," which are used mainly in the public health sector.

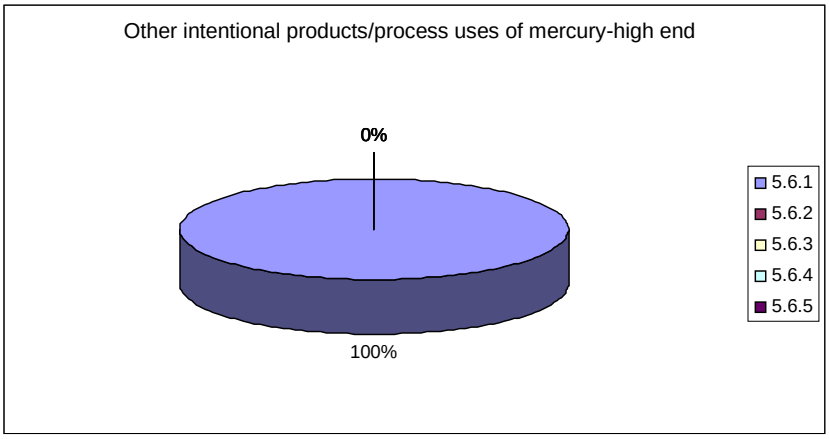
In regard to subcategory 5.6.2 “Manometers and gauges,” there is no information on activity levels, but the National Customs Service has data on imports of these products as well as for mercury-containing chemicals used in laboratory analysis.

Graphs 15 and 16 display the participation of each subcategory at low end and high end values for this source category:

Graph 15 Subcategory participation – low end estimate



Graph 16 Subcategory participation – high end estimate

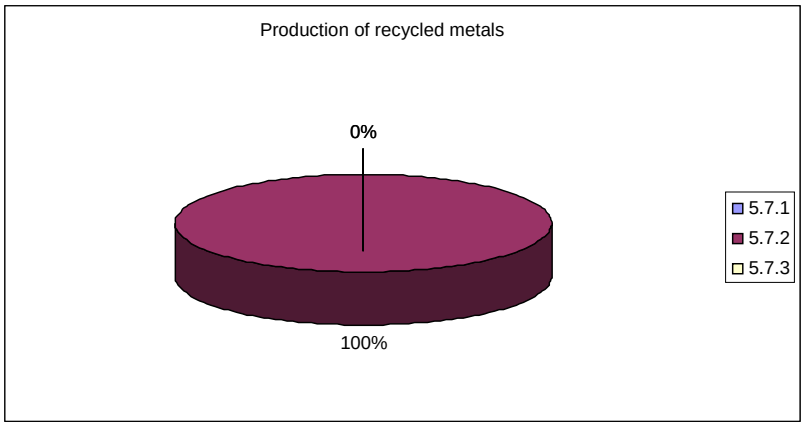


2.2.6 Important subcategories for Source Category 5.7: Production of recycled metals (secondary metal production)

The only subcategory identified under this source category was 5.7.2 "Production of recycled ferrous metals (iron and steel)," the main source of which is a local Chilean company.

Emission estimation was not possible for this subcategory because the Toolkit does not report any input or output factors for the calculation and it was not possible to generate the information needed to carry out such estimations.

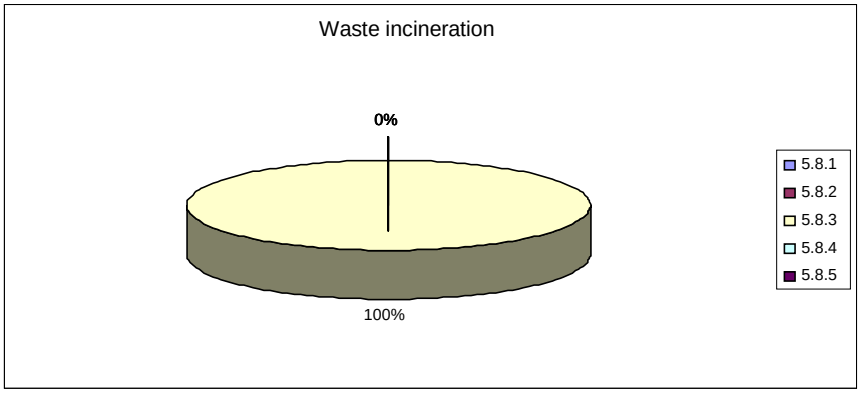
Graph 17 Subcategory participation



2.2.7 Important subcategories for source category 5.8: Waste incineration

A single subcategory was identified under this source category: "Incineration of medical waste." No activities were reported in the country for any other subcategory.

Graph 18 Subcategory participation

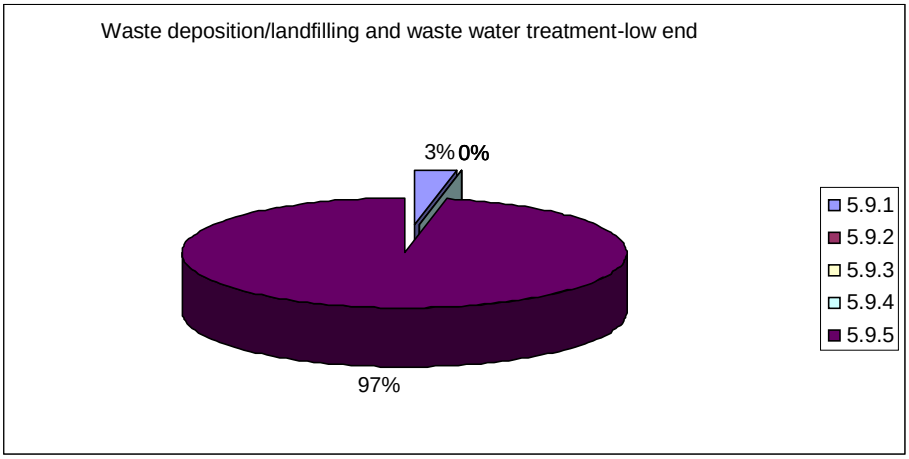


2.2.8 Important subcategories for source category 5.9: Waste deposition/landfilling and waste water treatment.

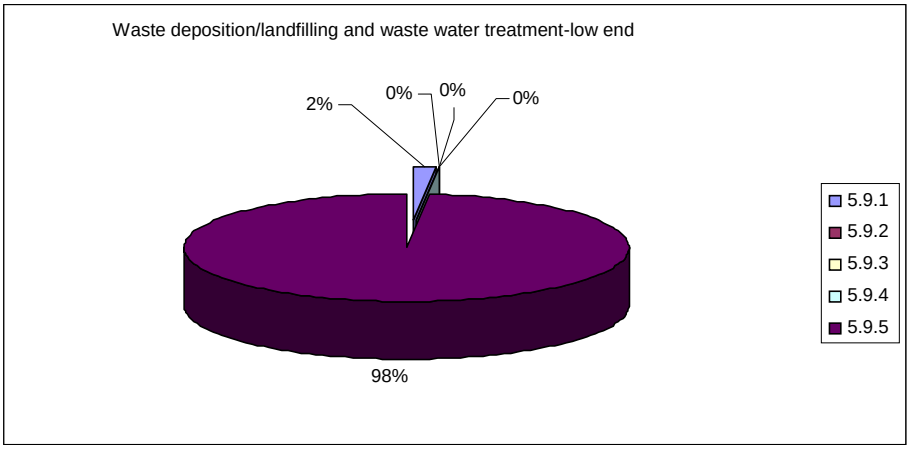
In this source category, two subcategories were identified in Chile, namely "Controlled landfills/deposits" and "Waste water system/treatment;" national standards currently regulate mercury concentrations in discharges to watercourses.

The graphs below show the participation of each subcategory by low end and high end estimates:

Graph 19 Subcategory participation- low end estimate



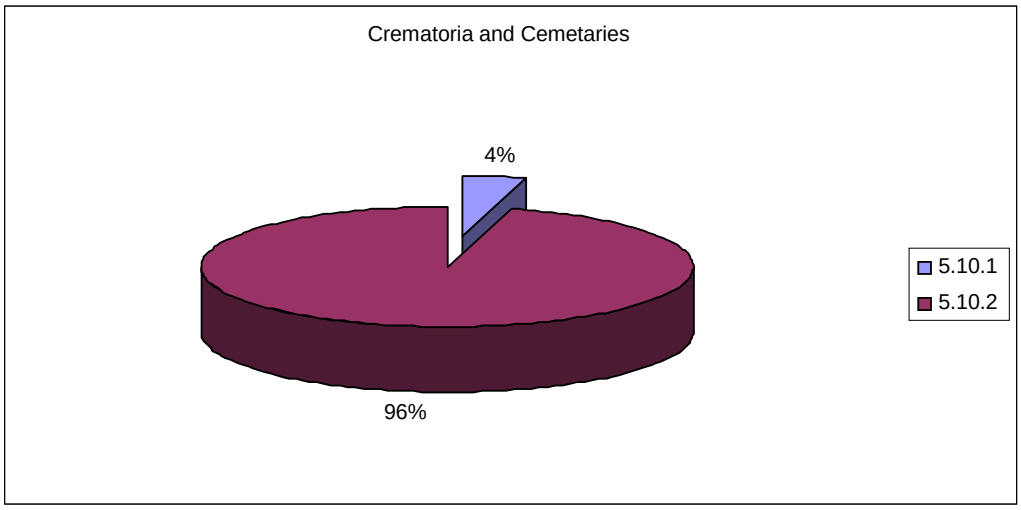
Graph 20 Subcategory participation – high end estimate



2.2.9 Important subcategories for source category 5.10: Crematoria and Cemeteries

Two subcategories from the Toolkit were identified under this source category in Chile, with cemeteries (5.10.2) presenting the greatest releases of mercury. In this case the low end and high end input factors are equal, and therefore only one graph is presented:

Graph 21 Subcategory participation



2.3 Information Gaps

In general, a lot of information is still lacking for most subcategories studied; for this reason the default factors suggested in the Toolkit were used.

For those subcategories for which the Toolkit reports no input factors, the inventory based estimates on data reported by other countries in similar situations. This information was collected within the Toolkit. The same methodology was used for output factors.

In regard to the output distribution for each release pathway, when the Toolkit did not give suggested values for a given subcategory, a distribution was applied based on the efficiency of abatement equipment and/or expert consultation.

One of the greatest gaps in the emissions estimation data was for the category 5.2 "Primary (virgin) metal production," mainly associated with activity levels of small scale gold mining operations using mercury amalgamation processes and with zinc and copper production (in regard to measurements of copper ore, cooper concentrate and tailing deposits). This information will become available, but was not available when this study went to press.

In categories 5.5 "Consumer products with intentional use of mercury" and 5.6 "Other intentional products/process uses," many mercury containing products were identified in

Chile, but it was not possible to quantify these products under the current import classification system used by the customs service in our country.

In the case of subcategory 5.6.3 "Laboratory chemicals and equipment," mercury containing compounds entering the country for use in chemical laboratories were identified, but these could not be quantified due to the complexity of the compounds they contained.

For subcategory 5.7.3 "Production of other recycled metals," aluminum recycling activity was reported but it was not possible to estimate mercury releases as no input and output factors could be established.

In subcategory 5.9.1 "Controlled landfills/deposits," output factors could not be established for leached material and the Toolkit does not offer default factors.

2.4 Conclusions

The inventory that was developed is a first step towards addressing concerns regarding this element in Chile. The degree of uncertainty in regard to "activity rates" and "input factors and output distribution factors" were better when industries provided more information on their processes (for example in the cement and petroleum sectors).

The general analysis of the results offered above indicates that future efforts should be aimed at improving the information available to perfect the inventory before any major decisions are made in regard to mercury management. In the mining sector in particular, there is a high degree of uncertainty due to the lack of information on the mercury content of mineral concentrates, ore and tailings, etc.

To accomplish this, efforts should focus on implementing key measures such as establishing working groups in different sectors and conducting situation analyses to enable and improve access to more precise and de-aggregated information for each sector.

In that regard, progress already achieved in the cement and petroleum sectors, for example, has enabled (high end) mercury emission estimates to be reduced, illustrating that having more and better information generates less uncertain results that are more in line with the actual situation in the country.

One of the highest levels of uncertainty is found in the sector associated with mercury containing products. In the short term this situation could be improved through measures such as enhancing the National Customs Service classification system to identify such products when they enter the country; today, the information required is quite disperse, which hinders the clear identification of mercury containing products.

A follow up system should also be designed to track mercury containing products from their entry into Chile up to their final sale to consumers. It is further recommended that

there be a declaration system for mercury bearing products destined for the private health care system, as access to information in this sector is highly limited. In the public health sector, however, a certain degree of access to information has been achieved, and the intention is to continue improving the information available to facilitate the design of action plans for the short and medium term.

3 IDENTIFIED SOURCES OF MERCURY RELEASE

Table 3 Summary of high end release estimates by source subcategory and release pathway

C	Sub -C	Source category	Exists? (y/n)	Estimated mercury release in Kg/y					
				Air	Water	Soil	Products	General waste treatment	Treated Waste
5.1		**Extraction and use of fuels/energy sources**							
	5.1.1	**Coal combustion in large power plants**	y	1611.1	0	0	0	254.4	0
	5.1.2	**Other coal use**	y	1313	0	0	0	129	38
	5.1.3	**Mineral oils - extraction, refining and use**	y	83	31	8	0	6	15
	5.1.4	**Natural gas - extraction, refining and use**	y	433	0	0	0	48	0
	5.1.5	**Other fossil fuels - extraction and use**	n	0	0	0	0	0	0
	5.1.6	**Biomass fired power and heat production**	y	355	0	0	0	0	0
	5.1.7	**Geothermal power production**	n	0	0	0	0	0	0
5.2		**Primary (virgin) metal production**							
	5.2.1	**Mercury extraction and initial processing**	n	0	0	0	0	0	0
	5.2.2	**Gold and silver extraction with mercury-amalgamation process**	y	0	0	4215	468	0	0
	5.2.3	**Zinc extraction and initial processing**	y	0	0	56	0	0	0
	5.2.4	**Copper extraction and initial processing**	y	3619	724	242699	14476	0	8686
	5.2.5	**Lead extraction and initial processing**	n	0	0	0	0	0	0
	5.2.6	**Gold extraction and initial processing by methods other than mercury amalgamation**	y	380	0	114705	0	0	0
	5.2.7	**Aluminum extraction and initial processing**	n	0	0	0	0	0	0
	5.2.8	**Other non-ferrous metals - extraction and processing**	n	0	0	0	0	0	0
	5.2.9	**Primary ferrous metal production**	y	1040	0	0	0	0	55
5.3		**Production of other minerals and materials with mercury impurities**							
	5.3.1	**Cement production**	y	720	0	0	0	0	0
	5.3.2	**Pulp and paper production**	y	3	0	0	0	0	0

C	Sub -C	Source category	Exists? (y/n)	Estimated mercury release in Kg/y					
				Air	Water	Soil	Products	General waste treatment	Treated Waste
	5.3.3	Production of lime and light weight aggregate	y	28	0	0	0	3	0
	5.3.4	Others minerals and materials	y	40	0	0	0	4	0
5.4		Intentional use of mercury in industrial processes							
	5.4.1	Chlor-alkali production with mercury-technology	n	0	0	0	0	0	0
	5.4.2	VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst	n	0	0	0	0	0	0
	5.4.3	Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst	n	0	0	0	0	0	0
	5.4.4	Other production of chemicals and polymers with mercury compounds as catalysts	n	0	0	0	0	0	0
5.5		Consumer products with intentional use of mercury							
	5.5.1	Thermometers with mercury	y	212	637	0	-	1274	0
	5.5.2	Electrical switches and relays with mercury	y	407	0	407	-	3253	0
	5.5.3	Light sources with mercury	y	0	0	0	-	3	0
	5.5.4	Batteries with mercury	y	0	0	0	-	2838	0
	5.5.5	Biocides and pesticides	n	0	0	0	-	0	0
	5.5.6	Paints	n	0	0	0	-	0	0
	5.5.7	Pharmaceuticals for human and veterinary uses	y	0	0	0	-	0	0
	5.5.8	Cosmetics and related products	n	0	0	0	-	0	0
5.6		Other intentional product/process uses							
	5.6.1	Dental mercury-amalgam fillings	y	65	455	0	1952	390	390
	5.6.2	Manometers and gauges	y	0	0	0	-	0	0
	5.6.3	Laboratory chemicals and equipment	y	0	1	0	0	1	2
	5.6.4	Mercury metal use in religious rituals and folklore medicine	n	0	0	0	-	0	0
	5.6.5	Miscellaneous product uses	n	0	0	0	-	0	0
5.7		Production of recycled metals ("secondary"							

C	Sub-C	Source category	Exists? (y/n)	Estimated mercury release in Kg/y					
				Air	Water	Soil	Products	General waste treatment	Treated Waste
		metal production)							
	5.7.1	**Production of recycled mercury ("secondary production")**	n	0	0	0	-	0	0
	5.7.2	**Production of recycled ferrous metals (iron and steel)**	y	41	0	0	0	5	0
	5.7.3	**Production of other recycled metals**	n	0	0	0	0	0	0
5.8		**Waste incineration**							
	5.8.1	**Incineration of municipal/general waste treatment**	n	0	0	0	0	0	0
	5.8.2	**Incineration of hazardous waste**	n	0	0	0	0	0	0
	5.8.3	**Incineration of medical waste**	y	43	0	0	0	0	1
	5.8.4	**Sewage sludge incineration**	n	0	0	0	0	0	0
	5.8.5	**Informal waste incineration**	n	0	0	0	0	0	0
5.9		**Waste deposition/landfilling and waste water treatment**							
	5.9.1	**Controlled landfills/deposits**	y	121	?	?	-	-	-
	5.9.2	**Diffuse deposition under some control**	n	-	-	-	-	-	-
	5.9.3	**Informal local disposal of industrial production waste**	n	0	0	0	-	-	-
	5.9.4	**Informal dumping of general waste treatment**	n	0	0	0	-	-	-
	5.9.5	**Waste water system/treatment**	y	0	778	120	0	5020	1865
5.10		**Crematoria and cemeteries**							
	5.10.1	**Crematoria**	y	14	0	0	-	0	0
	5.10.2	**Cemeteries**	y	0	0	320,34	-	0	0
Sum of quantified releases:			-	**10527.3**	**2626.5**	**362528.4**	**16896.6**	**13228.9**	**11013.6**

Table 4 Summary of low end mercury releases by subcategory and release pathway

C	Sub-C	Source Category	Exists ? (y/n)	Estimated mercury outputs, Kg/y					
				Air	Water	Land	Products	General Waste	Sector-Spec. treatment
5.1		**Extraction and use of fuels/energy sources**							
	5.1.1	**Coal combustion in large power plants**	y	161.1	0	0	0	25.4	0
	5.1.2	**Other coal use**	y	145	0	0	0	15	4
	5.1.3	**Mineral oils - extraction, refining and use**	y	33	31	8	0	0	15
	5.1.4	**Natural gas - extraction, refining and use**	y	4	0	0	0	0	0
	5.1.5	**Other fossil fuels - extraction and use**	n	0	0	0	0	0	0
	5.1.6	**Biomass fired power and heat production**	y	159	0	0	0	0	0
	5.1.7	**Geothermal power production**	n	0	0	0	0	0	0
5.2		**Primary (virgin) metal production**							
	5.2.1	**Mercury extraction and initial processing**	n	0	0	0	0	0	0
	5.2.2	**Gold and silver extraction with mercury-amalgamation process**	y	0	0	4215	468	0	0
	5.2.3	**Zinc extraction and initial processing**	y	6	0	72	17	0	17
	5.2.4	**Copper extraction and initial processing**	y	241	48	234592	965	0	579
	5.2.5	**Lead extraction and initial processing**	n	0	0	0	0	0	0
	5.2.6	**Gold extraction and initial processing by methods other than mercury amalgamation**	y	380	0	114705	0	0	0
	5.2.7	**Aluminum extraction and initial processing**	n	0	0	0	0	0	0
	5.2.8	**Other non-ferrous metals - extraction and processing**	n	0	0	0	0	0	0
	5.2.9	**Primary ferrous metal production**	y	52	0	0	0	0	3
5.3		**Production of other minerals and materials with mercury impurities**							
	5.3.1	**Cement production**	y	400	0	0	0	0	40
	5.3.2	**Pulp and paper production**	y	3	0	0	0	0	0
	5.3.3	**Production of lime and light weight aggregate**	y	28	0	0	0	3	0
	5.3.4	**Others minerals and materials**	y	40	0	0	0	4	0
5.4		**Intentional use of mercury in industrial processes**							
	5.4.1	**Chlor-alkali production**	n	0	0	0	0	0	0

C	Sub -C	Source Category	Exists ? (y/n)	Estimated mercury outputs, Kg/y					
				Air	Water	Land	Products	General Waste	Sector-Spec. treatment
		with mercury-technology							
	5.4.2	**VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst**	n	0	0	0	0	0	0
	5.4.3	**Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst**	n	0	0	0	0	0	0
	5.4.4	**Other production of chemicals and polymers with mercury compounds as catalysts**	n	0	0	0	0	0	0
5.5		**Consumer products with intentional use of mercury**							
	5.5.1	**Thermometers with mercury**	y	74	223	0	-	446	0
	5.5.2	**Electrical switches and relays with mercury**	y	33	0	33	-	260	0
	5.5.3	**Light sources with mercury**	y	0	0	0	-	3	0
	5.5.4	**Batteries with mercury**	y	0	0	0	-	1179	0
	5.5.5	**Biocides and pesticides**	n	0	0	0	-	0	0
	5.5.6	**Paints**	n	0	0	0	-	0	0
	5.5.7	**Pharmaceuticals for human and veterinary uses**	y	0	0	0	-	0	0
	5.5.8	**Cosmetics and related products**	y	0	0	0	-	0	0
5.6		**Other intentional product/process uses**							
	5.6.1	**Dental mercury-amalgam fillings**	y	16	114	0	488	98	98
	5.6.2	**Manometers and gauges**	y	0	0	0	-	0	0
	5.6.3	**Laboratory chemicals and equipment**	y	0	1	0	0	1	2
	5.6.4	**Mercury metal use in religious rituals and folklore medicine**	n	0	0	0	0	0	0
	5.6.5	**Miscellaneous product uses**	n	0	0	0	-	0	0
5.7		**Production of recycled metals ("secondary" metal production)**							
	5.7.1	**Production of recycled mercury ("secondary production")**	n	0	0	0	-	0	0
	5.7.2	**Production of recycled ferrous metals (iron and steel)**	y	4	0	0	0	0	0
	5.7.3	**Production of other recycled metals**	n	0	0	0	0	0	0
5.8		**Waste incineration**							
	5.8.1	**Incineration of municipal/general waste**	n	0	0	0	0	0	0

C	Sub-C	Source Category	Exists ? (y/n)	Estimated mercury outputs, Kg/y					
				Air	Water	Land	Products	General Waste	Sector-Spec. treatment
		treatment							
	5.8.2	**Incineration of hazardous waste**	n	0	0	0	0	0	0
	5.8.3	**Incineration of medical waste**	y	9	0	0	0	0	0
	5.8.4	**Sewage sludge incineration**	n	0	0	0	0	0	0
	5.8.5	**Informal waste incineration**	n	0	0	0	0	0	0
5.9		**Waste deposition/landfilling and waste water treatment**							
	5.9.1	**Controlled landfills/deposits**	y	12	?	?	-	-	-
	5.9.2	**Diffuse deposition under some control**	n	-	-	-	-	-	-
	5.9.3	**Informal local disposal of industrial production waste**	n	0	0	0	-	-	-
	5.9.4	**Informal dumping of general waste treatment**	n	0	0	0	-	-	-
	5.9.5	**Waste water system/treatment**	y	0	226	4	0	98	61
5.10		**Crematoria and cemeteries**							
	5.10.1	**Crematoria**	y	4	0	0	-	0	0
	5.10.2	**Cemeteries**	y	0	0	80.085	-	0	0
Sum of quantified releases:			-	**1764.122**	**643.18**	**353707.8**	**1938.3**	**2134.8**	**818.32**

Table 5 Report on the existence of each subcategory identified

C	Sub-C	Source Category	Exists in Chile? (y/n)
5.1		**Extraction and use of fuels/energy sources**	
	5.1.1	**Coal combustion in large power plants**	Y
	5.1.2	**Other coal use**	Y
	5.1.3	**Mineral oils - extraction, refining and use**	Y
	5.1.4	**Natural gas - extraction, refining and use**	Y
	5.1.5	**Other fossil fuels - extraction and use**	None identified
	5.1.6	**Biomass fired power and heat production**	Y
	5.1.7	**Geothermal power production**	None identified
5.2		**Primary (virgin) metal production**	
	5.2.1	**Mercury extraction and initial processing**	None identified
	5.2.2	**Gold and silver extraction with mercury-amalgamation process**	Y
	5.2.3	**Zinc extraction and initial processing**	Y
	5.2.4	**Copper extraction and initial processing**	Y
	5.2.5	**Lead extraction and initial processing**	None identified
	5.2.6	**Gold extraction and initial processing by methods other than mercury amalgamation**	Y
	5.2.7	**Aluminum extraction and initial processing**	None identified
	5.2.8	**Other non-ferrous metals - extraction and processing**	None identified
	5.2.9	**Primary ferrous metal production**	Y
5.3		**Production of other minerals and materials with mercury impurities**	
	5.3.1	**Cement production**	Y
	5.3.2	**Pulp and paper production**	Y
	5.3.3	**Production of lime and light weight aggregate**	Y
	5.3.4	**Others minerals and materials**	Y
5.4		**Intentional use of mercury in industrial processes**	
	5.4.1	**Chlor-alkali production with mercury-technology**	None identified
	5.4.2	**VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst**	None identified
	5.4.3	**Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst**	None identified
	5.4.4	**Other production of chemicals and polymers with mercury compounds as catalysts**	None identified
5.5		**Consumer products with intentional use of mercury**	
	5.5.1	**Thermometers with mercury**	Y
	5.5.2	**Electrical switches and relays with mercury**	Y
	5.5.3	**Light sources with mercury**	Y
	5.5.4	**Batteries with mercury**	Y

C	Sub-C	Source Category	Exists in Chile? (y/n)
	5.5.5	Biocides and pesticides	None identified
	5.5.6	Paints	None identified
	5.5.7	Pharmaceuticals for human and veterinary uses	Not quantified
	5.5.8	Cosmetics and related products	None identified
5.6		Other intentional product/process uses	
	5.6.1	Dental mercury-amalgam fillings	Y
	5.6.2	Manometers and gauges	Y
	5.6.3	Laboratory chemicals and equipment	Y
	5.6.4	Mercury metal use in religious rituals and folklore medicine	None identified
	5.6.5	Miscellaneous product uses	None identified
5.7		Production of recycled metals ("secondary" metal production)	
	5.7.1	Production of recycled mercury ("secondary production")	None identified
	5.7.2	Production of recycled ferrous metals (iron and steel)	Y
	5.7.3	Production of other recycled metals	Y
5.8		Waste incineration	
	5.8.1	Incineration of municipal/general waste treatment	None identified
	5.8.2	Incineration of hazardous waste	None identified
	5.8.3	Incineration of medical waste	Y
	5.8.4	Sewage sludge incineration	None identified
	5.8.5	Informal waste incineration	No data available
5.9		Waste deposition/landfilling and waste water treatment	
	5.9.1	Controlled landfills/deposits	Y
	5.9.2	Diffuse deposition under some control	None identified
	5.9.3	Informal local disposal of industrial production waste	None identified
	5.9.4	Informal dumping of general waste treatment	None identified
	5.9.5	Waste water system/treatment	Y
5.10		Crematoria and cemeteries	
	5.10.1	Crematoria	Y
	5.10.2	Cemeteries	Y

4 QUANTIFYING MERCURY RELEASES

4.1 Category 5.1 "Extraction and use of fuels/energy sources"

4.1.1 Subcategory 5.1.1 "Coal combustion in large power plants"

General Information

In 2005, Chile had 14 operating coal-fired power plants distributed around the country as part of the Central Interconnected Grid (SIC) and the Far North Grid (SING).

These plants had steam turbines and each one of them used different fuel burning technologies, most of them based on pulverized coal and to a lesser extent the use of fluid bed burners (Petropower Power Plant), cyclonic burners (Bocamina Power Plant) and roller grate systems (Ventanas and Huasco Vapor power plants).

Parameters taken into account for estimating mercury releases associated with coal combustion in large power plants:

- Activity rate based on individual coal consumption in tons per year for each thermoelectric power plant.

Table 6 shows the activity rate for each subcategory:

Table 6 "Coal consumption in Chilean Thermoelectric Power Plants"

Coal-burning power plants	Location	Consumption tons/yr (*)	Annual power generation Mw/hour	Specific Consump. Kg/Kw hour	Ref.-year
Central Térmoeléctrica Tarapacá	Puerto Patache	188322.16	422247	0.446	CNE-2005
Central Térmica Mejilllones 1	Mejillones	6345.345	14587	0.435	CNE 2005
Central Térmica Mejilllones 2	Mejillones	8754.84	21096	0.415	CNE 2005
Nueva Tocopilla 1	Tocopilla	79416.045	198045	0.401	CNE 2005
Nueva Tocopilla 2	Tocopilla	67134.288	169104	0.397	CNE 2005
Tocopilla Unidad 12	Tocopilla	30135.203	58973	0.511	CNE 2005
Tocopilla Unidad 13	Tocopilla	72169.554	147586	0.489	CNE 2005
Tocopilla Unidad 14	Tocopilla	106068.48	276220	0.384	CNE 2005
Tocopilla Unidad 15	Tocopilla	152615.511	390321	0.391	CNE 2005
Huasco	Vallenar	10846.464	11136	0.974	CNE 2005
Laguna Verde	Valparaíso	68238.85	80281	0.85	CNE 2005
Ventanas 1	Ventanas	134484.485	324059	0.415	CNE 2005
Ventanas 2	Ventanas	333822.214	840862	0.397	CNE 2005
Bocamina	Coronel	161006.38	423701	0.38	CNE 2005

(*) Source: Based on "Fijación de precios de nudo" (Node price setting), CNE 2005

Table 7 "Consumption of coal-petcoke in Chilean Thermoelectric Power Plants "

Petroleum coke-burning Power Plants	Location	Consumption tons/yr (*)	Annual power generated Mw/hour	Specific Consump. Kg/Kw hour	Ref.-year
Central Térmica Mejilllones 1	Mejillones	93966.31	432029	0.435	CNE 2005
Central Térmica Mejilllones 2	Mejillones	171779.5	827853	0.415	CNE 2005
Nueva Tocopilla 1	Tocopilla	70340.01	350823	0.401	CNE 2005
Nueva Tocopilla 2	Tocopilla	71264.87	359017	0.397	CNE 2005
Tocopilla unidad 12	Tocopilla	0	0	0.511	CNE 2005
Tocopilla unidad 13	Tocopilla	0	0	0.489	CNE 2005
Tocopilla unidad 14	Tocopilla	104069.57	542029	0.384	CNE 2005
Tocopilla unidad 15	Tocopilla	33263.05	340287	0.391	CNE 2006
Guacolda 1	Huayco	199700.64	1109448	0.36	CNE 2005
Guacolda 2	Huayco	199936.26	1110757	0.36	CNE 2005
Petropower man	Hualpén	178219.11	365953	0.974	CNE 2005

(*) Consumption of coal based on 50% Petcoke fuel load.
Source: Based on "Fijación de Precios de nudo"(Node Price Setting), CNE 2005

Coal consumption (tons/year) for each power plant is estimated based on the National Energy Balance (BNE) and the document "Fijación de Precios de nudo" (Node Price Setting) published by the National Energy Commission (CNE 2005).

In addition, information was cross referenced with declarations made in accordance with Ministry of Health Supreme Decree Nº 138/05[1], and in the study "Apoyo a la Implementación de Norma de Emisión para Centrales termoeléctricas" (Supporting the Implementation of an Emissions Standard for Thermoelectric Power Plants) (CNE 2007).

Information needed to develop this category

- Source of the coal used.

In 2005 the country's energy sector imported coal from the following countries: Indonesia (33%), Australia (21%), Canada (14%), Colombia (14%), New Zealand (14%) and the USA (4%), Source: "Política de Seguridad Energética, diagnóstico y líneas de acción," Karen Poniachik, 2006"

[1] This Supreme Decree obligates companies in the following sectors and/or source types to provide the information necessary to estimate air pollutant emissions: steam and/or hot water boilers; cellulose production; primary and secondary smelters; thermoelectric power plants; cement, lime and gypsum production; glass production; ceramic production; metallurgy; petrochemical, asphalt and generating equipment.

It was not possible to establish the exact source of the coal used in each power plant or the mercury content in the coal by country of origin. No information was obtained for pre-treatment of coal before use.

- Emission control equipment used in each unit and its efficiency in reducing Hg emissions

Power plants in Chile use mainly electrostatic precipitators and fabric filters, particulate matter abatement equipment whose efficiency in regard to mercury are based on those reported in the Toolkit.

No information was obtained on the final disposal of the waste collected in each power plant.

Estimation methodology

After undertaking a proportional distribution of the power plants and weighting values for unknown mercury content in the coal, the input factor was in the range suggested by the Toolkit.

To estimate emissions in this subcategory the input factors give in the Toolkit were used; their distribution by release pathway was based on the abatement equipment used in each power plant, taking into account the efficiency rate reported in the Toolkit.

The subcategory was broken down into point sources corresponding to individual plants.

Table 8 Summary Table, subcategory 5.1.1: Coal combustion in large power plants

5.1.1: Coal combustion in large power plants	**Unit**	**Use**			**Sum of releases into pathway from assessed part of life cycle**	
		Unspecified	ESP	Baghouse BBB		
Activity rate	Tons/yr	68239	3306287	356438	-	
Input factor for phase ***1**	gHg/ ton	High end 0.5	Low end 0.05		-	
Inputs calculated for phase ***2**	Kg Hg/yr	1865	187		-	
Output distribution factors for phase: *3		Unspecified	ESP	BBB		
- Air		1	0.9	0.5	-	
- Water					-	
- Land					-	
- Product impurities					-	
- General waste treatment			0.1	0.5	-	
- Sector-specific treatment/disposal					-	
Outputs/releases		Unspec.	ESP	BBB	High	Low

5.1.1: Coal combustion in large power plants	Unit	Use						Sum of releases into pathway from assessed part of life cycle	
		Unspecified		ESP		Baghouse BBB			
calculated at: *4		High	Low	High	Low	High	Low	end	end
- Air	Kg Hg /year	34.12	3.41	1487.83	148.78	44.55	4.46	1566.5	156.65
- Water	Kg Hg /year								
- Land	Kg Hg /year								
- Product impurities	Kg Hg /year								
- General waste treatment	Kg Hg /year			165.32	16.53	44.55	4.46	209.87	20.99
-Sector-specific treatment/disposal	Kg Hg /year								

Table 9 High end estimate by subcategory, region and release pathway

High end estimate by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.1.1	**Coal combustion in large power plants**	I	84.744				9.4161081		94.1610
		II	755.339				83.9266001		839.2660
		III	364.554				40.5060132		405.0601
		V	244.857				23.415335		268.2727
		VIII	161.562				97.159785		258.7222
			1611.058	0	0	0	254.424	0	1865.482

Table 10 Low end estimate by subcategory, region and release pathway

Low end estimate by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/disposal	Total
5.1.1	**Coal combustion in large power plants**	I	8.4744973				0.9416108		9.4161
		II	75.533941				8.3926600		83.926
		III	36.455412				4.0506013		40.506
		V	24.485743				2.3415335		26.827
		VIII	16.156242				9.7159875		25.872
			161.10583	0	0	0	25.442393	0	186.548

4.1.2 Subcategory 5.1.2 "Other coal use"

General Information

In 2005, the following sectors accounted for 34.8% of all coal consumed in the country: industrial, mining, iron and steel, in-house power generation, public sector and residential sector.

Coal production also occurs, though to a lesser extent, in regions VIII and XII; coke production occurs mainly in the iron and steel industry for use as a raw material in iron production.

Parameters taken into account for estimating emissions from "Other coal use"

- Activity rate for coal consumption in tons per year for each sector

Table 11 "Coal consumption by consumption centers, national level"

Industrial Sector Mining Sector	Location (regions)	Coal consumption tons/year	Reference-year (*)
Iron Industry	IV	85000	Balance Energético CNE 2005
Cement Industry	II,V,VII,RM,VIII	199000	Balance Energético CNE 2005
Sugar Industry	VII, VIII	126000	Balance Energético CNE 2005
Fishing Industry	V,VIII,X	19000	Balance Energético CNE 2005
Misc. Industry	V,R.M.,VII,VIII,X	198000	Balance Energético CNE 2005
Misc. Mines	II,III,IV	3000	Balance Energético CNE 2005
Total Industrial and Mining consumption	National	630000	Balance Energético CNE 2005
Public and Residential sector	Location	Coal consumption Tons/year	Reference-year(*)
Public sector	National	5000	Balance Energético CNE 2005
Residential	National	1000	Balance Energético CNE 2005
Iron and Steel Sector	Location (region)	Coal consumption tons/year	Reference-year(*)
Ironworks	V,R.M.,VIII	723000	Balance Energético CNE 2005
Industrial and Mining Sector	Location	Coal consumption tons/year	Reference-year (*)
Coal-petcoke boilers	National	78000	Balance Energético CNE 2005

(*) Broken down by region, currently under review, under DS 138.

Table 12 "Coal-fired power generation"

Power generation	Location (region)	Consumption tons/year	Reference-year
In-house generation (**)	II, III IV	13000	Balance Energético CNE 2005

(**) Power generated to meet a facility's own needs; this refers to industrial and mining operations that generate power to cover their own needs.

- Activity rate for quantity of coal produced.

Table 13 "Coal Production as per Annual Mining Report "

Coal production	Location	Tons/year	Source of information
ENACAR (*)	VIII Region	138056.00	Anuario de Minería 2005
Chabunco S.A.	XII Region	594309.00	Anuario de Minería 2005

- Activity rate for quantity of coke produced.

Table 14 "Coke production. Annual Mining Report "

Coke production	Location	Tons/year	Source of information
Huachipato	VIII Region	305000	Balance Energético CNE 2005

Coal consumption in the mining, industrial, iron and steel, public and residential sectors was obtained from the BNE 2005, published by the National Energy Commission of Chile, cross referenced with information from MINSAL D.S. Nº 138/2005 and the Annual Survey of Industry (ENIA); these sources were also used for information on coke production.

Information needed to develop this subcategory

i. Identification of the origin of the coal used.

It was not possible to establish this on an individual basis.
Processed coal that is to be converted into coke through dry distillation originates in Canada and Australia (Source: Compañía de Acero del Pacífico, CAP).
No information was obtained on pre-treatments of coal.
No information was obtained on emission control equipment used and/or its efficiency in reducing Hg emissions.

ii. Identification of Hg content in used coal.

This was determined based on US EPA values supplied in the Toolkit for Hg content values by country of origin.

iii. Identification of emission control equipment used in each unit and its efficiency in reducing Hg emissions.

Information obtained from D. S. 138.

iv. Identification on the final deposition of waste collected.

It was not possible to identify the final disposition of waste collected.

Estimation method

For estimates in this subcategory, regarding the use of coal in boilers in the different sectors involved, the low end input factor (0.05 g Hg /ton) and high end factor (0.5 g Hg /ton) suggested in the Toolkit were used. Distribution by release pathway was based on the abatement equipment used in each unit, which in this case is 100% atmospheric release as the existing boilers have no emission controls installed.

For coal production an input factor of 0.03 g Hg / ton was used as both low and high end factor; this figure is the US EPA (1997) value and was taken from the Toolkit, which mentions this air emission factor for mercury release in German facilities.

For coke production, input factors were used with the low end value (0.05 g Hg /ton) and high end value (0.5 g Hg /ton) suggested in the Toolkit. The release pathway distribution in this case was 90% to air (coke produced by metallurgical companies in a process that uses both coke and burned gas in the same plant) and 10% to general waste treatment.

The subcategory was broken down into point sources at the level of individual establishments for coal and coke production.

Table 15 Summary Table, subcategory 5.1.2: Other coal uses

5.1.2: Coal production and Coke production	**Unit**	**Production**				**Use**		**Sum of releases from assessed part of life cycle**
Activity rate	Tons/yr	732365		305000		2610000		
		Coal		Coke		High	Low	-
		High	Low	High	Low			
Input factors for phase ***1**	gHg/ ton	0.03	0.03	0.5	0.05	0.5	0.05	-
Inputs calculated for phase ***2**	Kg Hg/year	22	22	152.51	15.25	1305	130.5	-
Output distribution factors for phase: *3								
- Air		0.9		0.75		0.9		-
- Water								-
- Land								-

5.1.2: Coal production and Coke production	Unit	Production				Use		Sum of releases from assessed part of life cycle	
- Product impurity								-	
- General waste treatment		0.1				0.1		-	
- Sector-specific treatment/disposal				0.25				-	
Estimated outputs/releases at: *4		High end	Low end	High end	Low end	ESP		High end	Low end
						High end	Low end		
- Air	Kg Hg /year	19.77	19.77	114.38	11.44	1178.4	117.84	1312.55	154.11
- Water	Kg Hg /year								
- Land	Kg Hg /year								
- Products	Kg Hg /year								
- General waste treatment	Kg Hg /year	2.2	2.2			126.6	12.66	128.75	14.86
- Sector-specific treatment/disposal	Kg Hg /year			38.13	3.81			38.13	3.81

Table 16 High end releases by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/ disposal	Total
5.1.2	**Other coal use**	VIII	156.227				0.414		156.642
		XII	16.046				1.783		17.829
			172.274	0	0	0	2.197	0	174.471

Table 17 Low end releases by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.1.2	**Other coal use**	VIII	18.978				0.414		19.392
		XII	16.046				1.783		17.829
			35.024	0.000	0.000	0.000	2.197	0.000	37.221

4.1.3 Subcategory 5.1.3 "Mineral oils- extraction, refining and use"

Overview Approach and Point Source Approach

General Information
This subcategory includes the extraction, refining and combustion of mineral oils, which are generally called "crude oils" or petroleum oils."

The Magallanes region is responsible for 100% of Chile's petroleum production, while refining is carried out by the Empresa Nacional del Petróleo (ENAP) in Region V (Con-Con) and Region VIII (Talcahuano). Mineral oil uses also include combustion boilers for petroleum grades 5 and 6.

Parameters considered for estimating "Other coal use"

- Activity rate based on petroleum production in tons/year.

Table 18 "Petroleum Production in Chile"

Crude oil production	Location	M^3	Source of information
ENAP	XII region	192032	Anuario de Minería 2005

- Activity rate based on quantity of crude oil refined, tons per year

Table 19 "Petroleum refining in Chile"

Crude oil refining	Location	m^3	Source of information
Holding ENAP Domestic crude	Regions V & VIII	221856	Anuario de Minería 2005
Holding ENAP Imported crude	Regions V & VIII	11951539	Anuario de Minería 2005

- Activity rate based on petroleum distillates used in these sectors:
  - Transportation
  - Industry and Mining
  - Commercial, public and residential
  - Energy sector
  - Transformer substations

Table 20 "National level consumption of petroleum distillates"

Mining and Industrial Sector	Location (region)	Coal consumption tons/year	Reference-year (*)
Total Industrial and Mining Consumption	National	1908750	Balance Energético CNE 2005
Public and Residential Sector	Location	Coal consumption tons/year	Reference-year (*)
Total Public and Residential Consumption	National	163750	Balance Energético CNE 2005
Transportation Sector	Location (region)	Coal consumption tons/year	Reference- year (*)
Total Transportation consumption	National	7228150	Balance Energético CNE 2005

(*) Broken down by region, currently under review through DS 138

Table 21 "Energy sector consumption "

Energy sector	Location (region)	Consumption tons/year	Reference-year
Energy sector and transformer substations	National	530594	Balance Energético CNE 2005

Information needed to develop this subcategory

i. Type and Country of Origin for crude oil refined in Chile.

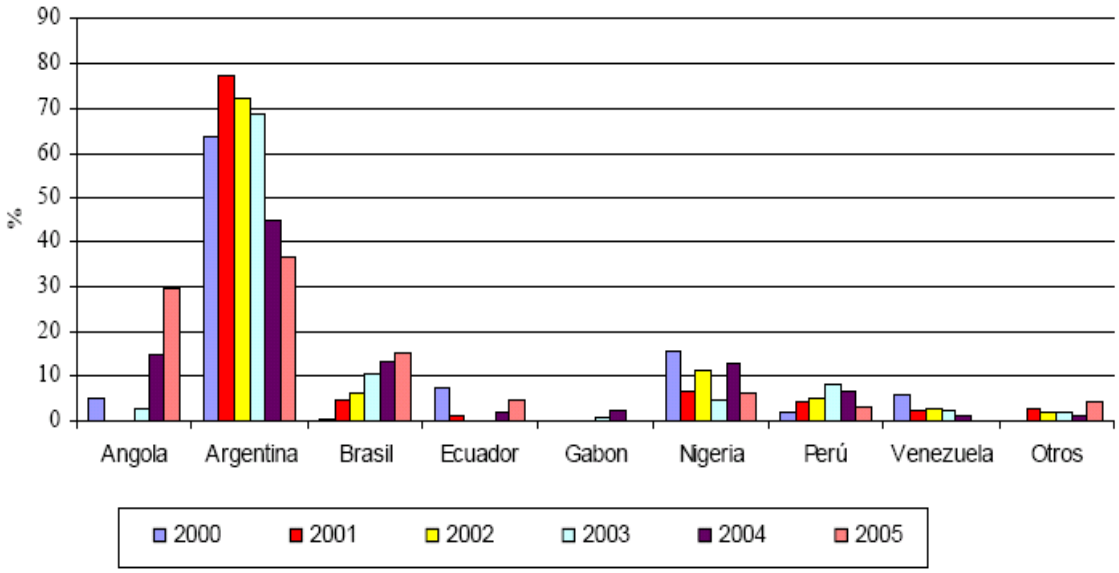
Table 22 shows the quantities of crude oil imported into Chile by country of origin

Table 22 "Crude oil imports by country of origin"

Country of origin	m^3	Hg content- $\mu g/m^3$	Source of information
Angola	3549793	1.6	ENAP
Argentina	4521511	16.1	ENAP
Brazil	1868295	1.1	ENAP
Nigeria	604842	1.8	ENAP
Others	1407098	ND	ENAP

The graph below displays crude oil imports by country of origin:

Graph 22 Crude oil imports by country of origin



ii. Identification of Hg contents in crude oil refined in Chile.

ENAP provided information on the origin of crude oil refined in Chile; this data can be seen in Table 22. It is important to note that in the case of Nigeria, the mercury content of crude imported to Chile varies by specific source in-country and information was not available for all those sources. However, the value given in the table corresponds to the prevailing mercury content for crude oil produced in the country.

Estimation method

The input factor was determined on the basis of the study **"**Mercury in Crude Oil Processed in the United States (2004)" by S. Markwhilek et al. In the case of crude oil without a mercury concentration value (approximately 7.3% of the total), the weighted average was applied; for combustion, an input factor corresponding to 10% of the value used for refining was used according to the proportion set out in the Toolkit.

Table 23 Summary Table, subcategory 5.1.3: Mineral oils- extraction, refining and use

5.1.3: Mineral oils- extraction, refining and use	**Unit**	**Production**		**Refining**		**Use**		**Sum of releases from assessed part of life cycle**	
Activity rate	Tons/ year	192032		10347386		10942324			
		High	Low	High	Low	High	Low	-	
Input factors for phase ***1**	mgHg/ ton	10	300	7.48	7.48	0.748	0.748	-	
Inputs calculated for phase ***2**	Kg Hg/year	57.61	1.92	77.40	77.40	8.18	8.18	-	
Output distribution factors for phase: *3									
- Air		0.9		0.3		1		-	
- Water				0.4				-	
- Land				0.1				-	
- Product impurities								-	
- General waste treatment		0.1						-	
-Sector-specific treatment/disposal				0.2				-	
Outputs/releases calculated at: *4		High	Low	High	Low	High	Low	High	Low
- Air	Kg Hg /year	51.85	1.73	23.22	23.22	8.18	8.18	83.25	33.13
- Water	Kg Hg /year			30.96	30.96			30.96	30.96
- Land	Kg Hg /year			7.74	7.74			7.74	7.74
- Product impurities	Kg Hg /year								
- General waste treatment	Kg Hg /year	5.76	0.19					5.76	0.19
-Sector-specific treatment/disposal	Kg Hg /year			15.48	15.48			15.48	15.48

Table 24 High end releases by subcategory, region and release pathway

High end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.3	Mineral oils - extraction, refining and use	I	0.002						0.002
		II	0.003						0.003
		III	0.017						0.017
		V	11.055	14.618	3.654			7.309	36.636
		RM	0.022						0.022
		VI	0.011						0.011
		VII	0.002						0.002
		VIII	10.811	14.401	3.600			7.200	36.012
		X	0.020						0.020
		XI	0.003						0.003
		XII	53.305	1.941	0.485		5.761	0.970	62.462
			75.249	30.959	7.740	0.000	5.761	15.480	135.189

Table 25 Low end releases by subcategory, region and release pathway

Low end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.3	Mineral oils - extraction, refining and use	I	0.002						0.002
		II	0.003						0.003
		III	0.017						0.017
		V	11.055	14.618	3.654			7.309	36.636
		RM	0.022						0.022
		VI	0.011						0.011
		VII	0.002						0.002
		VIII	10.811	14.401	3.600			7.200	36.012
		X	0.020						0.020
		XI	0.003						0.003
		XII	3.184	1.941	0.485		0.192	0.970	6.773
			25.129	30.959	7.740	0.000	0.192	15.480	79.500

4.1.4 Subcategory 5.1.4 "natural gas – extraction, refining and use"

Approach: Overview approach and point source approach

General Information

This category includes natural gas extraction, refining and combustion. In Chile, natural gas production, like petroleum production, is based in Region XII of Magallanes. Natural gas combustion in Chile in 2005 was carried out in facilities such as power plants and in the industrial and mining sectors, as well as in the public and residential sectors.

- Activity rate based on natural gas production in m^3/year

Table 26 "Natural Gas production by ENAP"

Natural gas production	Location	m3/year	Source of information
ENAP	National	2393992	Anuario de Minería 2005

- Activity rate based on sector-specific consumption in m^3/year.

Table 27 "Natural Gas: Industrial and Mining Sector"

Industrial and Mining Sector	Location	Millions of m3/year	Reference-year
Natural Gas	National	959000000.00	Balance CNE 2005

Table 28 "Natural Gas: Public sector and residential combustion"

Public and residential sectors	Location	millions of m3/year	Reference-year
Natural Gas	National	503000000.00	Balance CNE 2005

Table 29 "Natural gas consumption at the national level"

Transportation Sector	Location (region)	Gas consumption m^3/year	Reference-year
Total Transportation Sector	National	1908750	Balance Energético CNE 2005
Energy Sector	Location	Gas consumption m^3/year	Reference-year
Total Energy Sector consumption	National	163750	Balance Energético CNE 2005
Transformer substations	Location (region)	Gas consumption m^3/year	Reference-year
Total Consumption Transformer Substations	National	7228150	Balance Energético CNE 2005

Information needed to develop this subcategory

i. Identifying the origin of natural gas.

All natural gas imported to Chile in 2005 came from Argentina (Source "Mercado del gas natural en Chile," CNE, 2006")

ii. Identifying the Hg content in natural gas.

No Hg content or measurements were identified, so the default values established in the Toolkit were used.

iii. Identifying emission control equipment used in each unit and its Hg reducing efficiency.

Table 30 presents natural gas-fired power plants and their respective abatement equipment:

Table 30 Abatement equipment. Natural-gas fired power plants"

Abatement equipment (*)						
Natural gas-fired power plants	PM 10	Efficiency	SOx	Efficiency	NOx	Efficiency
Central Atacama 1ª	No				Dry Low	80%
Central Atacama 1B	No				Dry Low	80%
Central Atacama 2ª	No				Dry Low	80%
Central Atacama 2B	No				Dry Low	80%
Central Térmica mejillones 3	No				Reduction System	< 30 ppm V
Central TurboGAS Nº3	No		No		No	
Tocopilla Unidad 16	No				No Data	
Centrales Termica Taltal 1	No				Dry Low	
Centrales Termica Taltal 2	No				Dry Low	
Central Nehuenco	No				Dry Low	No Data
Central Nehuenco TG 9B	No				Iny. Agua	No Data
Central Nehuenco II	No				Dry Low	No Data
Central San isidro	No		No		No	
Central Térmica Horcones TG	No		No		No	
Central Térmica Coronel TG	No				Water injection	No Data
Central Nueva Renca	No				Low NOx burners	No Data

(*) Source: "Propuesta e Implementación de Normas Atmosféricas para Fuentes Fijas a Nivel Nacional y Recopilación de Información de Soporte Técnico-Económico para la dictación de una Norma de Emisión para Centrales Termoeléctricas" (Proposal and Implementation of Atmospheric Emission Standards for Stationary Sources at the National Level and Collection of Technical-Economic Information to Support the Enactment of an Emission Standard for Thermoelectric Plants).

Estimation Methodology

Based on input and output factors established in the Toolkit.
Source broken down for point source, by establishment.

Table 31 Summary Table, subcategory 5.1.4: Natural gas – extraction, refining and use

5.1.4: Natural gas – extraction, refining and use	**Unit**	**Production**		**Use**		**Sum of releases from assessed part of life cycle**	
Activity rate	m^3/year	2393992000		5406383655			
		High	Low	High	Low	-	
Input factors for phase ***1**	µgHg/ m^3N	2	200	0.03	0.4	-	
Inputs estimated for phase ***2**	Kg Hg/year	478.8	4.79	2.16	0.16	-	
Output distribution factors for phase: *3							
- Air		0.9		1		-	
- Water						-	
- Land						-	
- Products						-	
- General waste treatment		0.1				-	
-Sector-specific treatment/disposal						-	
Outputs/releases estimated at: *4		High	Low	High	Low	High	Low
- Air	Kg Hg /year	430.92	4.31	2.16	0.16	433.1	4.47
- Water	Kg Hg /year						
- Land	Kg Hg /year						
- Products	Kg Hg /year						
- General waste treatment	Kg Hg /year	47.88	0.48			47.88	0.48
-Sector-specific treatment/disposal	Kg Hg /year						

Table 32 High end release by subcategory, region and release pathway

High end output by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.4	**Natural gas - extraction, refining and use**	II	0.481						0.481
		III	0.097						0.097
		V	0.311						0.311
		RM	0.139						0.139
		XII	430.920				47.880		
			431.949	0.000	0.000	0.000	47.880	0.000	479.829

Table 33 Low-end release by subcategory, region and release pathway

Low-end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.4	**Natural gas - extraction, refining and use**	II	0.036						0.036
		III	0.007						0.007
		V	0.023						0.023
		RM	0.010						0.010
		XII	4.309				0.479		4.788
			4.386	0.000	0.000	0.000	0.479	0.000	4.865

4.1.5 Subcategory 5.1.5 "Other fossil fuels – extraction and use"

Approach: Overview approach

General Information

This subcategory refers to the extraction and use of other fossil fuels such as peat and shale, among others. In 2005 the National Mining and Geology Service did not report any production of these fossil fuels in Chile.

4.1.6 Subcategory 5.1.6 "Biomass-fired power and heat production"

General Information

This subcategory refers to the combustion of biomass for power and/or heat, including wood burning (small branches, bark, sawdust, woodchips, peat and agricultural waste such as straw and citrus pellets, among others (UNEP, 2003)).

Chile has biomass-fired power plants distributed from regions IV to XII. Wood burning is also carried out at the residential, commercial and institutional level.

It is important to note that forest fires have been included under this category, though this activity was not addressed in the Toolkit.

Parameters considered for estimating "Biomass fired power and heat production"

- Activity rate, wood consumption by region in tons per year

Table 34 "Residential wood consumption by region"

Wood consumption sector	Location	Tons/year	Reference-year (*)
Residential	IV	158760	Centro de Microdatos U. de Chile, 2006
Residential	V	69131	Centro de Microdatos U. de Chile, 2006
Residential	VI	468883	Centro de Microdatos U. de Chile, 2006
Residential	VII	1737238	Centro de Microdatos U. de Chile, 2006
Residential	VIII	2341014	Centro de Microdatos U. de Chile, 2006
Residential	IX	1485064	Centro de Microdatos U. de Chile, 2006
Residential	X	3302928	Centro de Microdatos U. de Chile, 2006
Residential	XI	459280	Centro de Microdatos U. de Chile, 2006
Residential	XII	281477	Centro de Microdatos U. de Chile, 2006
Residential	RM	90133	Centro de Microdatos U. de Chile, 2006
Total Residential		**10393908**	
Wood consuming sector	Location	Tons/year	Reference-year
Commercial and institutional	V	10881	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	VI	1680.80	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	VII	11279.50	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	VIII	66328.70	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	IX	67275.80	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	X	373405.70	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	XI	83630.10	Centro de Microdatos U. de Chile, 2006
Commercial and institutional	RM	12204.60	Centro de Microdatos U. de Chile, 2006
Total Commercial and Institutional		**626686.20**	
Wood consumption sector	Location	Tons/year	Reference-year
Industrial	IV	271884.00	Centro de Microdatos U. de Chile, 2006
Industrial	V	289139.00	Centro de Microdatos U. de Chile, 2006
Industrial	VI	192838.00	Centro de Microdatos U. de Chile, 2006
Industrial	VII	1078895.00	Centro de Microdatos U. de Chile, 2006

Wood consumption sector	Location	Tons/year	Reference-year
Industrial	VIII	1479555.00	Centro de Microdatos U. de Chile, 2006
Industrial	IX	654519.00	Centro de Microdatos U. de Chile, 2006
Industrial	X	135528.00	Centro de Microdatos U. de Chile, 2006
Industrial	XI	3107.00	Centro de Microdatos U. de Chile, 2006
Industrial	RM	25306.00	Centro de Microdatos U. de Chile, 2006
Total Industrial Consumption		**4130771.00**	
Industrial waste	Country	5076000.00	Centro de Microdatos U. de Chile, 2006

(*) "Diagnóstico del Mercado de la Leña" (Wood Market Analysis), Centro de Microdatos U. de Chile, 2006

- Activity rate for biomass and black liquor consumption in recovery and power boilers

Table 35 "Biomass-fired power plants "

Biomass-fired power plants	Location	Tons/year	Source of information
Central Constitución	Region VII	194400	CNE 2005
Central Nueva Aldea	Region VIII	1180	CNE 2005
Central Laja	Region VIII	1003632	CNE 2005

- Activity rate for forest fires by region, in tons burned per year

Table 36 "Forest fires"

Forest Fires	Location	Tons/year	Reference-year
Fires	National	701691	CONAF

Estimation Methodology

Estimated emissions from forest fires were based on information provided by CONAF (National Forest Service) corresponding to hectares that burned in 2005, with a load factor of 25 tons/ha for forested areas and 15 ton/ha for scrubland. The information corresponded to the city of Temuco, the only source of data available.

The input factors used were taken from the Toolkit; the low end input factor was based on a study conducted in Denmark (Skårup *et al*., 2003), and the high end input factor was based on a study conducted in Sweden (Kindbom and Munthe, 1998)

For all other subcategories, input factors suggested in the Toolkit were used. The subcategory "Biomass fired power and heat production" was de-aggregated by region.

Table 37 Summary Table, subcategory 5.1.6: Biomass-fired power and heat production

5.1.6: Biomass-fired power and heat production	**Unit**	**Use**						**Sum of releases from assessed part of life cycle**	
Activity rate	Tons/ year	15854255.392							
		Wood burning		Forest fires		Biomass power plants		-	
Input factors for phase ***1**	gHg/ ton	High 0.01	Low 0.02	High 0.007	Low 0.07	0.0026		-	
Estimated inputs for phase ***2**	Kg Hg/year	303	151	49	4,9	3,11		-	
Output distribution factors to: *3									
- Air		1		1		0.9		-	
- Water								-	
- Land								-	
- Products								-	
- General waste treatment						0.1		-	
-Sector-specific treatment/disposal								-	
Estimated outputs/releases to: *4		High	Low	High	Low			High	Low
- Air	Kg Hg /year	303	151	49	4.9	2.8	2.8	354.8	56.7
- Water	Kg Hg / year								
- Land	Kg Hg / year								
- Products	Kg Hg / year								
- General waste treatment	Kg Hg / year					0.31	0.31	0.31	0.31
-Sector-specific treatment/disposal	Kg Hg / year								

Table 38 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.6	**Biomass fired power and heat production**	IV	8.613						8.613
		V	7.383						7.383
		RM	2.550						2.550
		VI	13.268						13.268
		VII	57.003				0.051		57.054
		VIII	80.089				0.261		80.350
		IX	44.137				0.000		44.137
		X	76.237				0.000		76.237
		XI	10.920						10.920
		XII	5.630				0.000		5.630
			305.831	0.000	0.000	0.000	0.312	0.000	306.142

Table 39 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.1.6	**Biomass fired power and heat production**	IV	4.306						4.306
		V	3.692						3.692
		RM	1.280						1.280
		VI	6.634						6.634
		VII	28.729				0.051		28.780
		VIII	41.220				0.261		41.481
		IX	22.069				0.000		22.069
		X	38.119				0.000		38.119
		XI	5.460						5.460
		XII	2.815						2.815
			154.323	0.000	0.000	0.000	0.312	0.000	154.635

4.2 Category 5.2 Primary (virgin) metal production

General Information
Chile is a country of mines, and mining has been a crucial factor in the country's economic and social development.

Small, medium and large scale mining operations have positioned the country as one of the largest global producers of copper, gold and silver, making this one of the most important categories for mercury releases.

4.2.1 Subcategory 5.2.1. "Mercury extraction and initial processing"

General Information
As of 2005, no mercury extraction or processing is carried out in Chile.

4.2.2 Subcategory 5.2.2 "Gold and silver extraction with mercury amalgamation process"

General Information
The traditional technique of extracting gold through mercury amalgamation is still firmly rooted among small scale miners in our country. Today many of these artisan miners still employ this technique in their operations, which are distributed mainly between regions III and IV.

Parameters taken into account for estimating "Gold and silver extraction with mercury amalgamation process"

There is currently a register of small scale mining operations in Chile for regions III and IV, but it was not possible to break down the activity rate associated with each individual operation; some of these were visited when the register was built as potentially contaminated sites.

In regard to estimating the use of Hg associated with gold and silver production, the following table shows activity levels for gold and silver producing operations in Chile that employ mercury amalgamation in gold extraction, in kilograms per year.

- Activity rate of mining operations using mercury amalgamation in kilograms per year

Table 40 "Gold production using mercury amalgamation. Regions III and IV"

Gold mining using amalgamation	Location	Kg of Fine	Source of information
Small scale mining operations	III and IV	1561.00	SERNAGEOMIN 2005

Table 41 Silver mining operations using amalgamation, Region III

Silver mining operations using amalgamation	Location	Kg of Fine	Source of information
Small scale mining operations	III	133	SERNAGEOMIN 2005

Estimation Methodology

Input factors used were those suggested by the Toolkit for "Extraction from concentrate."

Land, and to a lesser extent air, are considered the main release pathways for Hg emissions resulting from gold extraction, as the vast majority of small scale producers do not use any measures or technology to capture such emissions.

Table 42 Summary Table, subcategory 5.2.2: Gold and silver extraction with Mercury Amalgamation process.

5.2.2 Gold and silver extraction with Mercury Amalgamation process	**Unit**	**Production**		**Sum of releases to all pathways from assessed part of life cycle**	
Activity rate	Kg/year	1561			
		Tailings		-	
Input factor for phase ***1**	KgHg / Kg gold produced	3		-	
Inputs calculated for phase ***2**	KgHg/ year	4683		-	
Output distribution factors for phase: *3					
- Air				-	
- Water				-	
- Land		0.9		-	
- Products		0.1		-	
- General waste treatment				-	
- Sector-specific treatment/disposal				-	
Outputs/releases calculated for: *4		High	Low	High	Low
- Air	Kg/ year				
- Water	Kg/ year				
- Land	Kg/ year	4214.7	4214.7	4214.7	4214.7
- Products	Kg/ year	468.3	468.3	468.3	468.3
- General waste treatment	Kg/ year				
- Sector-specific treatment/disposal	Kg/ year				

Table 43 High end releases by subcategory, region and release pathway

High end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.2.2	**Gold and silver extraction with mercury amalgamation processes**	III-IV	79.800	26.600	26.600				133.000

Table 44 Low end releases by subcategory, region and release pathway

Low end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.2.2	**Gold and silver extraction with mercury amalgamation processes**	III-IV	79.800	26.600	26.600				133.000

4.2.3 Subcategory 5.2.3. "Zinc extraction and initial processing"

General Information

Zinc extraction in Chile is carried out exclusively in Region XI by El Toqui mining company. Only zinc concentrates are produced; no smelting is carried out in Chile.

Parameters taken into account for estimating "Zinc extraction and initial processing"

- Activity rate for Zinc production, tons per year

Table 45 "National zinc production"

Zinc production	Location	Tons of fine	Source of information
Minera Toqui	Region XI	28841	SERNAGEOMIN 2005

Estimation Methodology

A concentration factor of 0.69 g of Hg per ton in the tailings was used, based on a value reported in the Toolkit for the zinc concentrate production by Brunswik, Canada (Klimenko and Kiazimov, 1987).

To determine the quantity of tailings generated, a preliminary estimate was calculated based on an ore grade of 7.9% (Source: Boletín Minero Nº 1130, SONAMI) and 30% of zinc content in the concentrate.

The information collected indicates that releases were mainly to land and occur during the extraction process.

Table 46 Summary Table, subcategory 5.2.3: Zinc extraction and initial processing.

5.2.3 Zinc extraction and initial processing	**Unit**	**Production**	**Sum of releases to the pathway from assessed part of life cycle**
Activity rate	Tons/year	80682	
		Tailings	-
Input factor for phase ***1**	gHg / ton.	0.69	-
Estimated inputs for phase ***2**	KgHg/year	55.67	-
Output distribution factors for phase: *3			
- Air			-
- Water			-
- Land		1	-
- Products			-
- General waste treatment			-
- Sector-specific treatment/disposal			-
Outputs/releases calculated for: *4			
- Air	Kg/year		
- Water	Kg/year		
- Land	Kg/year	55.67	55.67
- Products	Kg/year		
- General waste treatment	Kg/year		
- Sector-specific treatment/disposal	Kg/year		

Table 47 High end releases by subcategory, region and release pathway

High end releases by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurity in pro-ducts**	**General waste treatme nt**	**Sector specific treatment/ disposal**	**Total**
5.2.3	**Zinc extraction and initial processing**	XII			55.700				55.700

Table 48 Low end releases by subcategory, region and release pathway

Low end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatme nt	Sector specific treatment/ disposal	Total
5.2.3	**Zinc extraction and initial processing**	XII			55.700				55.700

4.2.4 Subcategory 5.2.4. "Copper extraction and initial processing"

General Information

Chile has six copper smelters in its copper production chain, and it is at this stage that most mercury is released from copper concentrate. The section below analyzes this subcategory "Copper extraction and initial processing" and its contribution to total Hg emissions in Chile.

Parameters taken into account for estimating "Copper extraction and initial processing"

- Activity rates for copper production in Chile, in tons per year

Table 49 "Copper production from sulphidic ore"

Copper production	Location	Tons/year	Source of information
Copper concentrate	national	3146743	SERNAGEOMIN-2005

Table 50 " National cathode production "

Copper production	Location	Tons/year	Source of informatión
Cathodes	national	2.412700	SERNAGEOMIN-2005

- Activity rates for primary copper smelters in Chile, in tons per year

Table 51 "Primary smelters - ENIA-INE"

Primary smelters	Location	Tons/year	Source of information (*)
Chuquicamata CODELCO	Chuquicamata	447231	DS 138
Altonorte NORANDA	Antofagasta	271872	DS 138
Potrerillos CODELCO	Potrerillos	289619	DS 138
Hernán Videla Lira (ENAMI)	Paipote	97161	DS 138
Ventanas (CODELCO-VENTANAS)	Ventanas	424000	In situ
Chagres (Anglo American Chile) Caletones (CODELCO)	Catemu Caletones	372008 374687	DS 138 DS 138

Information needed to develop this subcategory

i. Identification of Hg content in copper concentrates.
ii. Identification of pre-treatment of concentrates.
iii. Identification of emission control equipment used in each unit and its efficiency for capturing Hg released.
iv. Identification of final deposition of waste generated.

The above information could not be obtained before this report went to press.

Estimation Methodology

The estimation used a concentration factor of 0.69 g /tons of Hg present in the tailings, based on a value reported in the Toolkit for copper concentrate production by Brunswik, in Canada (Klimenko and Kiazimov, 1987).

To determine the quantity of tailings generated from sulphidic ore, a preliminary estimate was calculated based on 0.9% Cu (Source: "Sistema de Control de Gestión de las empresas mineras del Estado, November 2005 COCHILCO) and 30% Cu contained in the concentrate (Source: CODELCO webpage).

Release distribution is assumed to be mainly to land.

For cathodes produced for pyrometallurgical processing the input and output factors suggested in the Toolkit was used. This subcategory was de-aggregated into point sources at the level of individual establishments.

Table 52 Summary Table, subcategory 5.2.4: "Copper production and initial processing"

5.2.4 Copper production and initial processing	Unit	Production			Sum of releases to pathway from assessed part of life cycle	
		Tailings	From concentrate			
Activity rate	Ton	339148957	2412700			
		Tailings	From Concentrate		-	
			High	Low		
Input factor for phase ***1**	gHg/ton	0.69	1	15	-	
Inputs estimated for phase ***2**	KgHg/year	234013	36191	2413	-	
Output distribution factors for phase: *3		Tailings	From Concentrate			
- Air			0.1		-	
- Water			0.02		-	
- Land		1	0.24		-	
- Products			0.4		-	
- General waste treatment					-	
-Sector-specific treatment/disposal			0.24		-	
Estimated outputs/releases to: *4		Tailings	From Concentrate		High	Low
			High	Low		
- Air	Kg/year		3619.05	241.27	3619.05	241.27
- Water	Kg/year		723.81	48.25	723.81	48.25
- Land	Kg/year	234013	8685.72	579.05	242698.7	234592.1
- Products	Kg/year		14476.2	965.08	14476.2	965.08
- General waste treatment	Kg/year					
-Sector-specific treatment/disposal	Kg/year		8685.72	579.05	8685.72	579.05

The tables below shows mercury releases from smelters, by region

Table 53 High end releases by subcategory, region and release pathway

High end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment / disposal	Total
5.2.4	**Copper extraction and initial processing**	II	1078.655	215.731	2588.771	4314.618		2588.771	10786.545
		III	580.170	116.034	1392.408	2320.680		1392.408	5801.700
		V	1194.012	238.802	2865.629	4776.048		2865.629	11940.120
		VI	562.031	112.406	1348.873	2248.122		1348.873	5620.305
			3414.867	682.973	8195.681	13659.468	0.000	8195.681	34148.670

Table 54 Low end releases by subcategory, region and release pathway

Low end releases by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment / disposal	Total
5.2.4	Copper extraction and initial processing	II	71.910	14.382	172.580	287.641		172.585	719.098
		III	38.678	7.736	92.827	154.712		92.827	386.780
		V	79.601	15.920	191.042	318.403		191.042	796.008
		VI	37.469	7.494	89.925	149.875		89.925	374.687
			227.658	45.532	546.374	910.631	0.000	546.379	2276.573

4.2.5 Subcategory 5.2.5. "Lead extraction and initial processing"

General Information
Like Zinc, lead production in Chile is located exclusively in Region XI and is carried out by El Toqui mining company.

No activity levels were considered for this category since it is included under the zinc extraction process.

4.2.6 Subcategory 5.2.6. "Gold extraction and initial processing by methods other than mercury amalgamation"

General Information
Gold production in Chile occurs in regions II, III, IV, V, RM and XI, where the country's largest reserves are concentrated. Production is mainly in the form of metallic gold, gold doré and gold concentrate.

Parameters taken into account for estimating "Gold extraction and initial processing by methods other than mercury amalgamation"

- Activity rate, in tons per year

Table 55 "Gold production "

Gold production	Location	Fine Tons /year	Source of information
Large mining companies	National	5205.00	Anuario de minería 2005
Medium mining companies	National	13912	Anuario de minería 2005

Atmospheric emission measurements have been reported for one gold mining company using a Gold cyanidation process. The operation is located in Region III and has

atmospheric emissions of 40.01 Kg of mercury per year. Emissions were estimated using US EPA methodologies 1 to 5 for the quantification of volumetric gas flow.

Estimation Method

The input and output factors suggested in the Toolkit were used in this case.
Sources were de-aggregated as point sources in each region.

Table 56 Summary Table, subcategory 5.2.6: Gold extraction and initial processing by methods other than mercury amalgamation.

5.2.6: Gold extraction and initial processing by methods other than mercury amalgamation.	**Unit**	**Production**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	Tons/year	19.12		-	
Input factors for phase ***1**	g Hg / ton	6020		-	
Estimated inputs for phase ***2**	KgHg/year	115084.34		-	
Output distribution factors for phase: *3					
- Air		0.0033		-	
- Water				-	
- Land		0.9977		-	
- Products				-	
- General waste treatment				-	
- Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	379.78	379.78	379.78	379.78
- Water	Kg/year				
- Land	Kg/year	114704.6	114704.6	114704.6	114704.6
- Products	Kg/year				
- General waste treatment	Kg/year				
- Sector-specific treatment/disposal	Kg/year				

Table 57 **High end release by subcategory, region and release pathway**

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impur-ity in products	General waste treat-ment	Sector specific treatment/ disposal	Total
5.2.6	**Gold extraction and initial processing by methods other than mercury amalgamation (a**	II	189.085		57109.275				57298.360
		III	145.042		43806.978				43952.020
		IV	10.529		3180.071				3190.600
		V	28.408		8580.192				8608.600
		RM	46.447		14028.313				14074.760
		XI	57.413		17340.387				17397.800
			476.923		144045.217	0.000	0.000	0.000	144522.140

Table 58 **Low end release estimate by subcategory, region and release pathway**

Low end release estimate by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.2.6	**Gold extraction and initial processing by methods other than mercury amalgamation**	II	189.085		57109.275				57298.360
		III	145.042		43806.978				43952.020
		IV	10.529		3180.071				3190.600
		V	28.408		8580.192				8608.600
		RM	46.447		14028.313				14074.760
		XI	57.413		17340.387				17397.800
			476.923		144045.217	0.000	0.000	0.000	144522.140

4.2.7 Subcategory 5.2.7. "Aluminum extraction and initial processing"

No extraction or initial processing of aluminum from bauxite is carried out in Chile.

Not applicable.

4.2.8 Subcategory 5.2.8. "Other non-ferrous metals – extraction and processing"

General Information
This subcategory refers to the extraction and processing of other non-ferrous metals that could be a source of mercury releases; these include silver, nickel, cobalt, tin, antimony, molybdenum and tungsten, among others.

The bulk of silver extracted in Chile is produced as a by-product of copper and gold production. Direct silver production amounted to 133 tons/year in 2005 from small scale mining operations and was considered under the subcategory "Gold and silver extraction with mercury-amalgamation process."

4.2.9 Subcategory 5.2.9. "Primary ferrous metal production"

General Information
One of the main uses of iron in Chile is to produce cast iron and steel, metallic materials that are widely used in residential and institutional construction, public works, the manufacturing, shipping, automotive, metal-mechanical industries and the manufacture of electromagnets. Iron production in Chile is carried out in regions III and IV by large- and medium-sized iron mining companies.

Pig iron (a smelted material obtained in the blast furnace from iron ore) is being produced by Siderúrgica Cía. and Aceros del Pacífico. These companies are supplied mainly by the mining companies located in regions III and IV have the same parent company.

Parameters taken into account for estimating "Primary ferrous metal production"

- Activity rate for iron production in tons per year

Table 59 "Iron ore production"

Production of iron ore	Location	tons/year	Mts (*)	Reference-year
Cía. Minera Huayco	Region III	5983441	3484515	Anuario de Minería 2005
Cía. Minera del Pacífico	Region IV	1878620	1222441	Anuario de Minería 2005

(*) Metric tons smelted

- Activity rate for pig iron production in tons per year

Table 60 "Pig Iron production"

Pig iron production mills	Location	Tons/year	Reference-year
Cía. Aceros del Pacífico	VIII	1095000	CAP-2005

Information needed to develop this subcategory:

i. Measurements of mercury content in raw material
ii. Identification of emission control equipment used and its efficiency in capturing Hg releases
iii. Identification of final deposition of waste generated

None of the above information could be obtained before this report went to press.

Estimation Methodology

The Toolkit suggest an input factor for pig iron production that is not in line with local realities. In Chile, iron ore is extracted and processed into pellets in regions III and IV (Hg release in these regions) and the limestone for this process comes from Region XII.

An input factor was estimated using the suggested value in the Toolkit and local pig iron production.

Coke production, which is part of the production chain in this category, was estimated in Category 5.1, “Extraction and use of fuels/energy sources.”

Table 61 Summary Table, subcategory 5.2.9 Primary ferrous metal production

5.2.9: Primary ferrous metal production	**Unit**	**Pig iron production**		**Sum of releases to the pathway from assessed part of life cycle**	
Activity rate	Tons/year	1095000			
		High	Low	-	
Input factor for phase ***1**	g Hg / ton	0.05	1	-	
Estimated inputs for phase ***2**	KgHg/year	1095	55	-	
Output distribution factors for phase: *3					
- Air		0.95		-	
- Water				-	
- Land				-	
- Products				-	
- General waste treatment				-	
- Sector-specific treatment/disposal		0.05		-	
Estimated outputs/releases to:*4		High	Low	High	Low
- Air	Kg/year	1040.25	52.01	1040.25	52.01
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year				
- Sector-specific treatment/disposal	Kg/year	54.75	2.74	54.75	2.74

Table 62 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurity in pro-ducts**	**General waste treatme nt**	**Sector specific treatment/ disposal**	**Total**
5.2.9	**Primary ferrous metal production**	VIII	1040.250					54.750	1095.000

Table 63 Low end release by subcategory, region and release pathway

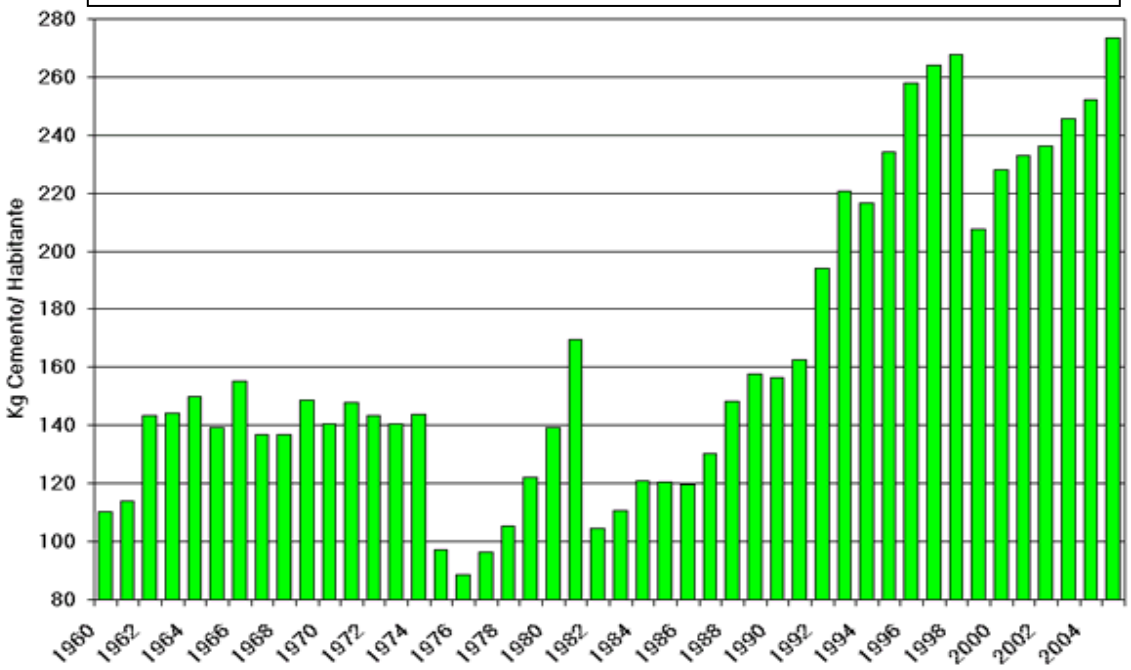
Low end release by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurit y in pro-ducts**	**General waste treatme nt**	**Sector specific treatment/ disposal**	**Total**
5.2.9	**Primary ferrous metal production**	VIII	52.025					2.738	54.763

4.3 Category 5.3 "Production of other minerals and materials with mercury impurities"

General Information
This category includes two subcategories, with one of these –Cement Production –having a per capita consumption in Chile of 270 kg of cement per inhabitant in 2004.
In the second subcategory—pulp and paper production—Chile is one of the top ten global producers and one of the top five in exports.

Graph 22 below illustrates the evolution of annual per capita cement consumption in Chile.

Graph 23 Evolution per capita consumption in Chile (Kg. cement per inhab.)



4.3.1 Subcategory 5.3.1. "Cement production"

General Information
Trace quantities of mercury have been identified in the many different raw materials used to produce cement. The origin of this metal is from naturally occurring mercury in the virgin materials used in the process (limestone, coal, petroleum, etc.). The use of alternative fuels (solid and/or liquid) as raw material can significantly increase the total mercury input into the cement production process if not controlled. The main release pathway for the mercury present in raw materials is air release; there are also trace amounts of mercury present in processed cement. Cement produced in Chile is pozzolanic cement.

Parameters taken into account for estimating "Cement production."

- Activity rate for cement production

Table 64 "Cement production"

Cement production	Location	Tons/year	Source of information
INACESA-Antofagasta	Antofagasta	286750	Company
Cemento Melón	El Melón	1391183	Company
Cemento Polpaico	Polpaico	1407584	Company
INACESA-Curicó	Curicó	516738	Company
Cementos Bío-Bío	Bío-Bío	396745	Company
Total		**3999000**	

Estimation Methodology

A high end emission factor of 0.18 ppm was assigned, estimated on the basis of a maximum concentration established in the "Ministry Secretary General of the Presidency's Emission Standard for Waste Incineration and Coincineration" and an air emission factor of 0.1 ppm, suggested in the Toolkit.

Based on the information collected, only air distribution was applied because only an air emission factor was used. The Subcategory was broken down into point sources at the facility level.

Table 65 Summary Table, subcategory 5.3.1: Cement Production.

5.3.1 Cement Production	**Unit**	**Production**		**Sum of releases to the pathway from assessed part of life cycle**	
Activity rate	Tons/year	3999000			
		High	Low	-	
Input factor for phase ***1**	g Hg / ton	0.18	0.1	-	
Estimated inputs for phase ***2**	KgHg/year	720	400	-	
Output distribution factors for phase: *3					
- Air		1		-	
- Water				-	
- Land				-	
- Products				-	
- General waste treatment				-	
- Sector-specific treatment/disposal				-	
Estimated outputs/releases for: *4		High	Low	High	Low
- Air	Kg/year	720	400	720	400
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year				
- Sector-specific treatment/disposal	Kg/year				

Table 66 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurity in pro-ducts**	**General waste treatme nt**	**Sector specific treatment/ disposal**	**Total**
5.3.1	**Cement production**	II	51.615						51.615
		V	250.413						250.413
		RM	253.365						253.365
		VII	93.013						93.013
		VIII	71.414						71.414
			719.820						719.820

Table 67 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/ disposal	Total
5.3.1	**Cement production**	II	28.675						28.675
		V	139.118						139.118
		RM	140.758						140.758
		VII	51.674						51.674
		VIII	39.675						39.675
			399.900						399.900

4.3.2 Subcategory 5.3.2. "Pulp and paper production"

Point Source Approach

General Information

Chile's pulp and paper industry is dominated by two large companies.

Pulp production uses chemical and mechanical methods applied to raw wood. The source of mercury is associated with trace amounts found in the wood, in the fuels used for power generation, and in the chemicals employed in the pulp production process.

Parameters taken into account for estimating emissions from "Pulp and paper production"

- Activity rate based on biomass consumption

Table 68 "Biomass-fired recovery and power boilers "

Biomass-fired recovery and power boilers	Location	Tons/year	Source of information
Planta Constitución CELCO	Region VII	96749	CNE 2005
Planta Licancel	Region VII	569910	CNE 2005
Planta Arauco	Region VIII	158871	CNE 2005
Planta Cholguan	Region VIII	195388	CNE 2005
Celulosa Valdivia	Region IX	86145	CNE 2005

- Activity rate based on consumption of black liquor

Table 69 Black liquor-fired recovery and power boilers

Black liquor-fired recovery and power boilers	Location	Tons/year	Source of information
Planta Constitución CELCO	Region VII	504100	CNE 2005
Planta Licancel	Region VII	237339	CNE 2005
Planta Arauco	Region VIII	1941761	CNE 2005
Planta Nueva Aldea	Region VIII	1721	CNE 2005
Celulosa Valdivia	Region IX	443412	CNE 2005

Estimation Methodology

In this case, input and output factors suggested in the Toolkit were used, based on biomass and black liquor consumption.

The subcategory was broken down into point sources at the individual establishment level.

Table 70 Summary Table, subcategory 5.3.2: Pulp and Paper Production

5.3.2 Pulp and paper production	**Unit**	**Production**		**Sum of releases to pathway from assessed part of life cycle**
		Biomass	Black Liquor	
Activity Rate		1107063	2128333	
		Biomass	L.Negro	-
Input factors for phase ***1**	g Hg / ton	0.0026	0.00002	-
Estimated inputs for phase ***2**	KgHg/year	2.88	0.04	-
Output distribution factors for phase: *3				
- Air		0.9		-
- Water				-
- Land				-
- Products				-
- General waste treatment		0.1		-
- Sector-specific treatment/disposal				-
Estimated outputs/releases to: *4				
- Air	Kg/year	2.63		2.63
- Water	Kg/year			
- Land	Kg/year			
- Products	Kg/year			
- General waste treatment	Kg/year	0.29		0.29
- Sector-specific treatment/disposal	Kg/year			

Table 71 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurity in products**	**General waste treatment**	**Sector specific treatment/ disposal**	**Total**
5.3.2	**Pulp and paper production**	VII	1.573				0.175		1.748
		VIII	0.848				0.094		0.942
		X	0.210				0.023		0.233
			2.631	0.000	0.000	0.000	0.292	0.000	2.923

Table 72 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.3.2	**Pulp and paper production**	VII	1.573				0.175		1.748
		VIII	0.848				0.094		0.942
		X	0.210				0.023		0.233
			2.631	0.000	0.000	0.000	0.292	0.000	2.923

4.3.3 Subcategory 5.3.3. "Production of lime and light weight aggregate"

General Information

This subcategory includes production of lime, which is carried out in Chile in regions II, III and the Metropolitan Region (RM).

Parameters taken into account for estimating emissions from "Production of lime and light weight aggregates"

- Activity rate for lime production, in tons per year

Table 73 "Lime Production "

Lime Production	Location	Tons/year	Source of information
INACESA Antofagasta	Antofagasta	297281	Company
INACESA Copiapó	Copiapó	109512	Company
SOPROCAL S.A.	RM	165009	Company

Estimation Methodology

Based on input and output factors suggested by the Toolkit.

Table 74 Summary Table, subcategory 5.3.3: Lime production.

5.3.1 Lime production	Unit	Production	Sum of releases to pathway from assessed part of life cycle
Activity rate - Ton		571802	-
Input factors for phase ***1**	g Hg / ton	0.055	-
Estimated inputs for phase ***2**	KgHg/year	31	-
Output distribution factors for phase: *3			
- Air		0.9	-
- Water			-
- Land			-
- Products			-
- General waste treatment		0.1	-
- Sector-specific treatment/disposal			-
Estimated outputs/releases to: *4			
- Air	Kg/year	28.3	28.3
- Water	Kg/year		
- Land	Kg/year		
- Products	Kg/year		
- General waste treatment	Kg/year	3.14	3.14
- Sector-specific treatment/disposal	Kg/year		

Table 75 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/ disposal	Total
5.3.3	**Production of lime and light weight aggregates**	II	14.715				1.635		16.350
		III	5.421				0.602		6.024
		RM	8.168				0.908		9.075
			28.304	0.000	0.000	0.000	3.145	0.000	31.449

Table 76 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/ disposal	Total
5.3.3	**Production of lime and light weight aggregates**	II	14.715				1.635		16.350
		III	5.421				0.602		6.024
		RM	8.168				0.908		9.075
			28.304	0.000	0.000	0.000	3.145	0.000	31.449

4.3.4 Subcategory 5.3.4. "Other minerals and materials"

General Information
The Toolkit has little data on this subcategory.
Gypsum and ceramic production were also included under this subcategory.

Parameters taken into account for estimating emissions of "Other minerals and materials"

- Activity rate for Gypsum production in tons per year

Table 77 "Production of gypsum plaster. Annual Mining Report 2005"

Gypsum production	Location	Tons/year	Reference-year
Gypsum production	II	15204	Anuario de minería 2005
Gypsum production	IV	4950	Anuario de minería 2005
Gypsum production	RM	309836	Anuario de minería 2005

- Activity rate for ceramic production, in tons per year

Table 78 "Ceramic production. RM and Region VII. Source: ENIA "

Ceramic production (*)	Location	Tons/year	Source of information
RM,VIII	País	147275	ENIA

(*)Batuco, Nacimiento and Fanaloza ceramic companies

Estimation Methodology
Estimations used input and output factors suggested by the Toolkit for lime production.

Table 79 Summary Table, subcategory 5.3.4: Other minerals and materials

5.3.4 Production and processing of other minerals and materials	**Unit**	**Production**		**Sum of releases to pathway from assessed part of life cycle**
		Gypsum	Ceramics	
Activity rate	Ton/year	660753	147275	
		Gypsum	Ceramics	-
Input factors for phase ***1**	g Hg / ton	0.055	0.055	-
Estimated inputs for phase ***2**	KgHg/year	36	8	-
Output distribution factors for phase: *3				
- Air		0.9		-
- Water				-
- Land				-
- Products				-
- General waste treatment		0.1		-
- Sector-specific treatment/disposal				-
Estimated outputs/releases to: *4				
- Air	Kg/year	32.71	7.29	40
- Water	Kg/year			
- Land	Kg/year			
- Products	Kg/year			
- General waste treatment	Kg/year	3.63	0.81	4.44
- Sector-specific treatment/disposal	Kg/year			

Table 80 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		**Region**	**Air**	**Water**	**Land**	**Impurity in pro-ducts**	**General waste treatment**	**Sector specific treatment/ disposal**	**Total**
5.3.4	**Other minerals and materials**	II	0.753				0.084		0.836
		IV	0.245				0.027		0.272
		RM	22.316				2.480		24.796
		VIII	0.311				0.035		0.345
			23.625	0.000	0.000	0.000	2.625	0.000	26.250

Table 81 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impur-ity in product s	General waste treatment	Sector specific treatment/disposal	Total
5.3.4	**Other minerals and materials**	II	0.753				0.084		0.836
		IV	0.245				0.027		0.272
		RM	22.316				2.480		24.796
		VIII	0.311				0.035		0.345
			23.625	0.000	0.000	0.000	2.625	0.000	26.250

4.4 Category 5.4 "Intentional use of Mercury in industrial processes"

4.4.1 Subcategory 5.4.1. "Chlor-alkali production with mercury technology"

Not currently applicable in Chile.

The chlor-soda company Occidental Chemical Chile, which is located in Region VIII, abandoned its former mercury cell chlor-alkali production process in 1991, replacing it with the membrane process.

4.4.2 Subcategory 5.4.2. "VCM (vinyl-chloride-monomer) production with mercury dichloride (HgCl2) as catalyst.

Not applicable in Chile.

4.4.3 Subcategory 5.4.3. "Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst"

Not applicable in Chile.

4.4.4 Subcategory 5.4.4. "Other production of chemicals and polymers with mercury compounds as catalyzers"

Not applicable in Chile.

4.5 Category 5.5 "Consumer products with intentional use of mercury"

General information

'Consumer products with intentional mercury use' is a very broad category and the destination of the releases (air, water or land) depends on a variety of variables such as the product usage, useful life, life cycle, and other aspects. Thus, emissions in this category depend on the kind of product, the production process, its handling during use and its final disposal as waste. Emissions are also estimated by taking into account input and output distribution factors. No products of this nature are reported to be manufactured in Chile.

Emissions estimation methodology and emission factors for products

Under the methodology supplied in the Toolkit, Hg emissions associated with the use of mercury-containing products are calculated by multiplying the consumption of a given product or activity rate by "input factors" that correspond to the quantity of mercury estimated in each product. These values are then multiplied by "distribution factors" corresponding to estimated percentages that would be released to the air, water, land, as waste, etc.

The values for input and output distribution factors are obtained from the study conducted using the best available information, which includes information from manufacturer's specifications, country of origin and/or values given in the Toolkit.

Emissions for this category were estimated using the following general equation provided by the Toolkit:

Equation 1:"Equation defined in the Toolkit"

$$E = IF * AR * DF$$

Where

E : Emissions of pollutant under study [Tons/year]

IF : Input factor of the contaminant under study, based on type of product [Ton Hg. /Ton product]

AR : Activity rate, defined in this case as the annual consumption of the product under study [Tons/year].

DF : Distribution factors for air, water, land or waste, expressed in percentages for each product.

Unlike in other categories, for this subcategory it is necessary to use historical data for products that have entered the country, as the useful life, use and disposal of these means that the mercury they contain will not necessarily be released during the same year they enter the country.

The development of subcategories 5.5 and 5.6 began with the review of the EPA's "Mercury Products Database" in order to identify those products in Chile that contain mercury.

4.5.1 Subcategory 5.5.1. Thermometers with mercury

General information

Mercury thermometers have been used traditionally to measure temperature in all kinds of areas, with the main ones identified as those used in medical, environmental, wine industry, food preparation, and industrial applications.

Parameters taken into account for estimating emissions from "Thermometers with mercury"

- Activity rate for thermometers with mercury

Table 82 "Thermometers by type as of 2005, in units "

Consumption	Location	Tons/year	Source of information
Medical thermometers	National	1058012,72	Customs service
Environmental thermometers	National	107137,69	Customs service

Information needed to develop this subcategory

It must be noted that as a preliminary step in estimating consumption of these devices at the national level, the Occupational Health Unit of the Ministry of Health's Undersecretary of Public Health formulated a questionnaire to capture information on the use of mercury containing instruments and their presence in the country's public health units.

In a meeting held with that entity, Ministry representatives agreed on the need to implement a new survey, which will be distributed to public health services. It was not possible to apply that instrument in developing the Inventory, but its application will be possible as part of the "Risk Management Plan" and its subsequent updates in the RETC (Chile's PRTR).

Twenty private health care facilities in Chile were surveyed in a limited fashion, given the limited amount of time available for the study and the fact that most private facilities do not give out information readily. When this report went to press no information was available on this survey. (See Annex 1)

Estimation Methodology

The thermometers that could be quantified were medical and environmental.

To calculate the total number of thermometers that were disposed of in 2005, a breakage rate of 5% per year was assumed and a cumulative calculation was undertaken, considering all thermometers that have entered the country since 1990. This was applied for both kinds of thermometers quantified.

For the input factor the values suggested in the Toolkit were used; the output distribution was based on that suggested by the Toolkit for the following assumption: "No or very limited separate thermometer collection."

"All or most general waste is collected and handled in a publicly controlled manner."

Table 83 Summary Table, subcategory 5.5.1: Thermometers with mercury

5.5.1: Thermometers with mercury	**Unit**	**Use**				**Sum of releases to pathway from assessed part of life cycle**	
		Medical		Environ-mental			
Activity rate	Units	1058013		107138			
		Medical		Environ.		-	
Input factor for phase ***1**	g Hg / item	High 1.5	Low 0.5	High 5	Low 2	-	
Estimated inputs for phase ***2**	items/ year	1587	529	536	214	-	
Output distribution factors for phase: *3							
- Air		0.1				-	
- Water		0.3				-	
- Land						-	
- General waste treatment		0.6				-	
-Sector-specific treatment/disposal						-	
Estimated outputs/releases to: *4		High		Low		High	Low
- Air	Kg/year	212.27		74.33			
- Water	Kg/year	636.81		222.98			
- Land	Kg/year						
- General waste treatment	Kg/year	1273.62		445.97			
-Sector-specific treatment/disposal	Kg/year						

4.5.2 Subcategory 5.5.2. Electrical switches and relays with mercury

General information

The use of mercury in electrical switches covers a wide range of products, uses and contents. Chile itself does not produce electrical switches.

Parameters taken into account for estimating "Electrical Switches and relays with mercury"

- Activity rate, inhabitants estimated at 2005

Table 84 "Inhabitants as of 2005, by statistical compendium"

Inhabitants	Location	Tons/year	Source of information
	National	16267278	INE

It was not possible to quantify the importation of electrical switches with real and historical import data, product type, model, brand, company, importer, product description and place of origin through the National Customs System, as current customs classifications are too broad and do not specify whether individual products such as switches contain mercury or not.

No industrial or trade associations or other institutions generate or collect data on this activity.

Estimation Methodology

Based on the activity rate suggested in the Toolkit, which is based on number of inhabitants, in this case from 2005.

Input factors used were those suggested in the Toolkit and output distribution was based on the following assumption, "No or very limited separate switches collection. All or most general is waste collected and handled in a publicly controlled manner."

Table 85 Summary Table, subcategory 5.5.2: Electrical and electronic switches, contacts and relays with mercury.

5.5.2: Electrical and electronic switches, contacts and relays with mercury	Unit	Use		Sum of releases to pathway from assessed part of life cycle	
Activity rate	Inhab.	16267278			
		High	Low	-	
Input factors for phase ***1**	g Hg / item	0.02	0.25	-	
Estimated inputs for phase ***2**	items/ year	4067	325	-	
Output distribution factors for phase: *3					
- Air		0.1		-	
- Water				-	
- Land		0.1		-	
- General waste treatment		0.8		-	
- Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	406.68	32.53	406.68	32.53
- Water	Kg/year				
- Land	Kg/year				
- General waste treatment	Kg/year	406.68	32.53	406.68	32.53
- Sector-specific treatment/disposal	Kg/year	3253.46	260.28	3253.46	260.28

4.5.3 Subcategory 5.5.3. Light sources with mercury

General information

Mercury is used in small quantities for different kinds of discharge lamps. The most common examples are fluorescent tubes and compact fluorescent lamps (CFL), notably metal halide, mercury vapor, high-pressure sodium, and neon lamps.

Chile does not produce lamps with mercury, and its activity level is therefore obtained through use and disposal of lamps produced elsewhere.

Parameters taken into account for estimating "Light sources with mercury"

- Activity rate for Light Sources in tons per year

Table 86 "Light Sources "

Light sources	Location	Tons/year	Source of information
Mercury vapor	National	115906.93	Customs Service

The activity rate required to estimate mercury emissions is determined by current and historical cumulative annual consumption of lamps and their disposal according to their usage.

Importations of these kinds of products come mainly from Germany, China, France, the USA and Japan.

Estimation Methodology

Mercury-containing lamps that could be identified are mercury vapor and fluorescent lighting; this data is based on information from the National Customs Service.

To estimate mercury vapor lamps that were disposed of in 2005 a breakage rate of 5% per year and a useful life of five years were assumed. A cumulative estimate was then calculated taking into account lamps that have entered the country since 2001.

The input factor suggested in the Toolkit for this kind of lamp was used, as well as an output distribution factor assigned by the Toolkit, based on the following assumption, "No or very limited separate lamps collection. All or most general is waste collected and handled in a publicly controlled manner."

Table 87 Summary Table, subcategory 5.5.3: Light sources with mercury.

5.5.3: Light sources with mercury	Unit	Use	Sum of releases to pathway from assessed part of life cycle
Activity rate - Ton	Units	115907	-
Input factor for phase ***1**	mg Hg / item	30	-
Estimated inputs for phase ***2**	KgHg/year	3.47	-
Output distribution factors for phase: *3			
- Air		0.05	-
- Water			-
- Land			-
- General waste treatment		0.95	-
- Sector-specific treatment/disposal			-
Estimated outputs/releases to: *4			
- Air	Kg/year	0.17	0.17
- Water	Kg/year		
- Land	Kg/year		
- General waste treatment	Kg/year	3.3	3.3
- Sector-specific treatment/disposal	Kg/year		

4.5.4 Subcategory 5.5.4. Batteries with mercury

General information

The use of mercury in batteries is one of the most significant uses of this pollutant. Mercury is used mainly in primary batteries, not for rechargeable batteries.

Chile does not produce batteries but does consume large quantities of them and has a weak waste disposal system.

Parameters taken into account for estimating "Batteries with Mercury"

- Activity rate for batteries by type of battery in tons per year

Table 88 "Batteries by type as of 2005, in tons "

Battery consumption	Location	Tons/year	Source of information
Mercury oxide	National	1.71	Chilean Customs
Zinc- air	National	2.13	Chilean Customs
Silver oxide button cells	National	13.24	Chilean Customs
Alkaline other than button cells	National	2212	Chilean Customs

The activity rate required to estimate mercury emissions is given by the annual and historical consumption of batteries by their different uses. To obtain these values the

detailed information required in terms of battery models, brands, companies, importers, product descriptions and place of origin was requested from the National Customs Service.

It was not possible to find sales figures broken down by region, municipality or import distributor.

Neither was it possible to take into account batteries inside the packages of other imported products, such as electronic devices and games, etc., a large number of which enter Chile with batteries included.

In this regard, the present study considers the following:

Batteries identified that contain mercury in their components include:

- Alkaline manganese batteries for intensely used devices such as walkmans, photographic cameras and games.
- Zinc air batteries, which are appropriate for hearing aids for the deaf, pacemakers and photographic equipment.
- Mercury oxide batteries for hearing aids, pacemakers and photography
- Silver oxide batteries for watches, calculators and photographic cameras

Estimation Methodology

To estimate batteries disposed of in 2005, a useful life of less than one year was assumed and therefore no historical cumulative values were taken into account, except for mercury-zinc cells, which were assigned a useful life of two years.

The input factors suggested in the Toolkit for different kinds of batteries was used, making it necessary to transform the activity rate unit into metric tons.

For the output factor, the output distribution factor suggested in the Toolkit was used, which is based on the following assumption, "No or very limited separate battery collection. All or most general is waste collected and handled in a publicly controlled manner."

Table 89 Summary Table, subcategory 5.5.4: Batteries with mercury.

5.5.4: Batteries with mercury	Unit	Use	Sum of releases to pathway from assessed part of life cycle
Activity rate – ton	Tons/ year	2229	-
Input factor for phase ***1**	mg Hg / item	4 - 320	-
Estimated inputs for phase ***2**	KgHg/ year	2838	-
Output distribution factors for phase : *3			
- Air			-
- Water			-
- Land			-
- General waste treatment		1	-
-Sector-specific treatment/disposal			-
Estimated outputs/releases to: *4			
- Air	Kg/year		
- Water	Kg/year		
- Land	Kg/year		
- General waste treatment	Kg/year	2838	2838
-Sector-specific treatment/disposal	Kg/year		

4.5.5 Subcategory 5.5.5. Biocides and pesticides

General information

Many mercury compounds are toxic to microorganisms and therefore they have been used as biocides in the paper industry, in paints, on seed grain and in other agricultural applications.

In Chile, under SAG Resolución Exenta Nº 996 of 1993, "the importation, manufacture, distribution, sale and use of agricultural pesticides that contain organic or inorganic mercury salts is prohibited."

This subcategory is therefore not applicable in Chile.

4.5.6 Subcategory 5.5.6. Paints

General information
According to ASIQUIM and a review of the study "Guide for the control and prevention pollution in the paint industry" published by CONAMA (1998), this category is not applicable in our country.

4.5.7 Subcategory 5.5.7. Pharmaceuticals for human and veterinary uses

General information
Mercury has been used as a preservative in various pharmaceutical products such as vaccines, eye drops, nasal solutions, antiseptics, gynecological drugs, herbal medicines and other products.

It was not possible to quantify this subcategory, but some mercury containing products sold in Chile were identified.

The types of compounds identified in pharmaceutical products include:

1. Mercurochrome disinfectant (also known as *metapío* in Chile)
2. Thimerosal, as a vaccine preservative
3. Yellow ointment (Eye ointment)

4.5.8 Subcategory 5.5.8. Cosmetics and related products

General information
Mercury has been used in creams and soaps to promote clear skin and as a preservative in some eye makeup and makeup remover. Mercury releases may occur during production, use and disposal of these products.

This sector is regulated in Chile under Decreto Supremo Nº 239/02, which includes a list of compounds banned in cosmetics, including mercury compounds.

4.6 Category 5.6 Other intentional product/process uses

4.6.1 Subcategory 5.6.1. Dental mercury-amalgam fillings

General information

Mercury-amalgam filings consist of an alloy or mercury, silver, copper and tin (with a usual mercury content of 44 to 51% by weight).

Mercury is released into the air and water and as waste during the production, use and disposal of amalgam fillings. These types of fillings are used widely in the public health sector in Chile.

Parameters taken into account for estimating "Dental mercury-amalgam fillings"

- Activity rate, estimated inhabitants as of 2005

Table 90 "Inhabitants in 2005, by 2005 statistical compendium"

Inhabitants	Location	Tons/year	Source of information
	National	16267278	INE

The Department of Oral Health of the Undersecretary of Ministerial Health conducted a survey in the public sector (before this study was launched) and obtained an initial estimate of the quantity of mercury used in amalgam fillings applied in the public sector.

The results indicate an average monthly applications of 40,994 amalgam fillings for the 457 chairs providing dental care, with a total mercury consumption of 23.4 kg. This indicates a total yearly use of around 281 kg of mercury, considering that 57% of all dental offices in the public health care system in Chile responded to this survey. Nevertheless, this sector represents only a segment of the sector, as there are many dentists operating in private practice in Chile, making it difficult to quantify this value using only the information provided by the Department of Oral Health.

It should be noted that, thanks to the efforts of the Department of Oral Health of the Ministry of Health, information is now available on the total number of fillings applied in the National Health Service (SNSS) offices from 1999 to 2006, including the Dental Health Programs in the Metropolitan Region of Santiago, which represents more than 45% of the national total. However, the number of amalgam fillings applied is not known. At a meeting held with the Assistant Director of the Department of Oral Health, the members of this department expressed their willingness to improve upon the information available and possibly introduce management plans.

Information was obtained from the National Customs Service on the entry into Chile of mercury for use in amalgam fillings. The Service reported that 2.1 tons of mercury was imported for this purpose by the State Procurement Department between 1997 and 2006.

A survey was applied among 20 private dental institutions in Chile but, as with the private health care facilities, little information was forthcoming in part because of their inability to supply such information and in part due to the time constraints of the study. No information had been obtained when this report went to press. (See Annex 1)

Given the above situation, the decision was made to apply the input and output factors established in the Toolkit, as it was not possible to establish a projected use in this subcategory at the national level.

Estimation Methodology

The activity rate suggested by the Toolkit is based on the number of inhabitants that, for the purpose of this study, corresponds to the population in 2005 for the assessed part of the cycle: "Dental preparations and procedures at dental offices."

The input factor suggested by the Toolkit used was based on an interval while the output distribution factor was chosen on the basis of the assumption "Dental preparations and procedures at dental offices (portion of current supply of mercury for dental amalgams)," in which an output of 60% was assumed, given that the mercury is left in the patient's mouth and will be released over time, through excretion and/or upon death.

No past statistics were applied, as the category of cemeteries and crematoria were considered as of 2005, which would cover mercury releases from fillings from previous years.

Table 91 Summary Table, subcategory 5.6.1: Dental mercury-amalgam fillings.

5.6.1: Dental mercury-amalgams	**Unit**	**Use**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	Inhabitants	16267278			
		High	Low	-	
Input factors for phase ***1**	g Hg / inhabitant	0.05	0.2	-	
Estimated inputs for phase ***2**	KgHg/year	3253	813	-	
Output distribution factors for phase : *3					
- Air		0.02		-	
- Water		0.14		-	
- Land				-	
- Products		0.6		-	
- General waste treatment		0.12		-	
- Sector-specific treatment/disposal		0.12		-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	65.07	16.27	65.07	16.27
- Water	Kg/year	455.48	113.87	455.48	113.87
- Land	Kg/year				
- Products	Kg/year	1952.07	488.05	1952.07	488.05
- General waste treatment	Kg/year	390.41	97.6	390.41	97.6
- Sector-specific treatment/disposal	Kg/year	367.88	97.6	367.88	97.6

4.6.2 Subcategory 5.6.2. Manometers and gauges

General information

Mercury is used in some blood pressure gauges (sphygmomanometers), industrial and meteorological manometers and pressure valves, and may be released when these instruments are used and/or in their final disposition.
There is no production of such instruments in Chile, only use and disposal.

Parameters taken into account for estimating mercury emissions from "Manometers and gauges"

- Activity rate for Manometers as of 2005

Table 92 "Manometers"

Manometers	Location	Tons/year	Source of information
Manometers	National	713	Chilean Customs Service

It was not possible to establish the quantity of manometers containing mercury that are sold in Chile.

For the same reason mentioned in the consumer products category, it also was difficult to determine the number of manometers operating with mercury.

Different kinds of gauges in use were also identified but it was not possible to identify all of those that contain mercury.

Gauges with Hg content that have been identified include:

1. Barometers
2. Hydrometers
3. Strain gauge
4. Barometer
5. Thermo-hygrometer
6. Manometers
7. Densimeter

The number of sphygmomanometers entering Chile in 2005 is known, but the small number of these, even without considering a Toolkit assumption for potential mercury release by the quantity of mercury contained (which corresponds to 0.002 g Hg / item in this category), means emissions are practically zero, and therefore it was not included in a summary table.

4.6.3 Subcategory 5.6.3. Laboratory chemicals and equipment

General information
Mercury is used in laboratory instruments, reagents, preservatives and catalysts. Part of the Hg contained in these instruments is released to the air, mainly through ventilation systems; however, mercury is also released through wastewater and through general waste disposal.

Through the National Customs Service the study was able to determine that 4 Kg of mercury was imported as a chemical product for laboratory use into Chile by a local lab.
The output factor applied was that suggested in the Toolkit, with a distribution of 30% to water, 30% to general waste and 40% to sector-specific treatment.

The entry of chemical products containing mercury for lab use was also identified but was not quantified because of the complexity of the compounds involved.

4.6.4 Subcategory 5.6.4. Mercury metal use in religious rituals and folklore medicine

Not applicable to Chile.

4.6.5 Subcategory 5.6.5. Miscellaneous product uses

General information
Based on information provided by the National Customs Service, it was not possible to identify or quantify the existence of these products.

4.7 Category 5.7. Production of recycled metals ("secondary" metal production)

General information
This category sets out three subcategories, among which only the production of recycled ferrous metals (iron and steel) is carried out in Chile.

4.7.1 Subcategory 5.7.1. Production of recycled mercury ("secondary production")

Not applicable in Chile.

4.7.2 Subcategory 5.7.2. Production of recycled ferrous metals (iron and steel)

General information

The production of recycled iron and steel begins with scrap metal and uses a number of high temperature processes. The mercury can be present in the recycled metals/materials as a result of natural mercury impurities in the original materials. Mercury can also be present from contamination by anthropogenic use of the metal, such as mercury switches or some other mercury containing products that leak into the scrap.

Parameters taken into account for estimating "Production of recycled ferrous metals (iron and steel)"

- Activity rate, Production of recycled iron and steel, in tons per year

Table 93 "Production of recycled iron and steel"

Production of recycled iron and steel	Location	Tons/year	Reference-year
	RM	450000	Gerdau- Aza 2005

Estimation Methodology

Input and output factors suggested by the Toolkit were used.
This subcategory was de-aggregated into individual point sources.

Table 94 Summary Table, subcategory 5.7.2: Production of recycled ferrous metals (iron and steel)

5.7.2: Production of recycled ferrous metals (iron and steel).	**Unit**	**Use**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	Tons/year	450000			
		High	Low	-	
Input factor for phase ***1**	g Hg / ton	0.1	0.01	-	
Estimated inputs for phase ***2**	KgHg/year	45	5	-	
Output distribution factors for phase : *3					
- Air		0.9		-	
- Water				-	
- Land				-	
- Products				-	
- General waste treatment		0.1		-	
- Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	40.5	4.05	40.5	4.05
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year	4.5	0.45	4.5	0.45
- Sector-specific treatment/disposal	Kg/year				

Table 95 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.7.2	**Production of recycled ferrous metals (iron and steel)**	RM	40.500				4.500		45.000

Table 96 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.7.2	**Production of recycled ferrous metals (iron/steel)**	RM	4.050				0.450		4.500

4.7.3 Subcategory 5.7.3. Production of other recycled metals

Point Source Approach

General information

The Toolkit suggests that it is possible that aluminum, copper, zinc and other metals commonly recycled in many countries have some mercury content. The original manufacturing process for most metals indicates that natural mercury impurities in the raw material do not remain to any significant degree in the processed metals. However, aluminum is one of a number of recycled metals that has the potential to release mercury.

Parameters taken into account for estimating emissions from "Production of other recycled metals"

- Activity rate for secondary smelters, in tons per year.

Table 97 "Smelters"

Smelters	Location	Tons/year	Reference-year
No company details	RM	2658	Projected-2005
No company details	RM	8177	Projected-2005
Sociedad Industrial Metalam	V region	250	Projected-2005
Fundición Imperial	VIII	209	Projected-2005
Fundición Inducto metal	X	12	Projected-2005

It was not possible to estimate emissions for the source identified, as the Toolkit does not report input and output distribution factors and the information needed to establish these factors and arrive at estimations could not be obtained.

4.8 Category 5.8. Waste Incineration

General information
For this category, only the subcategory of 'Incineration of medical waste' has been identified in Chile; the other subcategories are not applicable in Chile.

4.8.1 Subcategory 5.8.1. Incineration of municipal / general waste

Not applicable in Chile

4.8.2 Subcategory 5.8.2. Incineration of hazardous waste

Not applicable in Chile

4.8.3 Subcategory 5.8.3. Incineration of medical waste

General information
Chile does have companies that incinerate medical waste, which includes infectious and non-infectious waste generated by medical facilities such as: veterinary clinics, teaching hospital, private clinics, doctors' offices and dentist offices; medical laboratories and schools of medicine; human and veterinary medicine research units; among others.

Mercury content in the flow of medical waste originates mainly in the waste products themselves or in residues released in processes with intentional use of mercury. Mercury concentrations in each case will depend directly in how much of this metal is present in the waste (input value).

Parameters taken into account for estimating emissions from "Incineration of medical waste"

- Activity rate for Incineration of medical waste by region, in tons per year

Table 98 "Incineration of Medical Waste"

Incineration of Medical Waste	Location	Tons/yr	Reference-year (*)
	I	49856	Inv. Nac. Fuente Diox y Furanos 02
	II	20044	Inv. Nac. Fuente Diox y Furanos 02
	III	18368	Inv. Nac. Fuente Diox y Furanos 02
	IV	25092	Inv. Nac. Fuente Diox y Furanos 02
	V	7052	Inv. Nac. Fuente Diox y Furanos 02
	RM	255.35	Inv. Nac. Fuente Diox y Furanos 02
	VI	69208	Inv. Nac. Fuente Diox y Furanos 02
	VII	29192	Inv. Nac. Fuente Diox y Furanos 02
	VIII	284376	Inv. Nac. Fuente Diox y Furanos 02
	IX	113.16	Inv. Nac. Fuente Diox y Furanos 02
	X	156292	Inv. Nac. Fuente Diox y Furanos 02
	XI	35506	Inv. Nac. Fuente Diox y Furanos 02
	XII	14432	Inv. Nac. Fuente Diox y Furanos 02

(*)Based on projected growth of incineration sector companies.

Estimation of mercury releases and percentages to final receiving media:
Based on the information collected, emissions are distributed by release pathway into air, water, land, general waste treatment and sector-specific treatment and disposal.

Incineration with a double combustion chamber is rare in Chile and is only carried out by three companies, located in the Metropolitan Region (RM) and Region VIII.

Estimation Method
For the company PROCESAN S.A., which incinerates and manages medical waste, growth was projected based on regional reports and establishments listed in the Dioxin and Furan Inventory.

Estimation used input and output distribution factors suggested in the Toolkit.

This subcategory was broken down into point sources by individual establishment.

Table 99 Summary Table, subcategory 5.8.3: Incineration of Medical Waste.

5.8.3 Incineration of medical waste	**Unit**	**Use**				**Sum of releases to pathway from assessed part of life cycle**	
		Unspecified		ESP			
Activity rate	Tons/year	846.98		245			
		High		Low		-	
Input factor for phase ***1**	g Hg / t waste	40		8		-	
Estimated inputs for phase ***2**	KgHg/year	43.66		8.74		-	
Output distribution factors for phase : *3		Unspecified		ESP			
- Air		1		0.9		-	
- Water						-	
- Land						-	
- Products						-	
- General waste treatment						-	
-Sector-specific treatment/disposal				0.1		-	
Estimated outputs/releases to: *4		High	Low	High	Low	High	Low
- Air	Kg/year	33.8	6.78	8.8	1.76	42.68	8.54
- Water	Kg/year						
- Land	Kg/year						
- Products	Kg/year						
- General waste treatment	Kg/year						
-Sector-specific treatment/disposal	Kg/year			0.98	0.20	0.98	0.20

Table 100 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.8.3	Incineration of medical waste	I	1.994						1.994
		II	1.122						1.122
		III	0.735						0.735
		IV	1.004						1.004
		V	0.282						0.282
		RM	9.247					0.955	10.201
		VI	2.768						2.768
		VII	1.168						1.168
		VIII	11.588					0.024	11.611
		IX	4.526						4.526
		X	6.252						6.252
		XI	1.420						1.420
		XII	0.577						0.577
			42.683	0.000	0.000	0.000	0.000	0.978	43.661

Table 101 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.8.3	Incineration of medical waste	I	0.399						0.399
		II	0.224						0.224
		III	0.147						0.147
		IV	0.201						0.201
		V	0.056						0.056
		RM	1.849					0.191	2.040
		VI	0.554						0.554
		VII	0.234						0.234
		VIII	2.318					0.005	2.322
		IX	0.905						0.905
		X	1.250						1.250
		XI	0.284						0.284
		XII	0.115						0.115
			8.536	0.000	0.000	0.000	0.000	0.196	8.732

4.8.4 Subcategory 5.8.4. Sewage sludge incineration

Not applicable in Chile.

4.8.5 Subcategory 5.8.5. Informal waste incineration

Not applicable in Chile

4.9 Category 5.9. Waste deposition / landfilling and waste water treatment

In regard to waste water treatment, this practice is regulated in Chile by standards that limit mercury content in waste water released into water courses.

4.9.1 Subcategory 5.9.1. Controlled landfills/deposits

General information

The mercury content in waste is primarily derived from mercury used intentionally in products that are discarded, and from process residues. It also occurs as natural impurities in a variety of materials and as a trace anthropogenic pollutant in large volumes of material.

Parameters taken into account for estimating emissions from "Waste deposition"

- Activity rate for waste deposition, in tons per year

Table 102 "Waste Deposition "

Waste Deposition	Location	Tons/year	Reference
Informal garbage dump	national	688069.0	Catastro residuos* 2004
		688069.0	Catastro residuos 2004
Landfill	national	3129334.0	Catastro residuos 2004
		3129334.0	Catastro residuos 2004
Garbage dump	national	1587873.0	Catastro residuos 2004
		1587873.0	Catastro residuos 2004
Other	national	66480.0	Catastro residuos 2004
		66480.0	Catastro residuos 2004
Waste deposition	Location	Tons/year	Reference
Waste received	**National**	**5471756.0**	**Catastro residuos 2004**

*****Translator's note: "Waste Inventory"

Estimation Methodology

Input and output factors suggested in the Toolkit were used, and output releases were applied only to air, as no information could be obtained on leaching to estimate releases to other media.

Table 103 Summary Table, subcategory 5.9.1: Controlled landfills/deposits

5.9.1: Controlled landfills/deposits	**Unit**	**Use**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	M^3 gas	24167746,2			
		High	Low	-	
Input factor for phase ***1**	µg Hg / m^3 gas from landfill	500	5000	-	
Estimated inputs for phase ***2**	KgHg/year	120.83	12.083	-	
Output distribution factors for phase : *3					
- Air		1		-	
- Water				-	
- Land				-	
- Products				-	
- General waste treatment				-	
-Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	120.83	12.083	120.83	12.083
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year				
-Sector-specific treatment/disposal	Kg/year				

4.9.2 Subcategory 5.9.2. Diffuse deposition under some control

Not applicable

4.9.3 Subcategory 5.9.3. Informal local disposal of industrial production waste

Not applicable

4.9.4 Subcategory 5.9.4. Informal dumping of general waste

Not applicable

4.9.5 Subcategory 5.9.5. Waste water system/treatment

General information

Information was collected on mercury concentration measurements in water in the intake and outtake pipes with representative samples taken from waste water treatment plants and the resulting sewage sludge. Information was also obtained on the quantity of waste water treated and the amount of sludge produced.

Parameters taken into account for estimating emissions from "Waste water treatment systems"

- Activity rate waste water treatment, in m^3 per year

Table 104 "Treated waste water"

Location	M^3/year	Reference-year
I	26,436,628.8	SISS 2005
II	22,973,976	SISS 2005
III	16,307,265.6	SISS 2005
IV	25,935,206.4	SISS 2005
V	130,813,358	SISS 2005
RM	365,117,501	SISS 2005
VI	36,957,038.4	SISS 2005
VII	22,661,769.6	SISS 2005
VIII	80,003,678.4	SISS 2005
IX	10,334,347.2	SISS 2005
X	51,611,817.6	SISS 2005
XI	5,052,067.2	SISS 2005
XII	11,075,443.2	SISS 2005

Estimation Methodology

Sludge deposition was broken down as follows: mechanical treatment, when the treatment does not generate sludge; biological treatment (activated sludge) without application of sludge to land; and biological treatment with agricultural application.

The input factors applied were those suggested in the Toolkit.

The mercury output distribution factors were different from those suggested in the Toolkit because of the existence of legal standards that regulate mercury content in water discharged to water courses. The high end interval was therefore taken as 0.001 mg/l, for releases to water, and the input factor was then distributed evenly among all other final receiving media.

Table 105 Summary Table, subcategory 5.9.5: Waste water system/treatment.

5.9.5: Waste water system/treatment	**Unit**	**Use**						**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	M^3 treated water	778280096							
		High			Low			-	
Input factor for phase ***1**	mg Hg / m^3 treated water	0.5			10			-	
Estimated inputs for phase ***2**	KgHg/ year	7782.8			389.15			-	
Output distribution factors for phase : *3		Mech. Treatment		Mech.& Biol.		Mech.& Biol. [2]			
		High	Low	High	Low	High	Low		
- Air								-	
- Water		0.1	0.9	0.1	0.5	0.1	0.5		
- Land						0.3	0.2	-	
- Products								-	
- General waste treatment		0.9	0.1	0.6	0.3	0.3	0.15	-	
-Sector-specific treatment/disposal				0.3	0.2	0.3	0.15	-	
Estimated outputs/releases to: *4		High	Low	High	Low	High	Low	High	Low
- Air	Kg/year								
- Water	Kg/year	156.71	70.52	581.5	145.37	40.07	10.02	778.28	225.91
- Land	Kg/year					120.22	4.01	120.22	4.01
- Products	Kg/year								
- General waste treatment	Kg/year	1410.41	7.84	3488.97	87.22	120.22	3.01	5019.6	98.07
-Sector-specific treatment/disposal	Kg/year			1744.49	58.15	120.22	3.01	1864.7	61.16

[2] Then applied to soil

Table 106 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.9.5	Waste water system/treatment	I		26.437			237.107	0.823	264.366
		II		22.974			187.191	19.574	229.740
		III		16.307	3.936		94.513	48.316	163.073
		IV		25.935	1.769		206.728	24.920	259.352
		V		103.813	53.832		782.692	97.796	1038.134
		RM		365.118	5.752		2184.953	1095.353	3651.175
		VI		36.957			221.742	110.871	369.570
		VII		22.662			135.971	67.985	226.618
		VIII		80.004	44.002		436.020	240.011	800.037
		IX		10.334	10.927		51.079	31.003	103.343
		X		51.612			355.830	108.676	516.118
		XI		5.052			30.312	15.156	50.521
		XII		11.075			95.459	4.220	110.754
				778.280	120.218		5019.598	1864.705	7782.801

Table 107 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/ disposal	Total
5.9.5	Waste water system/treatment	I		11.842			1.349	0.027	13.218
		II		9.033			1.801	0.652	11.487
		III		4.117	0.131		2.328	1.578	8.154
		IV		10.010	0.059		2.083	0.816	12.968
		V		40.196	1.794		7.105	2.811	51.907
		RM		91.279	0.192		54.624	36.464	182.559
		VI		9.239			5.544	3.696	18.479
		VII		5.665			3.399	2.266	11.331
		VIII		20.001	1.467		10.900	7.634	40.002
		IX		2.584	0.364		1.277	0.942	5.167
		X		15.980			6.203	3.623	25.806
		XI		1.263			0.758	0.253	2.273
		XII		4.703			0.694	0.141	5.538
				225.912	4.007	0.000	98.065	60.902	388.887

4.10 Category 5.10. Crematoria and cemeteries

4.10.1 Subcategory 5.10.1. Crematoria

General information

Chile is one of the pioneers in this area in Latin America, but unlike most countries, Chile has no agency that regulates cremation businesses or promotes technologies and/or work methods in this area, making it difficult to obtain information here.

Parameters taken into account for estimating emissions from "Crematoria"

- Activity rate in bodies cremated in 2005

An industry webpage[3] was consulted and the activity level obtained for 2005 with an approximate interval of 2000 to 3000 individuals, according to the records therein.

Table 108 "Cremations"

Cremations	Location (region)	Cadavers	Reference-year (*)
	I	84	Inv. Nac. Fuente Diox y Furanos 02
	II	102	Inv. Nac. Fuente Diox y Furanos 02
	III	50	Inv. Nac. Fuente Diox y Furanos 02
	IV	129	Inv. Nac. Fuente Diox y Furanos 02
	V	422	Inv. Nac. Fuente Diox y Furanos 02
	RM	1336	Inv. Nac. Fuente Diox y Furanos 02
	VI	198	Inv. Nac. Fuente Diox y Furanos 02
	VII	234	Inv. Nac. Fuente Diox y Furanos 02
	VIII	460	Inv. Nac. Fuente Diox y Furanos 02
	IX	233	Inv. Nac. Fuente Diox y Furanos 02
	X	281	Inv. Nac. Fuente Diox y Furanos 02
	XI	18	Inv. Nac. Fuente Diox y Furanos 02
	XII	41	Inv. Nac. Fuente Diox y Furanos 02

(*) Projected activity rate based on growth among these companies

Estimation Methodology

The values given in the 2002 Inventory of Dioxins and Furans were updated to take into account the death rate in 2005 published by the National Statistics Bureau (INE), and the application of a weighted average for cremations as a percentage of all deaths, which was obtained from the abovementioned inventory.

The input and output factors suggested in the Toolkit were used.

[3] www.crematorios.cl

Table 109 Summary Table, subcategory 5.10.1: Crematoria.

5.10.1: Cremations	**Unit**	**Use**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	Cremations/ year	3587			
		High	Low	-	
Input factor for phase ***1**	g Hg / cadaver	1	4	-	
Estimated inputs for phase ***2**	KgHg/year	14.348	3.587	-	
Output distribution factors for phase : *3					
- Air		1		-	
- Water				-	
- Land				-	
- Products				-	
- General waste treatment				-	
-Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	14.35	3.59	14.35	3.59
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year				
-Sector-specific treatment/disposal	Kg/year				

Table 110 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.10.1	**Crematoria**	I	0.336						0.336
		II	0.408						0.408
		III	0.200						0.200
		IV	0.516						0.516
		V	1.688						1.688
		RM	5.344						5.344
		VI	0.792						0.792
		VII	0.936						0.936
		VIII	1.840						1.840
		IX	0.932						0.932
		X	1.124						1.124
		XI	0.072						0.072
		XII	0.164						0.164
			14.352						14.352

Table 111 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in products	General waste treatment	Sector specific treatment/disposal	Total
5.10.1	**Crematoria**	I	0.084						0.084
		II	0.102						0.102
		III	0.050						0.050
		IV	0.129						0.129
		V	0.422						0.422
		RM	1.336						1.336
		VI	0.198						0.198
		VII	0.234						0.234
		VIII	0.460						0.460
		IX	0.233						0.233
		X	0.281						0.281
		XI	0.018						0.018
		XII	0.041						0.041
			3.588						3.588

4.10.2 Subcategory 5.10.2. Cemeteries

General information

This subcategory is based on mercury releases from mercury-amalgam fillings in the deceased.

Parameters taken into account for estimating emissions from "Crematoria"

- Activity rate for bodies cremated in 2005

Table 112 "Cemeteries"

Cemeteries	Location	Bodies	Reference-year (*)
	I	1884	Inv. Nac. Fuente Diox y Furanos 02
	II	2266	Inv. Nac. Fuente Diox y Furanos 02
	III	1107	Inv. Nac. Fuente Diox y Furanos 02
	IV	2883	Inv. Nac. Fuente Diox y Furanos 02
	V	9429	Inv. Nac. Fuente Diox y Furanos 02
	RM	29822	Inv. Nac. Fuente Diox y Furanos 02
	VI	4409	Inv. Nac. Fuente Diox y Furanos 02
	VII	5221	Inv. Nac. Fuente Diox y Furanos 02
	VIII	10272	Inv. Nac. Fuente Diox y Furanos 02
	IX	5199	Inv. Nac. Fuente Diox y Furanos 02
	X	6262	Inv. Nac. Fuente Diox y Furanos 02
	XI	405	Inv. Nac. Fuente Diox y Furanos 02
	XII	925	Inv. Nac. Fuente Diox y Furanos 02

(*) Projected based on the total deaths reported by INE for 2005

Estimation Methodology

The values given in the 2002 Inventory of Dioxins and Furans were updated to take into account the death rate in 2005 published by the National Statistics Bureau (INE), applying the difference between total deaths and cremations.

The input and output factors suggested in the Toolkit were used.

Table 113 Summary Table Cemeteries

5.10.2: Cemeteries	**Unit**	**Use**		**Sum of releases to pathway from assessed part of life cycle**	
Activity rate	Burials/year	80085			
		High	Low	-	
Input factor for phase ***1**	g Hg / cadaver	4	1	-	
Estimated inputs for phase ***2**	KgHg/year	323.34	80.805	-	
Output distribution factors for phase : *3					
- Air				-	
- Water				-	
- Land		1		-	
- Products				-	
- General waste treatment				-	
- Sector-specific treatment/disposal				-	
Estimated outputs/releases to: *4		High	Low	High	Low
- Air	Kg/year	80.805	323.34	80.805	323.22
- Water	Kg/year				
- Land	Kg/year				
- Products	Kg/year				
- General waste treatment	Kg/year				
- Sector-specific treatment/disposal	Kg/year				

Table 114 High end release by subcategory, region and release pathway

High end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/disposal	Total
5.10.2	**Cemeteries**	I			7.536				7.536
		II			9.064				9.064
		III			4.428				4.428
		IV			11.532				11.532
		V			37.716				37.716
		RM			119.288				119.288
		VI			17.636				17.636
		VII			20.884				20.884
		VIII			41.088				41.088
		IX			20.796				20.796
		X			25.048				25.048
		XI			1.620				1.620
		XII			3.700				3.700
					320.336				320.336

Table 115 Low end release by subcategory, region and release pathway

Low end release by subcategory, region and release pathway		Region	Air	Water	Land	Impurity in pro-ducts	General waste treatment	Sector specific treatment/disposal	Total
5.10.2	**Cemeteries**	I			1.884				1.884
		II			2.266				2.266
		III			1.107				1.107
		IV			2.883				2.883
		V			9.429				9.429
		RM			29.822				29.822
		VI			4.409				4.409
		VII			5.221				5.221
		VIII			10.272				10.272
		IX			5.199				5.199
		X			6.262				6.262
		XI			0.405				0.405
		XII			0.925				0.925
					80.084				80.084

5 Conclusions from the Inventory

The development of this inventory based on high end and low end input factors suggested by the Toolkit enabled us to establish an interval that will serve as a baseline for Chile in measuring the continuous improvement of information in the future, especially given the large degree of uncertainty that currently exists in certain sectors in this area.

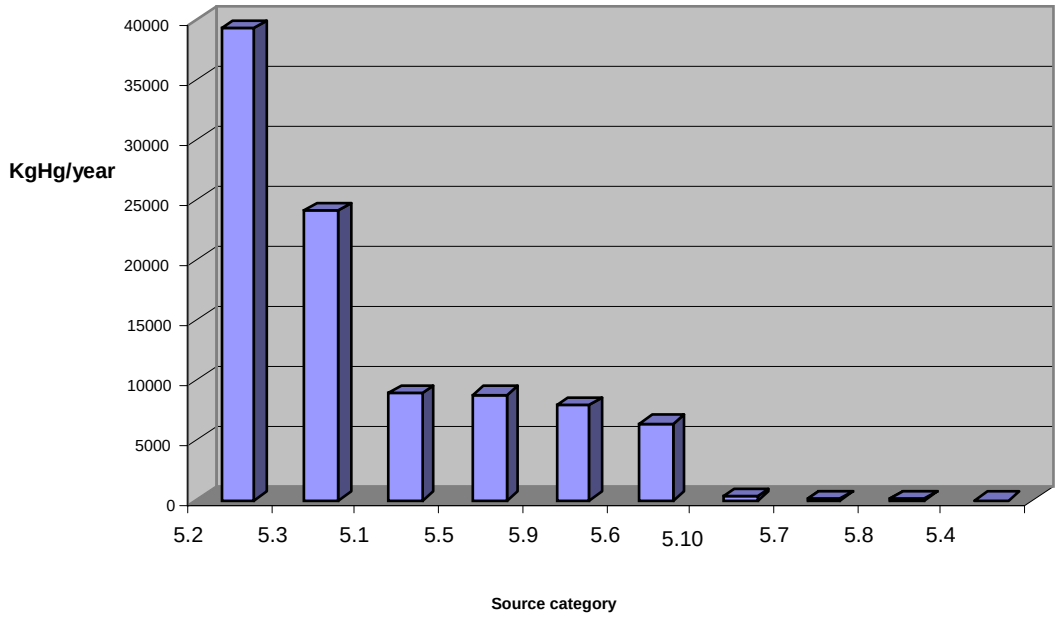
Still, in the process of building the inventory some information was obtained that reduced this uncertainty in specific sectors.

At the start of the study preliminary results were obtained with very wide intervals because there was insufficient detailed information available from all sectors. For this reason the study had to use the default input and output factors given in the Toolkit for all categories. Later, the results were updated and improved as new information was collected; this was particularly true for the cement and petroleum industries, where estimated emissions dropped considerably once better information was obtained. At the same time, the gap between Inventory's high end and low end estimates was narrowed, which also enabled the identification of output factors based on current regulations; such was the case with the "Waste water systems/treatment," which is regulated in Chile through Supreme Decrees.

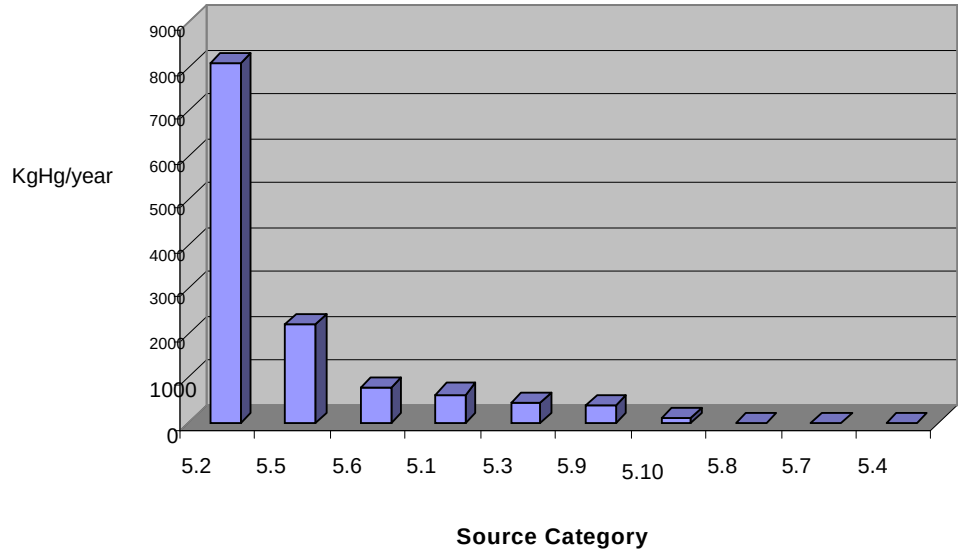
The cemetery and waste incineration sectors are also regulated in Chile through the recently adopted Standard, "Norma de Emisiones para la Incineración y Coincineración de Residuos" (Emission Standard for Incineration and Coincineration of Waste), which was used to establish the air emission factor for the cemetery sector. However, there should be an ongoing effort to continually improve the Inventory, obtaining information on mercury content generated in other parts of the process.

The graphs below show the behavior of different categories of the inventory before and after the incorporation of more accurate information in the above mentioned sectors.

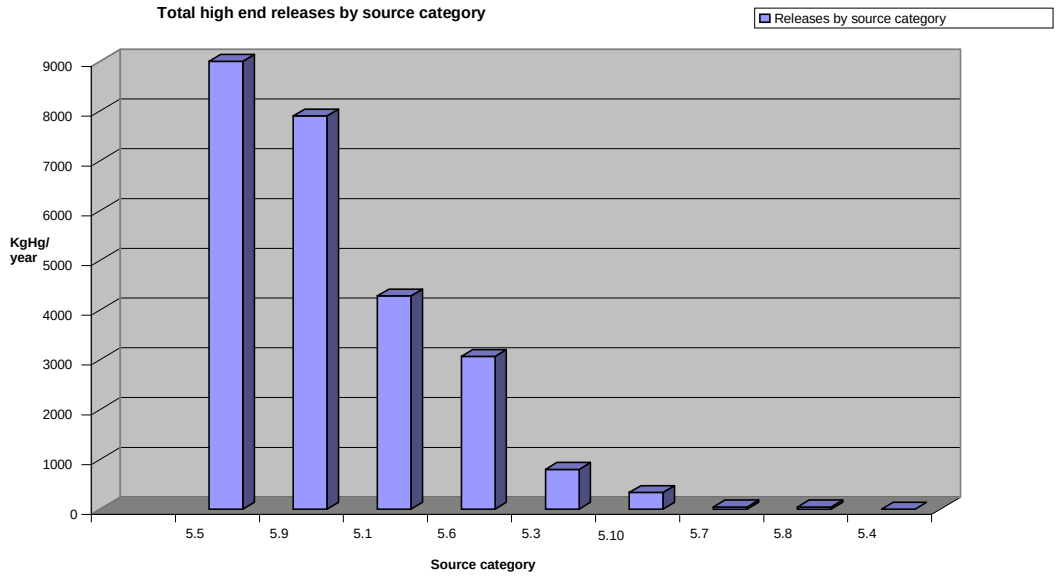
Graph 24 Categories with preliminary high end values



Graph 25 Categories with preliminary low end values

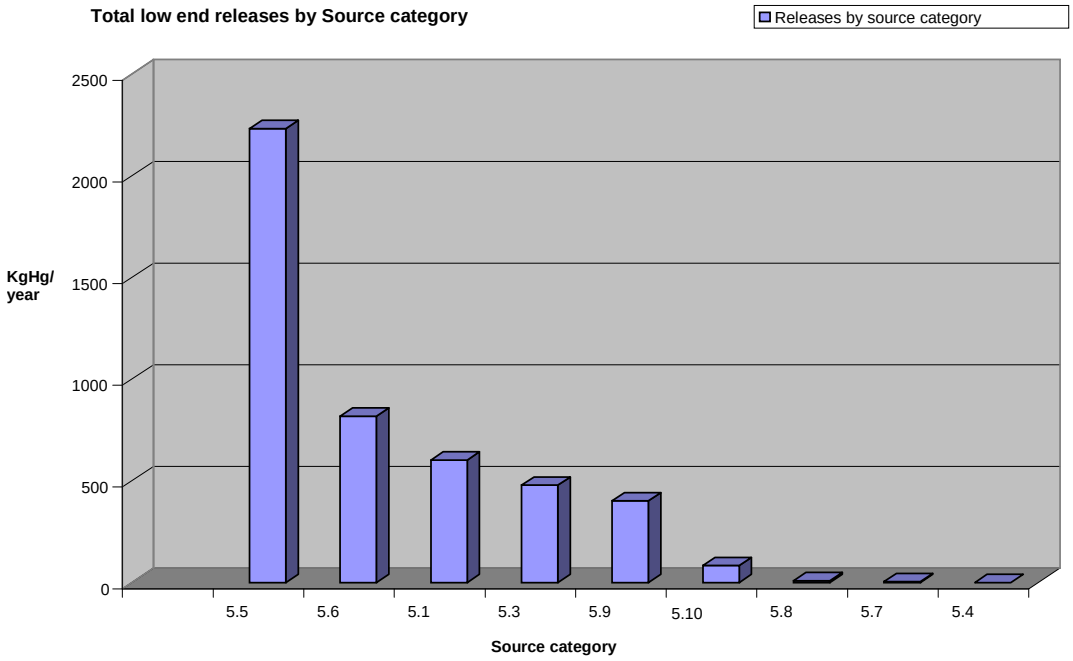


Graph 26 Categories with corrected high end values



Note: The largest category, Category 5.2 “Primary (virgin) metal production,” was not included on the graph.

Graph 27 Categories with corrected low end values

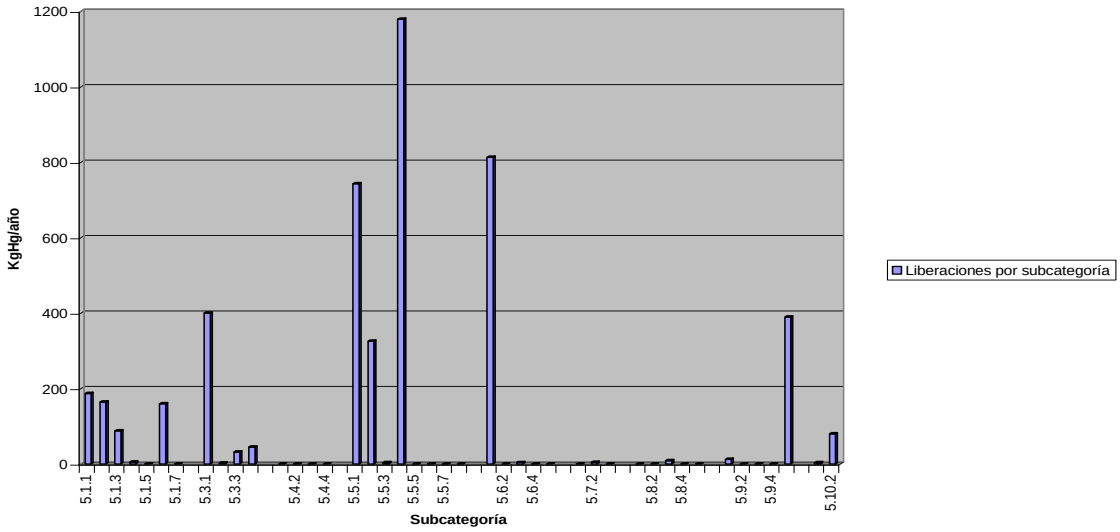


Note: The largest category, Category 5.2 “Primary (virgin) metal production” was not included in the graph.

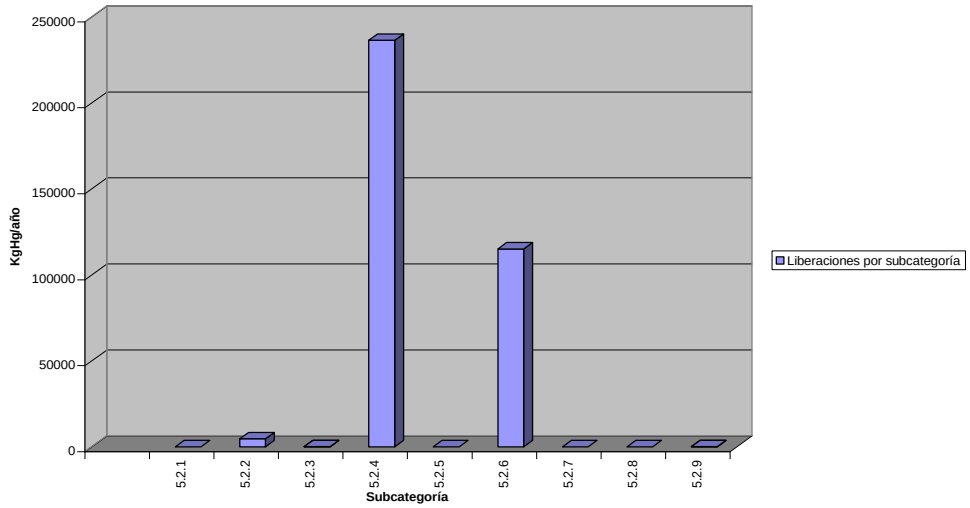
From the above graphs, it is notable that the categories 5.3 “Production of other minerals and materials with mercury impurities” and 5.1 “Extraction and use of fuels/energy sources” went from being the second and third largest sources, respectively, in the graph of “preliminary high end values” to sixth and forth place, respectively, in the graph “corrected high end values.” This reinforces the importance of having accurate, up to date information in line with local realities.

The following graphs display low end and high end releases by subcategory; these values will be analyzed further below.

Graph 28 Low end releases by subcategory (Kg Hg/year)

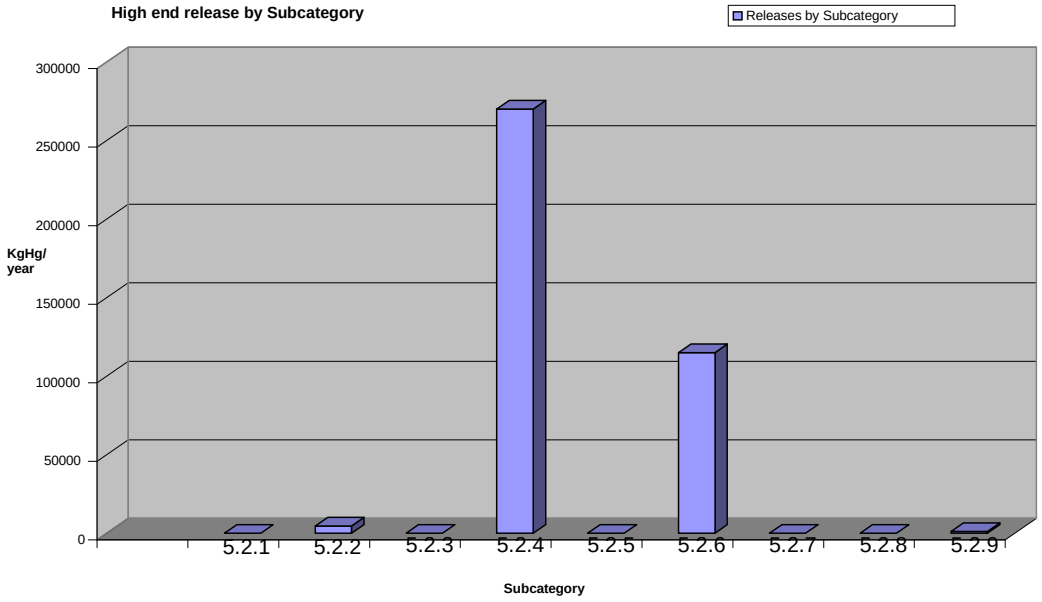


Graph 29 Low end release for the subcategory “Primary (virgen) metal production Kg Hg/year



Graph 30 High end releases by subcategory, Kg Hg/year

Graph 31 High end releases by subcategory for "Primary (virgin) metal production



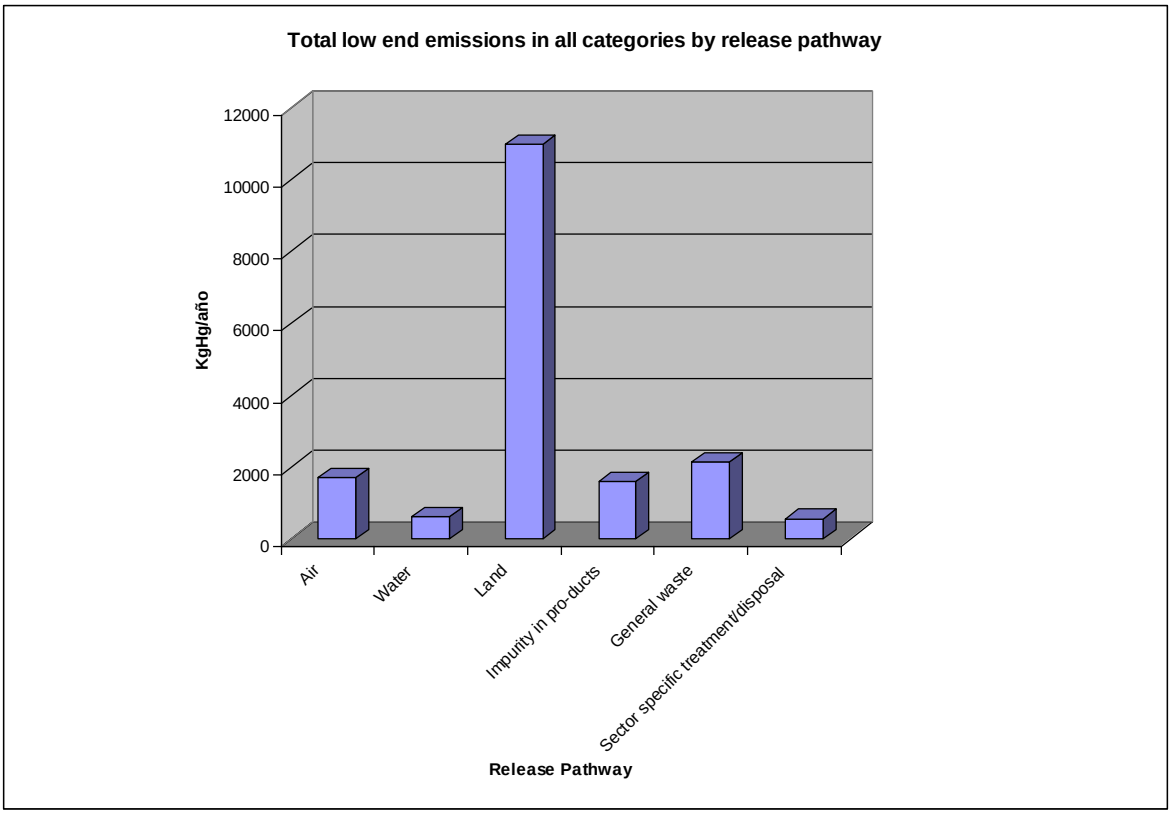
In the above graphs, releases of mercury are shown by subcategory; the category "Primary (virgin) metal production" has been shown separately in order to better illustrate the other subcategories, which have substantially lower values in comparison.

It is notable that the subcategory "Waste water systems/treatment" has a high input factor assigned by the Toolkit that makes its high end value stand out in the graph of "High end release by subcategory." It should also be noted that the output distribution is based on

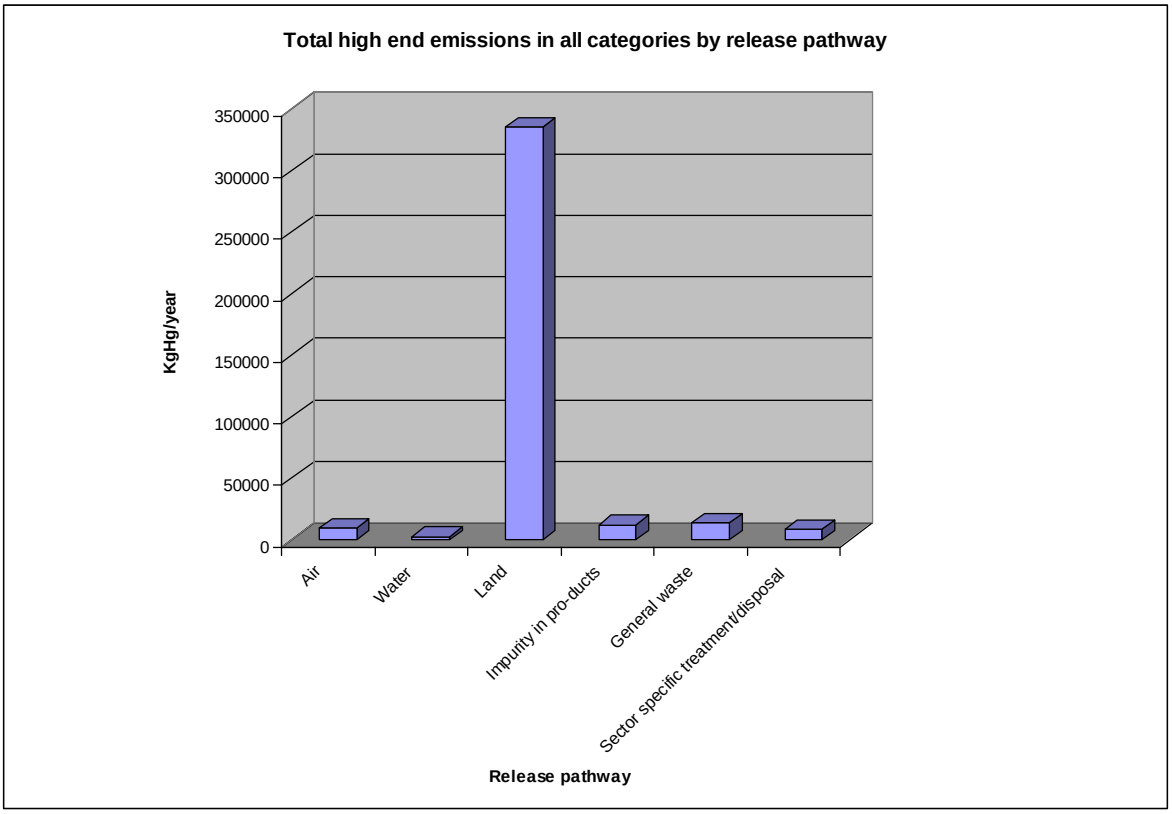
sludge for "sector-specific treatment system" and "general waste," as for releases into watercourses the value set out in Chilean legislation was used.

The graphs below show the low end and high end emissions in all subcategories, by release pathway. This data will be analyzed further below:

Graph 32 "Low end emissions by release pathway"



Graph 33 "High end emissions by release pathway"



In regard to the different release pathways, the above graphs allow us to identify land as the main release pathway for mercury emissions. The category that contributes most to such emissions into this medium is "Primary (virgin) metal production," mainly due to the waste (tailings) generated by enormous amount of ore processed in Chile's large scale copper mining operations and from gold extraction activities, whether or not these use a mercury amalgamation process.

The increment in general deposits derives from mercury containing products that are disposed of such as batteries, thermometers, and lamps, etc., and which do not undergo any treatment before deposition. In regard to different sectors, energy production in power plants fired by coal, biomass, petroleum, natural gas and petroleum distillates, as well as mining smelters and medical waste incineration are the main contributors to airborne releases of mercury in Chile. The category of "product impurities" is mainly due to the subcategories "Copper extraction and initial processing" and "Dental mercury-amalgam fillings."

The mining sector is one of the categories for which there is uncertainty in regard to the input and output distribution factors, as the information requested was not provided before the study deadline. The risk management plan should therefore include some measure to ensure that better information is obtained for this sector.

Other significant sources classified under "coal-fired power plants" and "Other coal use," and any other combustion process, regardless of the fuel used, should also be addressed where there is no applicable atmospheric mercury emission standard in force. One possible measure would be to mandate a declaration of mercury content in emissions from these sources under Supreme Decree 138.

Nevertheless, before any far reaching decisions are made, efforts must continue to focus on improving the quality of information available in order to continue improving the inventory. To accomplish this, it is necessary to introduce more precise measures, such as establishing opportunities for participation with different sectors, for example, working groups with waste management companies, in order to gain access to the required information.

It is worth noting that the activity "forest fires" has been incorporated into this Inventory under subcategory 5.1.6, "biomass-fired power and heat production."

Two other activities incorporated into the Inventory are "Production of ceramics" and "Gypsum production," which were included under subcategory 5.3.4 "Other minerals and materials." These activities were not included in the Toolkit but were identified as activities that could contribute to mercury releases in Chile and represent a contribution to the global mercury partnership.

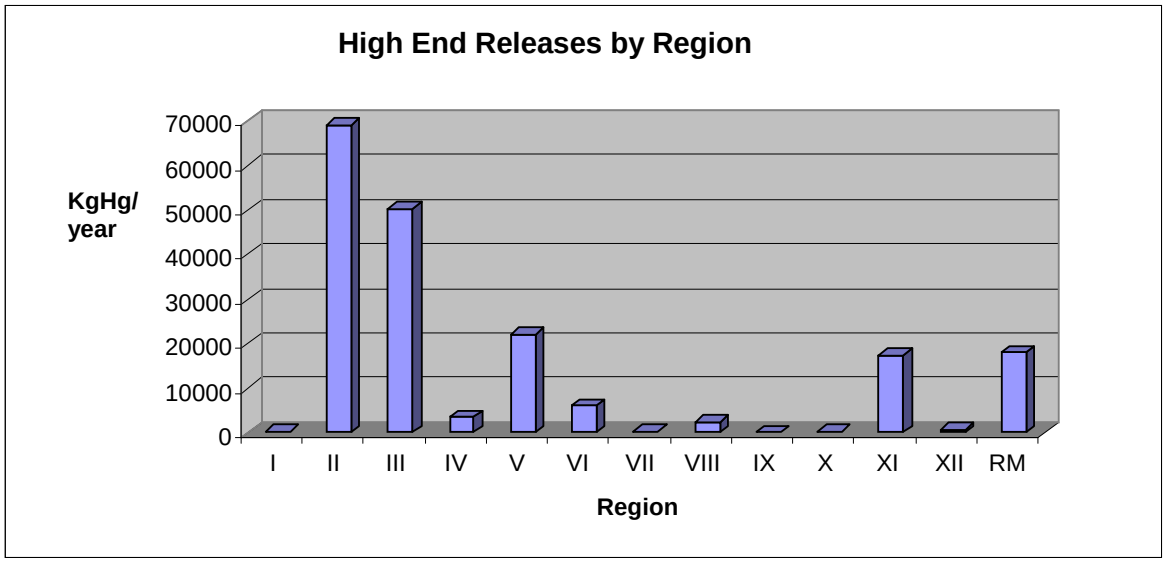
Another important aspect in building this Inventory was the combination of top-down and bottom-up approaches. The benefit of this is that it helped to reduce uncertainty in activity rates among different industrial sector businesses. In addition, it enabled an ongoing comparison and validation of information as it became available, which is also reflected in the fact that it was possible to break down some of this information at the regional level and in some cases even to the level of individual establishments. Finally, it provided a first impression of mercury releases in each region of the country.

The graphs below display mercury releases by region for the following subcategories:

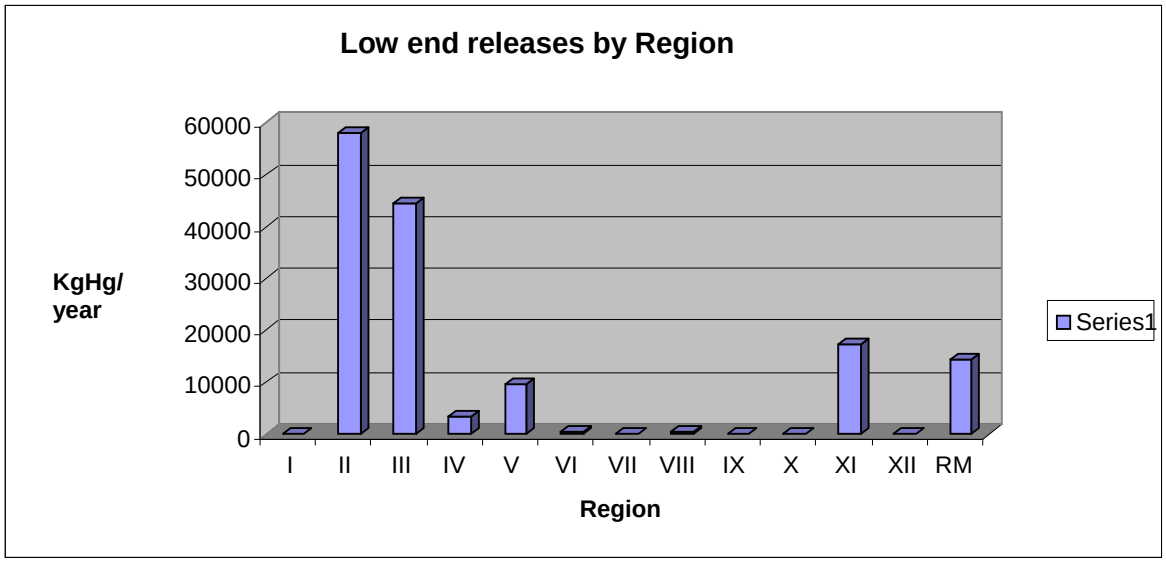
- 5.1.1 Coal combustion in large power plants
- 5.1.2 Other coal use
- 5.1.3 Mineral oils - extraction, refining and use
- 5.1.4 Natural gas - extraction, refining and use
- 5.1.6 Biomass-fired power and heat production
- 5.2.2 Gold and silver extraction with mercury-amalgamation
- 5.2.3 Zinc extraction and initial processing
- 5.2.4 Copper extraction and initial processing
- 5.2.6 Gold extraction and initial processing by methods other than mercury amalgamation.
- 5.2.9 Primary ferrous metal production
- 5.3.1 Cement production
- 5.3.2 Pulp and paper production

- 5.3.3 Production of lime and light weight aggregate
- 5.3.4 Others minerals and materials
- 5.7.2 Production of recycled ferrous metals (iron and steel)
- 5.8.3 Incineration of medical waste
- 5.9.5 Waste water system/treatment
- 5.10.1 Crematoria
- 5.10.2 Cemeteries

Graph 34 "High end releases by region"



Graph 35 "Low end releases by Region"



From the graphs above it is important to note that the regions with the highest mercury releases shown have a strong presence of mining operations, as analyzed above.

Finally, the categories "Consumer products with intentional use of mercury" and "Other intentional product/process uses," were identified as two of the categories with the highest amount of releases; in Chile such releases are mainly from the use and disposal of such products, as there is no industrial level production of these in the country and releases are due to the large number of imports. At the same time, these categories are the most uncertain ones, given that the input factors among different products is highly variable. In effect, the countless different products entering the country make it difficult under the current system to determine their mercury content, and how much of this could potentially be released into the environment (potential risk).

Despite this situation, some improvements that could be carried out in the short term in this category include improving the National Customs Service classification system, as information in the current system is quite disperse and therefore does not allow the precise identification of mercury containing products. In addition, Chile currently does not regulate the importation of products containing mercury, with the exception of pesticides, whose entry into the country has been regulated by Exempt Resolution since 1993. It would be worth reviewing this resolution with a view to bringing it gradually into line with international standards.

The study found that employees in the vast majority of private health care facilities are not permitted to give out information, and therefore the questionnaire that was applied in this sector did not yield satisfactory results. It is therefore necessary to design declaration systems for those products that can potentially release mercury such as thermometers, sphygmomanometers, dental amalgams and so on.

Lastly, at a number of meetings with national public sector agencies, including the National Customs Service, the representatives expressed their agency's willingness to take steps to improve the process of obtaining information.

Furthermore, the Occupational Health Unit of the Ministry of Health's Undersecretary of Public Health Clinics agreed to develop a new questionnaire to be distributed among public health services in order to improve the information available on the quantity and deposition of thermometers and sphygmomanometers used in public health clinics across the country. It was not possible to apply this instrument for the Inventory due to time constraints, but it could be applied as part of the "Risk Management Plan."

On another note, representatives of the Ministry of Health's Department of Oral Health expressed their intention to hold a meeting on this topic with the heads of the Department's Dental Health Programs in the Metropolitan Region, which represents more than 45% of the national total. The aim of that meeting would be to build opportunities for improving information on mercury containing products and ultimately to work together on developing a Risk Management Plan.

6 REGISTER OF MERCURY CONTAMINATED SITES

This study included field visits to sites potentially contaminated with mercury in the following regions of Chile: Region III of Atacama, Region IV of Coquimbo, Region V of Valparaiso, the Metropolitan Region, Region VIII of Bio Bio and Region X of Los Lagos.

To conduct these visits effectively, it was necessary to coordinate them with the respective regional offices of CONAMA, in order to generate a list of potential sites and program on-site activities.

The following section contains a report of activities associated with building the register of potentially contaminated sites in the regions studied.

- **Region III of Atacama**

The table below summarizes the places visited and the dates.

Table 116: "Visits made to potentially mercury-contaminated sites in Region III"

Region	Municipality	Date	Name of Site
III	Copiapó	17/10/2007	La Coipa mine tailings
III	Tierra Amarilla	18/10/2007	Pabellón Bajo Sector
III	Copiapó	18/10/2007	Porvenir tailings
III	Tierra Amarilla	18/10/2007	Maria Isabel Plant
III	Copiapó	18/10/2007	Castellón Plant
III	Copiapó	18/10/2007	Ojos de Agua Mining Plant
III	Copiapó	18/10/2007	El Cateador
III	Copiapó	18/10/2007	Guerrero Hermanos amalgamation plant
III	Copiapó	19/10/2007	Day Plant
III	Copiapó	19/10/2007	San Marino Plant
III	Copiapó	19/10/2007	Montserrat Plant
III	Copiapó	19/10/2007	Andacollo Plant
III	Copiapó	19/10/2007	Charito Plant

The figure below shows the locaiton of the sites visited in Region III.

Figure 1:"Locations visited in Region III of Atacama"

The following figures show the sites visited near the city of Copiapó.

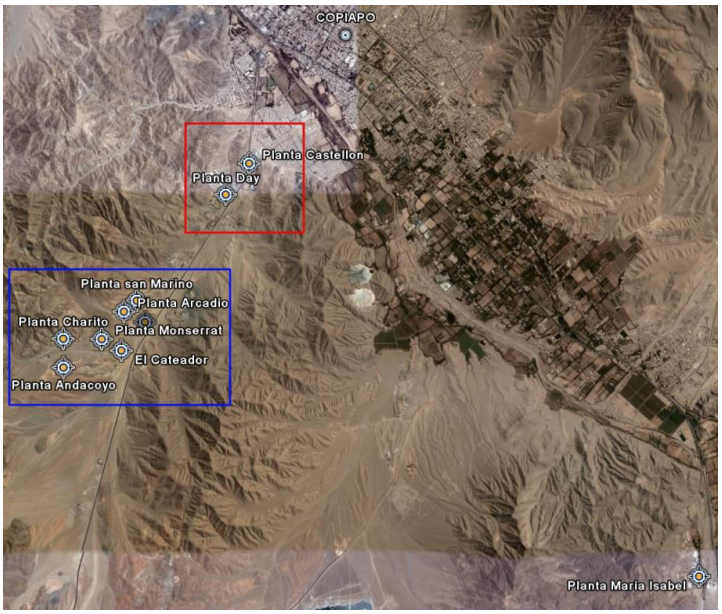


Figure2: "Sites visited in Copiapó"

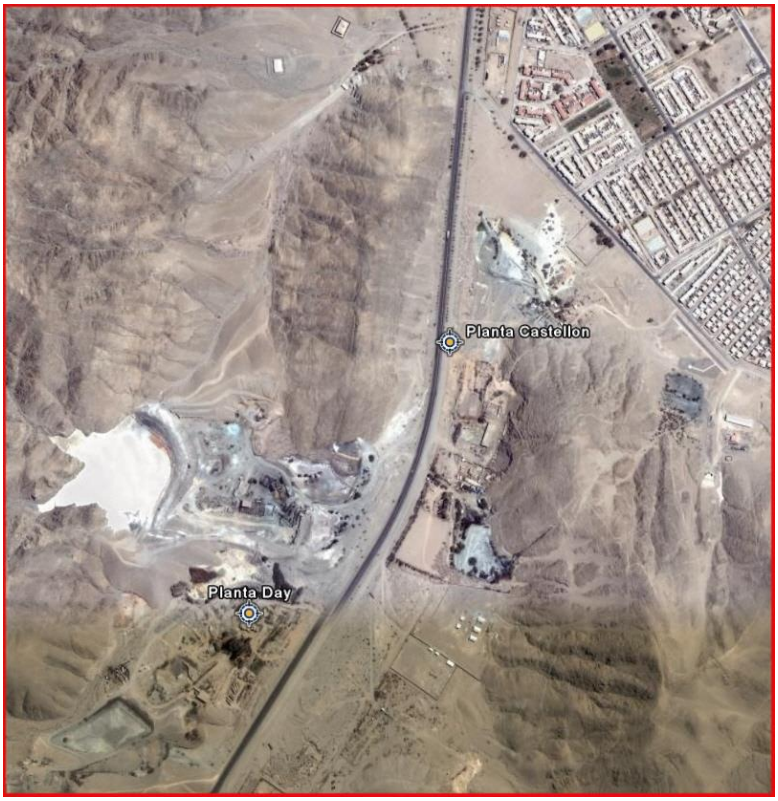


Figure 3: "Sites visited in Copiapó"

Figure 4: "Sites visited in Copiapó"

- **Region IV of Coquimbo**

The table below summarizes the places and dates of the visits in Region IV.

Table 117: "Visits to potentially mercury-contaminated sites in Region IV"

Region	Municipality	Date	Name of Site
IV	Punitaqui	23/08/2007	Abandoned mercury processing plant
IV	Punitaqui	23/08/2007	Old mine tailings
IV	Punitaqui	23/08/2007	Rajo Delirio – former gold-bearing operation
IV	Ovalle	23/08/2007	Mineral de Talca, La Ventolera Plant
IV	Ovalle	23/08/2007	Mineral de Talca lined tailings dam
IV	Andacollo	24/08/2007	Entry to Chepiquilla
IV	Andacollo	24/08/2007	Ponce Plant

The figure below shows the location of the sites visited in Region IV.

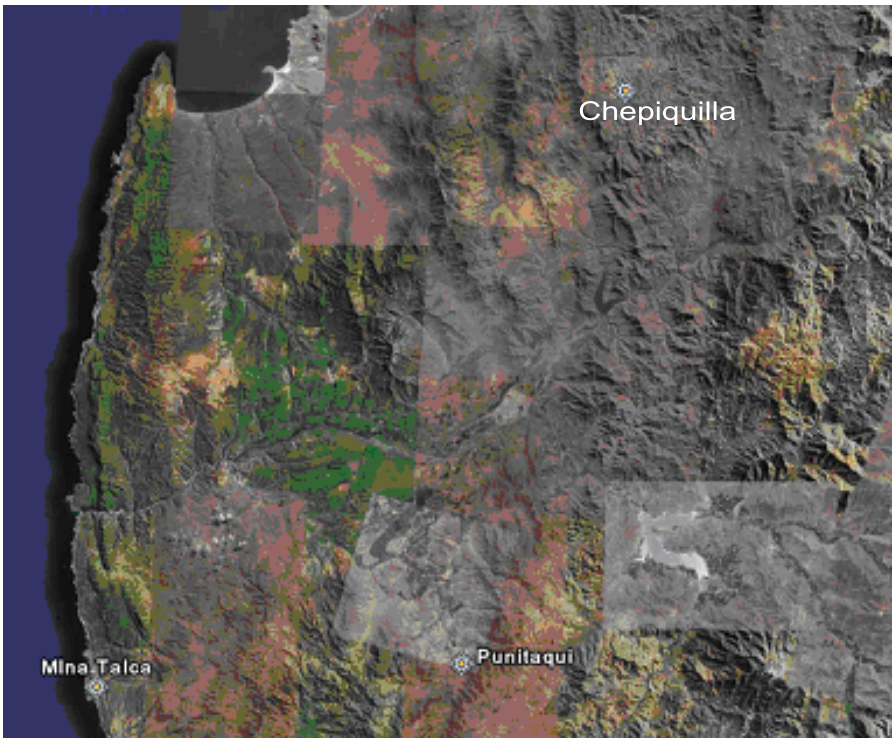


Figure 5: "Sites visited in Region IV of Coquimbo"

- **Region V of Valparaíso**

The following table summarizes the places visited and the dates of the visits in Region V.

Table 118: "Visits to potentially mercury-contaminated sites in Region V"

Region	Municipality	Date	Name of Site
V	Petorca	06/12/2007	Banks of Río Petorca
V	Petorca	06/12/2007	Banks of Río Petorca

The figure below shows the location of the sites visited in Region V.

Figure 6: "Sites visited in Region V of Valparaíso"

- **Region VIII of Bio Bio**

The table below summarizes the dates and places visited in Region VIII.

Table 119: "Visits to potentially mercury-contaminated sites in Region VIII of Bio Bio"

Region	Municipality	Date	Name of Site
VIII	Coihueco	04/12/2007	Del Prado mines
VIII	Talcahuano	04/12/2007	Lenga

The figure below shows the location of the sites visited in Region VIII of Bio Bio.

Figure7: "Sites visited in Region VIII of Bio Bio"

- **Region X of Los Lagos**

The table below summarizes the places and dates of visits in Region X.

Table 120: "Visits to potentially mercury-contaminated sites in Region X of Los Lagos"

Region	Municipality	Date	Name of Site
X	Puerto Montt	22/10/2007	Lagunitas Municipal Dump
X	Calbuco	22/10/2007	REXIN Industrial Dump
X	San José de Mariquina	23/10/2007	Madre de Dios Sector
X	Maullín	24/10/2007	Mar Brava
X	Maullín	24/10/2007	Pangal

The figure below illustrates the location of potentially mercury-contaminated sites visited in Region X of Los Lagos.

Figure 8: "Sites visited in Region X of Los Lagos"

- **Metropolitan Region**

The table below summarizes the places and dates of visits in the Metropolitan Region.

Table 121: "Visits to potentially mercury-contaminated sites in the Metropolitan Region"

Region	Municipality	Date	Name of Site
METROPOLITANA	TILTIL	11/12/2007	Loma Los Colorados KDM Sanitary Landfill

RESULTS OF THE REGISTER OF POTENTIALLY MERCURY-CONTAMINATED SITES

During the field visits the main task was to achieve preliminary findings on the most significant exposure pathways. To achieve this, the sites identified above were visited because of a presumption of mercury present. A basic Inspection Data Sheet was filled out in order to verify: environmental media potentially contaminated; points of exposure with the highest risk; most likely exposure pathways (ingestion, inhalation, direct contact, root absorption, etc.); and population potentially exposed to the substances involved.

This data sheet has been a crucial tool in carrying out the secondary prioritization of sites based on a point system that assesses their relative environmental risk. The completed data sheets can then be used to build a spreadsheet that weighs each risk factor in the preliminary risk assessment, using a weighting system to carry out comparative assessments among different potentially contaminated sites.

Point system

The information collected on the inspection data sheet for each potentially contaminated site (PCS) has enabled a secondary list to be built that prioritizes these potentially mercury-contaminated sites. This list categorizes each site based on the results obtained, according to their weighted value.

Weighting Sites

The weighting system gives a preliminary and qualitative estimation of the environmental risk of a given site by assigning the site a numerical value for different criteria on the inspection data sheet. As such, this assessment can be used to conduct a secondary prioritization of the site, in order to determine whether it merits a more detailed assessment.

Classification of sites

Once a site's score is calculated, it must be classified manually into one of the following categories:

Category 1: Site with high environmental and human health risk. The site urgently requires detailed risk assessment for remediation.

Category 2: Contaminated Site. The site requires detailed assessment of exposure. Could require monitoring.

Category 3: Site with Pollutants Present. The site requires a conclusive investigation on the presence of pollutants and preliminary risk assessment. The site may require monitoring.

Category 4: Site suspected of containing pollutants. The site requires quantitative (or semi-quantitative) measurement to identify the presence of pollutants.

Category 5: Site with Potential Presence of Pollutants. Site requires application of Inspection Data Sheet.

Category 0: Minimum Environmental and Public Health Risk. Site maybe excluded from the register.

To classify the inspected sites as Category 4 at least one of the following criteria must be present:

1. Presence of complete exposure pathways.

2. High preliminary risk, with score equal to or above 40 points.

3. Existence of quantitative or qualitative evidence that leads the inspectors to believe that there is a risk to human health and/or the environment.

The results of the register of potentially mercury-contaminated sites are presented below, and suggest a secondary prioritization of PCS based on the on-site application of the inspection data sheets.

Table 122: "Prioritization of Potentially Mercury-Contaminated Sites"

Name of Site	Municipality	Region	Score
Pabellón Sector	Tierra Amarilla	Atacama (III)	61
Ponce Plant	Andacollo	Coquimbo (IV)	56
Old mine tailings	Paiguano	Coquimbo (IV)	53
Porvenir mine tailings	Tierra Amarilla	Atacama (III)	53
Entry to Chepiquilla	Andacollo	Coquimbo (IV)	51
Banks of Río Petorca 1	Petorca	Valparaíso (V)	49
El Empalme Plant – Rexin	Puerto Montt	Los Lagos (X)	49
Lagunitas Garbage Dump	Puerto Montt	Los Lagos (X)	48
Tailing pile from La Coipa mine	Copiapó	Atacama (III)	47
Banks of Río Petorca 02	Petorca	Valparaíso (V)	47
Maria Isabel Plant	Tierra Amarilla	Atacama (III)	47
Punitaqui abandoned plant	Punitaqui	Coquimbo (IV)	41
Mineral de Talca	Ovalle	Coquimbo (IV)	41
Castellón Plant	Copiapó	Atacama (III)	40
El Cateador	Copiapó	Atacama (III)	38
Loma Los Colorados KDM Sanitary Landfill	Til- Til	Metropolitana (RM)	38
Minas del Prado Plant	Coihueco	Bio-Bio (VIII)	36
Day Plant	Copiapó	Atacama (III)	35
Andacoyo Plant	Copiapó	Atacama (III)	34
Arcadio Plant	Copiapó	Atacama (III)	34
Lenga Nature Sanctuary	Hualpén	Bio-Bio (VIII)	34
Rajo del Río	Punitaqui	Coquimbo (IV)	33
Charito Plant	Copiapó	Atacama (III)	33
Mineral de Talca lined tailings dam	Ovalle	Coquimbo (IV)	32
San Marino Plant	Copiapó	Atacama (III)	32
Madre de Dios Sector	Mariquina	Los Lagos (X)	31
Montserrat Plant	Copiapó	Atacama (III)	31
Mar Brava	Maullín	Los Lagos (X)	30
Ojo de Agua mining plant	Copiapó	Atacama (III)	30

7 CONCLUSIONS AND COMMENTS ON THE REGISTER OF POTENTIALLY MERCURY-CONTAMINATED SITES

- ***The nature of the pollutants analyzed and their associated risks***

Mercury is a substance that has a series of effects on human health and the environment and a pollutant that is part of the international chemical agenda. It is therefore highly important and is advisable to increase the weight of the results obtained from more detailed investigations that will be conducted for sites prioritized in this project.

- ***Mobility of pollutants***

Mercury's mobility is directly related to its path in the environment and to a large extent defines the risk associated with each potentially contaminated site. The field work therefore has taken into account the volatility of this substance as well as its movement by surface, sub-surface or underground currents, as well as its susceptibility to bioaccumulation as a compound or element.

- ***The pathways of mercury***

The inspection data sheets have also made it possible to take into account the different pathways through which mercury can reach the receptors (whether humans or components of an environmental media such as flora, fauna, water, etc.). In concrete terms, the sheet records information on the existence of watercourses, characteristics of the terrain, etc.

- ***Land use***

Lastly, the inspection data sheets include a section to record information on the land use to determine the potential existence of receptors that could come into contact with any mercury that could be present at the site.

On the prioritization of sites visited

As can be observed in the table on the Prioritization of Potentially Mercury-Contaminated Sites, the sites with the highest scores are those in the regions of Atacama and Coquimbo. Notable among these is the site called "Pabellón Sector" in Tierra Amarilla, with 61 points. This site is followed by the sites "Ponce Plant" in Andacollo (Region IV), with 56 points; "Old mine tailings" in Paiguano, and "Porvenir Tailings" in Tierra Amarilla, each with 53 points; and then the site identified in the data sheet as "Entry to Chepiquilla" in Andacollo, with 51 points.

The case of Andacollo in the Region of Coquimbo is a special case, which was evident in the field visit: The outskirts of the city are dotted with many abandoned gold mining operations. Today, these areas are residential, commercial and recreational zones, in many cases established only meters away from old mining tailings. Furthermore, the city of Andacollo itself is a national heritage site of major cultural and religious significance and attracts large numbers of tourists from around the country to two major Catholic religious festivals held here each year.

A similar situation occurs with the site "Lenga Nature Sanctuary" in the municipality of Hualpén in the Region of Bio Bio, which only scored 34 points even though it is a protected wilderness area.

Another special case is the site identified as "Mineral de Talca" in Ovalle, which despite being located only meters from the ocean and some two kilometers from a small scale fishing zone, only obtained 41 points in the system.

In conclusion, it is recommended that each one of the sites prioritized in this study be subjected to a new analysis in which the results of the inspection data sheets are correlated with the particular considerations for each site in terms of: mercury mobility, special toxicological features and the capacity for bioaccumulation. Land use must also be taken into account, not as a general classification (according to the land use classification system used in the data sheets), but as a more detailed analysis of each site that takes into account local customs and protection initiatives in force in the territories involved. It is advisable that these secondary analyses be undertaken by the Regional Operating Committees for soil contamination. These bodies involve all stakeholder groups such as regional and municipal government, academia, civil society, health, agriculture and education sectors, as well as mining and industry.

PHOTPGRAPHS FROM TEH REGISTER OF POTENTIALLY MERCURY-CONTAMINATED SITES

The photographs below represent some of the sites visited that are potentially contaminated with mercury.

Figure 9: "Around of the Basilica of Andacollo in the Region of Coquimbo"

Figure 10: "A Soccer Field in Andacollo in the Region of Coquimbo"

Figure 11: "A playground in Andacollo in the Region of Coquimbo"

Figure 12: "Sign inviting tourists to view gold smelting process in Andacollo in the Region of Coquimbo"

Figure 13: "A mine tailings dam near the ocean in Mineral de Talca, Ovalle, Region of Coquimbo"

Figure 14: "Lenga Nature Sanctuary, Hualpén municipality in the Region of Bio Bio"

Figure 15: "Pool of percolated liquid in a garbage dump, Region of Los Lagos"

8 References

1. United Nations Environment Program UNEP Chemical Division, *"Global Mercury Assessment*", Geneva, Switzerland, 288 pp. Dec 2002.

2. "Elementos Base para la Gestión Ambiental del Mercurio en Chile," Thesis for the degree of Civil-Chemical Engineer, Claudia Jara, 16/04/2007

3. "Diagnóstico de la Gestión de pilas y su peligrosidad como residuos en Chile," thesis project for the degree of Environmental Engineering Technician, USACH, Torres, M.

4. Brooks Ned T., Lennett David, "*Overview of Mercury Sources, Uses, Releases and Cycling*", United Nations Environmental Programme Mercury Workshop, Sept. 2004, Buenos Aires Argentina. Available at: http://www.chem.unep.ch/MERCURY/workshops/Buenos-Aires-proceedingsfinal.pdf.

5. Wiener James G., Krabbenhoft David P., Gary H. Heinz y Anton M.Scheuhammer, *"Handbook of Ecotoxicology"*, Sección II. Contaminant Sources and Effects, Ecotoxicology of Mercury, 2003, Lewis Publishers by CRC Press LLC, Second edition, Chap.16.

6. Mason, R. P., Fitzgerald, W. F., and Morel, F. M. M., *"The Biogeochemical Cycling of Elemental Mercury: Anthropogenic influences.* In: James G.Wiener, David P. Krabbenhoft, Gary H. Heinz and Anton M. Scheuhammer,*"Handbook of Ecotoxicology"*, Sección II. Contaminant Sources and Effects, Ecotoxicology of Mercury, 2003, Lewis Publishers by CRC Press LLC, Second edition, Chap.16.

7. Fitzgerald, W. F., Engstrom, D. R., Mason, R. P., and Nater, E. A., *"The case for atmospheric mercury contamination in remote areas"*, 1998 Environ. Sci. Technol., Vol: 32, pp 1-7.

8. Pacyna, E. G., Pacyna J. M., and Pirrone, N., *"European emissions of atmospheric mercury from anthropogenic sources in 1995*". En: Mason, R. P., Fitzgerald, W. F., and Morel, F. M. M., *"The Biogeochemical Cycling of Elemental Mercury: Anthropogenic influences",* 1994, Geochim. Cosmochim. Acta, 58, pp 3191-3198.

9. Ronald Eisler, Ph. D., "*Handbook of Chemical Risk Assessment. Health Hazards to Humans, Plants, and Animals"*, 2000, U.S. Geological Survey, Lewis Publishers, Volume 1.

10. Ming-Ho Yu, "*Environmental Toxicology. Biological and Health Effects of Pollutants*", 2005, Second Edition, CRC Press.

11. Pirrone, N., Pacyna, J. M. and Barth, H. (Guest Editors) (2001a): *"Atmospheric Mercury research in Europe, Special Issue of Atmospheric Environment"*. Vol.35/17. In: United Nations Environment Programme UNEP Chemicals, *"Global Mercury Assessment"*, Geneva, Switzerland, Dec 2002, Chap. 2, 33.

12. Mason, R. P. and Fitzgerald, W.F. (1996): Sources, sinks and biogeochemical cycling of mercury. In: United Nations Environment Programme UNEP Chemicals, *"Global Mercury Assessment"*, Geneva, Switzerland, Dec 2002, Chap. 2, 37.

13. Organization Pollution Probe, "*Mercury in the Environment. A Primer*", Canada, June 2003, Chap.4, pp 34-35.

14. "*Estadísticas de Incendios Forestales*". Corporación Nacional Forestal, Chile, 2006. Available at: www.conaf.cl.

15. Various authors, "*Informe País: Estado del Medio Ambiente en Chile 2005*", Geo Chile, Instituto de Asuntos Públicos, Centro de Análisis de Políticas Públicas, Universidad de Chile, Chile, Sept. 2006, 371 pp.

16. Oyarzún Jorge, "*Algunos metales y metaloides con propiedades tóxicas ocarcinogénicas: distribución natural y riegos por contaminación en Chile*", Revista Chilena de Salud Pública 2001, Vol 5 (2-3): 96-101.

17. Higueras Pablo, Oyarzún Roberto, Oyarzún Jorge, et al., "*Environmental assessment of copper-gold-mercury mining in the Andacollo and Punitaqui distric, northern Chile*", Editorial handling, Applied Geochemistry 19, 2004, 1855-1864.

18. Oyarzún Jorge, Oyarzún Roberto, Pavicic S., "*Estudio geoquimico prospectivo en un distrito de Cu-Au-Hg asociado a zona de cizalla: Punitaqui, Chile",* Boletín geológico y Minero, 2001, Vol. 112, Nº 2, pp. 75 – 84.

19. Díaz Oscar, Encina Francisco, et al., "*Influencia de variables estacionales, espaciales, biológicas y ambientales en la bioacumulación de mercurio total y metilmercurio en Tagelus dombei",* Revista de Biología Marina y Oceanografía, Julio de 2001, Vol: 36 (1), pp 15 – 29.

20. Pacyna, et al., "*Presentation to Global Transport Worshop"*, Ann Arbor, Sept. 2003, MI, pp 16-17. Available at: http://www.chem.unep.ch/MERCURY/workshops/Buenos-Aires-proceedingsfinal.pdf.

21. Wotruba Hermann, Hruschka Felix, et al, "*Manejo Ambiental en la Pequeña Minería"*, Manejo Integrado del Medio Ambiente en la Pequeña Minería, Swiss Agency for Development and Cooperation, 1998, La Paz, Bolivia, 302 pp.

22. Miranda Consultores (MIRCOMIN), "*Inventario de los recursos minerales de la IV Región de Coquimbo*", Vol II, 1978, SERPLAC IV Región de Coquimbo.

23. Various authors, "*Atlas de Faenas Mineras, Mapas y Estadísticas de Faenas Mineras de Chile*", Nº 2, Región III y IV, 2000, Servicio Nacional de Geología y Minería.

24. Various authors, "*Atlas de Faenas Mineras, Mapas y Estadísticas de Faenas Mineras de Chile*", Nº 3, Región V, VI, XIII, 2002, Servicio Nacional de Geología y Minería.

25. Valenzuela Pedro, "*Pequeña Minería, Potencial Riesgo Ambiental por Mercurio,Región de Coquimbo, Chile"*, Taller Regional para Fomentar la Sensibilización Sobre la Contaminación Causada por el Mercurio, Sept. 2004, Buenos Aires, Argentina.

26. Instituto Nacional de Estadísticas, "*Estudio determinación del Universo de los Pequeños Mineros Artesanales de Chile*", Ministerio de Minería, Gobierno de Chile, Dec 2005, 65pp.

27. La Celulosa, "*Proceso de producción de celulosa kraft*". Available at: www.papelnet.cl.

28. "*Mercurio en planta de celulosa Laja*", Observatorio Latinoamericano de Conflictos Ambientales. Available at: www.olca.cl,

29. "*Uso de Carbón de Petróleo en los Hornos 8 y 9 de la Planta Industrial La Calera de Empresas Lafarge S.A.",* Environmental Impact Study, Executive Summary. Available at: www.lafarge.cl.

30. *"Estadísticas en Consumo de Cemento*". Instituto del Cemento y del Hormigón de Chile. Available at: www.ich.cl. .

31. "*Catastro y Evaluación de los Recursos Vegetacionales Nativos de Chile*", Corporación Nacional Forestal Chile, 1997. Available at: www.conaf.cl. (Last visited: 25 January 2007).

32. Fritis Ricardo, "*La Producción de Mercurio en Chile*", Anales del Primer Congreso Panamericano de Ingeniería de Minas y Geología, Tomo Cuarto, Janaury 1942, Santiago, Chile, pp 1626-1635.

33. Pesenti Eduardo, Fernández Eduardo, Silva, Washington, "*Contaminación por Mercurio en la Minería Artesanal de la III Región de Atacama",* Universidad de Atacama, Instituto de Investigaciones Científicas y tecnológicas (IDICTEC). In: Proyecto de Cooperación Internacional ACDST-IDICTEC, "El Desarrollo Sustentable y el Medio Ambiente en la Minería Artesanal del Oro", Publisher from the International Seminar, Copiapó, Chile, 1999.

34. "*Levantamiento Catastral de los tranques de relaves en Chile"*, Etapa C: Regiones II y III, Tomo I, Informe Final del Estudio, Dec. 1990, SERNAGEOMIN, Ingeniería y Geotecnia Ltda.

35. "*Levantamiento Catastral de los tranques de relaves en Chile"*, Etapa B: Regiones IV, VI y VII, Tomo I, Informe Final del Estudio, March 1989, SERNAGEOMIN, Ingeniería y Geotecnia Ltda.

36. Silva B. Washington, *"Presencia de mercurio en tranques de relaves de plantas de amalgamación en la Región de Atacama (CHILE)"*, Revista de la Facultad de Ingeniería, Nº 014-015, 2000, Universidad de Atacama, Copiapó, Chile.

37. "*Diario Oficial de la Unión Europea*", EUR-Lex: El Derecho de la Unión Europea. Available at: http://europa.eu.

38. *"Comunicación de la Comisión al Consejo y al Parlamento Europeo",* Estrategia comunitaria sobre el mercurio, Enero de 2005, Comisión de las Comunidades Europeas, Bruselas. Available at: http://ec.europa.eu/environment/chemicals/mercury/pdf/com_2005_0020_es.pdf.

39. "North American Regional Action Plan on Mercury", Phase II, March 2000, North American Implementation Task Force on Mercury for PARAN. Available at: http://www.cec.org/files/PDF/POLLUTANTS/Hgparan.pdf.

40. "*Mercurio No*", Salud Sin Daño, Buenos Aires, Argentina. Available at: http://noalaincineracion.org/wp-content/uploads/mercuriono.pdf. United Nations Environment Programme UNEP Chemicals, *"Toolkit for the Identification and Quantification of Mercury Releases*", Pilot Draft, Geneva, Switzerland, Chap. 5, 171. Nov 2005.

9 Glossaries

Glossary I Acronyms and abbreviations

ACGIH : American Conference of Industrial Hygienists.

Acrodynia : Is a chronic form of mercury poisoning that occurs rarely. It is characterized by highly sensitive soles of the feet and palms of the hands with tingling sensation.

AFIPA : Asociación Nacional de Fabricantes e Importadores de Productos Fitosanitarios Agrícolas (National Association of Manufacturers and Importers of Agricultural Phytosanitary Products).

Alkylating agent: any of a group of substances capable of producing an electrophilic chemical reaction.

Amalgamation : alloy of mercury and noble metals such as gold or silver.

AMAP : Arctic Monitoring and Assessment Programme.

Anthropogenic : attributable to human activity.

ASIQUIM A.G. : Asociación Gremial de Industriales Químicos de Chile. (Chilean Chemical Industry Trade Association)

ATSDR : Agency for Toxic Substances and Disease Registry.

Bioaccumulation : progressive accumulation of persistent toxic substances in living beings.

Biogeochemistry: the circulation of chemical elements and compounds through an abiotic environment and through living things.

Biomagnification : the tendency of pollutants to concentrate in successive trophic levels.

BNE : Balance Nacional de Energía (National Energy Balance)

CEC : Commission for Environmental Cooperation.

chanc.-amalg. : crushing/amalgamation.

CMPC : Compañía Manufacturera de Papeles y Cartones. (Paper and Cardboard Manufacturing Company)

CNE : Comisión Nacional de Energía (National Energy Commission)

Coke : Solid residual by-product from coal distillation in a vacuum

CONAMA : Comisión Nacional del Medio Ambiente (National Environmental Commission)

CPA : Clean Production Agreement

D.S. : Decreto Supremo (Supreme Decree).

DGA : Dirección General de Aguas (National Water Authority).

DIRECTEMAR : Dirección General del Territorio Marítimo y Marina Mercante (General Directorate of the Maritime Territory and Merchant Marine).

EFSA : European Food Safety Authority.

EIPPCB : European Integrated Pollution Prevention and Control Bureau.

FA : Foreign Affairs.

FAO : United Nations' Food and Agriculture Organization.

FTA : Free Trade Agreement.

g : gram.

GEF : Global Environment Facility.

Hg : mercury.

Hg: monovalent mercury.

Hg0 : elemental mercury.

Hg2+ or Hg(II) : bivalent mercury, the most common form for organic and inorganic mercury compounds.

HgS : mercury sulfide or cinnabarite.

HW : Hazardous Waste.

ICU : Intensive Care Unit.

ILO : International Labor Organization.

kg : kilogram.

L : liter.

LBGMA : Ley Bases Generales del Medio Ambiente (Environmental Framework Law).

LIW : Liquid industrial waste.

LRTAP : Long-Range Transboundary Air Pollution.

m3 : cubic meter.

MAK : Maximum Workplace Concentration.

MeHg or MetilHg : methylmercury.

Metaloids : Elements that are in between metals and non-metals.

Metric ton : 1000 kg.

mg : milligram.

MINSAL : Ministry of Health.

MINSEGPRES : Ministry of the President's Office.

mm : millimeter.

MMSD : Mining, Minerals and Sustainable Development.

MOP : Ministry of Public Works.

MPL : Maximum permissible limit.

NAAEC : North American Agreement on Environmental Cooperation.

NAFTA : North American Free Trade Agreement.

NARAP : North American Regional Action Plan.

ng : nanogram (10-9 gram).

NGOs : Non-Governmental Organizations.

OECD : Organization for Economic Cooperation and Development.

OSHA : Occupational Safety and Health Administration.

PAMMA : Programa de Asistencia y Modernización de la Minería Artesanal (Small Scale Mining Assistance and Modernization Program)

pH : hydrogen potential. Equal to the negative logarithm of the hydrogen ion concentration.

Photoreduction: A light induced process that oxidizes the chelate (organic component), leaving the metal behind.

POPs : Persistent Organic Pollutants.

Porphyry : term derived from the Latin word “porphyra,” meaning "purple stone."

ppb : parts per billion.

PPDA : Air Pollution Prevention and Control Plan.

ppm : parts per million.

ppt : parts per trillion.

PROCHILE : Chilean Export Promotion Program.

PRTR: Pollutant Release and Transfer Register (known as RETC in Chile)

PTDI : Provisional Tolerable Daily Intake.

RAP-AL : Red de Acción en Plaguicidas y sus Alternativas de América Latina. (Latin American Action Network for Pesticides and their Alternatives)

REACH : Registration, Evaluation, Authorisation and Restriction of Chemicals.

RETC : Registro de Emisiones y Transferencia de Contaminantes. (Chile’s PRTR)

RPM : revolutions per minute.

SADEMI : Sociedad Abastecedora de la Minería (a mining supply company).

SAG : Servicio Agrícola y Ganadero (Chilean Agriculture and Livestock Service)

SAPU : Servicio de Atención Primaria de Urgencia (Primary Emergency Care Service).

SEREMI : Secretaría Regional Ministerial (Regional Ministerial Office)

SERNAGEOMIN : Servicio Nacional de Geología y Minería (National Geological and Mining Service).

SISS : Superintendencia de Servicios Sanitarios (Superintendent of Sanitary Services).

SONAMI : Sociedad Nacional de Minería (National Mining Association)

STEL : Short Term Exposure Limit.

TLV : Threshold Limit Value.

Trapiche : Aso known as “molino chileno” or Chilean mill, is a gold mining operation that uses mercury while the ore is being crushed, with amalgam plates on the sides.

TWA : Transcontinental and Western Air.

u : unit (thermometer, lamp, switch, object).

UNEP : United Nations Environment Programme.

UNIDO : United Nations Industrial Development Organization

US EPA : U.S. Environmental Protection Agency.

USA : United States of America.

USSR : Union of Soviet Socialist Republics.

Volts : unit of electric potential difference.

Watts : unit of power, equal to one joule per second.

WHO : World Health Organization.

µg : microgram (10-6 grams).

µg/m3N : micrograms per normal cubic meter.

10 Annexes

Annex 1

QUESTIONNAIRE FOR HEALTH CARE CENTERS

1. **Name of the establishment**

2. **Address**

The information requested will be held in strictest confidence and will be used solely for the purposes of a CONAMA study.

City	
Region	
Contact name	
Email	
Phone	

3. **Classification of the establishment (please fill in degree of complexity and volume indicators)**

Degree of complexity		***10.1 Volume of service***	**Nº/year**
Medical consultations		Nº consults	
Ambulatory procedures		Nº procedures	
Hospitalizations		Nº beds	

4. **What specialties does your establishment offer?**
(Please mark all applicable options)

Specialties	
Surgery	
Pediatric Surgery	
Hemodialysis	
Obstetrics	
Medicine	
Neonatology	
Neurosurgery	
Ophthalmology	
Ear, nose and throat	
Ward	
Specialties	
Medical ward	
Pediatrics	
Obstetrics	
Psychiatry	
Traumatology	
ICU	
Adult Emergency	
Urology	
Other (please specify)	

5. Quantity of thermometers and sphygmomanometer (digital and non-digital) acquired (Indicate year)

Instrument	**Type**			**Quantity**
Thermometer	Mercury	Axillary		
		Rectal		
	Digital	Axillary		
		Rectal		
Sphygmomanometer	Mercury (traditional)			
	Digital			

6. Number of instruments per specialty or unit

Specialty	Number of **Non-digital** thermometers		Number of Sphygmomanometer
	Axillary	Rectal	
Surgery			
Pediatric Surgery			
Hemodialysis			
Obstetrics			
Medicine			
Neonatology			
Neurosurgery			
Ophthalmology			
Ear, nose and throat			
Ward			
Specialties			
Medical ward			
Pediatrics			
Obstetrics			
Psychiatry			
Traumatology			
ICU			
Adult Emergency			
Urology			

7. **Are the thermometers given to patients as supplies?**

YES	NO

8. **If the answer above is "YES", how many were given out in 2005?**

Nº of thermometers given to patients in 2005	

9. **Rate of breakage or replacement of non-digital thermometers**

Nº of thermometers broken in 2005	

Nº of thermometers purchased in 2005	

10. **Replacement rate of non-digital sphygmomanometer**

Nº sphygmomanometers broken in 2005	

Nº of sphygmomanometers purchased in 2005	

11. **From which entity are these supplies purchased (thermometers and sphygmomanometers) and in what quantities?**

(Please specify units and approximate period of time, for example units/month or units/year)

Name of Distributor	Contact, e-mail or phone	Quantity

12. Is there a specific location in your facility for storing broken or inoperational instruments of this kind?

YES	NO

13. How does your facility handle this kind of waste? (include more than one response where applicable)

• Disposed of in the trash	**YES**		**NO**	
• Treated as hazardous waste and kept separate (in this case indicate how they are handled)				
• Disposed of by an another company (in this case please indicate the company name and phone and/or email)				

Annex 2

QUESTIONNAIRE FOR DENTAL HEALTH CENTERS

1. **Name of establishment**

2. **Address**

The information requested will be held in strictest confidence and will be used solely for the purposes of a CONAMA study.

Municipality	
City	
Region	
Contact name	
E-mail	
Phone	

3. **How many patient chairs does your establishment have?**

Nº of Chairs

4. **How many patient visits does your facility have each year? What percentage of these involve the application of mercury-amalgam fillings?**

Nº of patient visits per year	Total number or % of fillings applied per year	Number of mercury-amalgam fillings applied per year

5. **How are the amalgam fillings prepared?**

Manually	Mechanical amalgamator	Capsule form

6. **Do the spit sink and ejectors in your facility have filters installed to capture solid waste material?**

YES	
NO	

7. **How is waste containing mercury handled in your establishment, including filters, where applicable? (indicate more than one response where applicable)**

• Disposed of in regular trash	**YES**		**NO**	
• Disposed of in the sink	**YES**		**NO**	
• Treated as hazardous waste and separated	**YES**		**NO**	
	YES		**NO**	
• Handled by another company	**YES**		**NO**	

	YES		**NO**	

8. What quantity of supplies does your facility purchase for amalgam fillings?

(Please specify units and approximate period of time, for example kg/month, kg/year, grams/week, et c.)

Amount	Unit (Kg, gr) per period