Mercury Source Sector Assessment for the Greater Milwaukee Area

Prepared jointly by:

the Pollution Prevention Partnership
and the Milwaukee Metropolitan Sewerage District

September 1997

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SUMMARY

The Mercury Reduction Project for the Greater Milwaukee Area is a joint effort of the Pollution Prevention Partnership, Milwaukee Metropolitan Sewerage District (MMSD) and Wisconsin Department of Natural Resources. This Mercury Source Sector Assessment Report is the first result of the project. The assessment was developed to help set priorities for developing cooperative mercury education, technical assistance and collection programs.

Estimates of the amounts of mercury present, used and/or annually released to air, land and water within the MMSD service area are provided for 25 "source sectors." This 420 square mile area (including Milwaukee County and parts of Waukesha, Racine, Ozaukee and Washington Counties) is home to just over 1 million people.

The 25 mercury source sectors evaluated in this report include:

(1) batteries
(2) coal combustion--industry
(3) coal combustion--utilities
(4) crematories
(5) dental facilities
(6) educational institutions
(7) fluorescent lamps
(8) general industry
(9) hospitals and medical facilities
(10) households
(11) incinerators
(12) laboratories
(13) landfills
(14) lime production
(15) motor vehicle combustion
(16) municipal wastewater treatment
(17) oil combustion--industry
(18) oil combustion--residential
(19) secondary metal smelting
(20) septage
(21) switches--appliances
(22) switches--automotive
(23) switches—lighting
(24) thermostats
(25) veterinary facilities

The tables and figures on the next three pages summarize the relative amounts of mercury:

- annually released from purposeful uses;
- annually released due to trace impurities; and
- present or in use

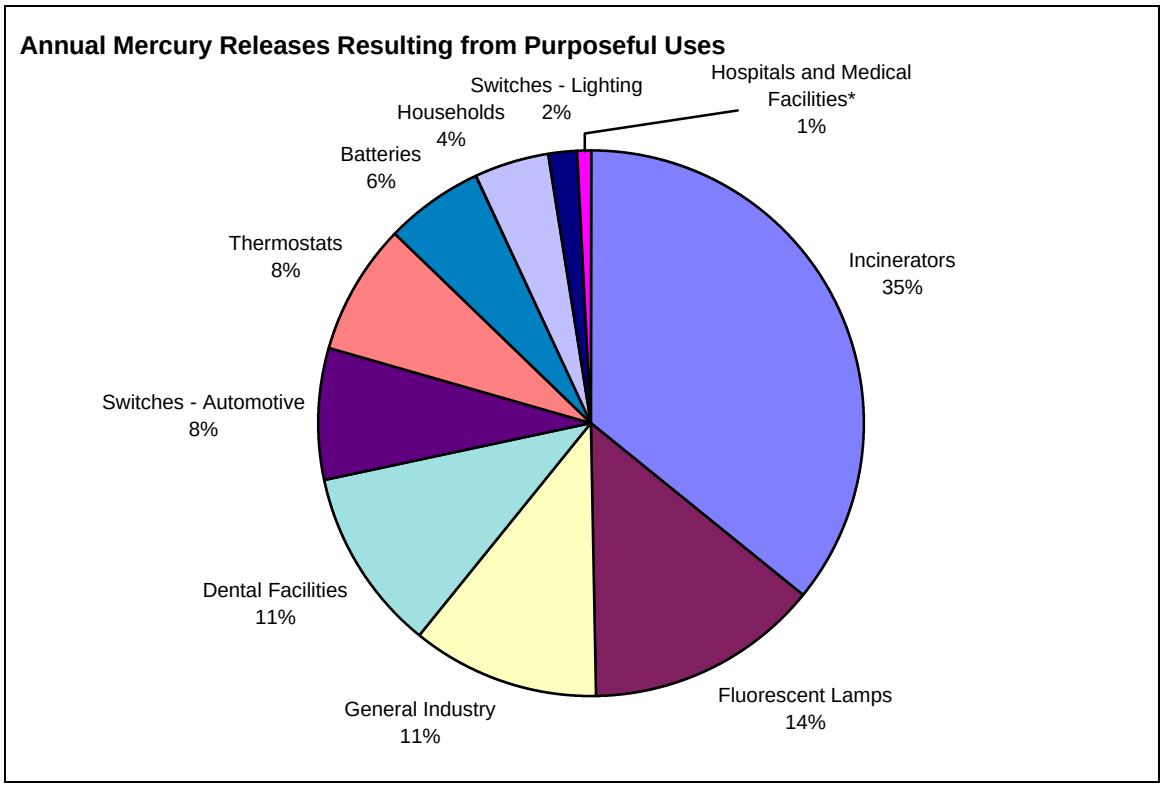
from the various source sectors in the Greater Milwaukee Area.

These estimates of the amounts of mercury from source sectors are rarely based on actual measurements from the Milwaukee area. More typically, they are based on extrapolating national or statewide estimates of the relative contributions from various mercury sources. For each sector the report utilizes the best information available and applies it to the Milwaukee situation. This Mercury Source Sector Assessment, along with selection criteria developed for the project, should provide a sound basis for developing an effective mercury reduction program.

Annual Mercury Releases Resulting from Purposeful Uses

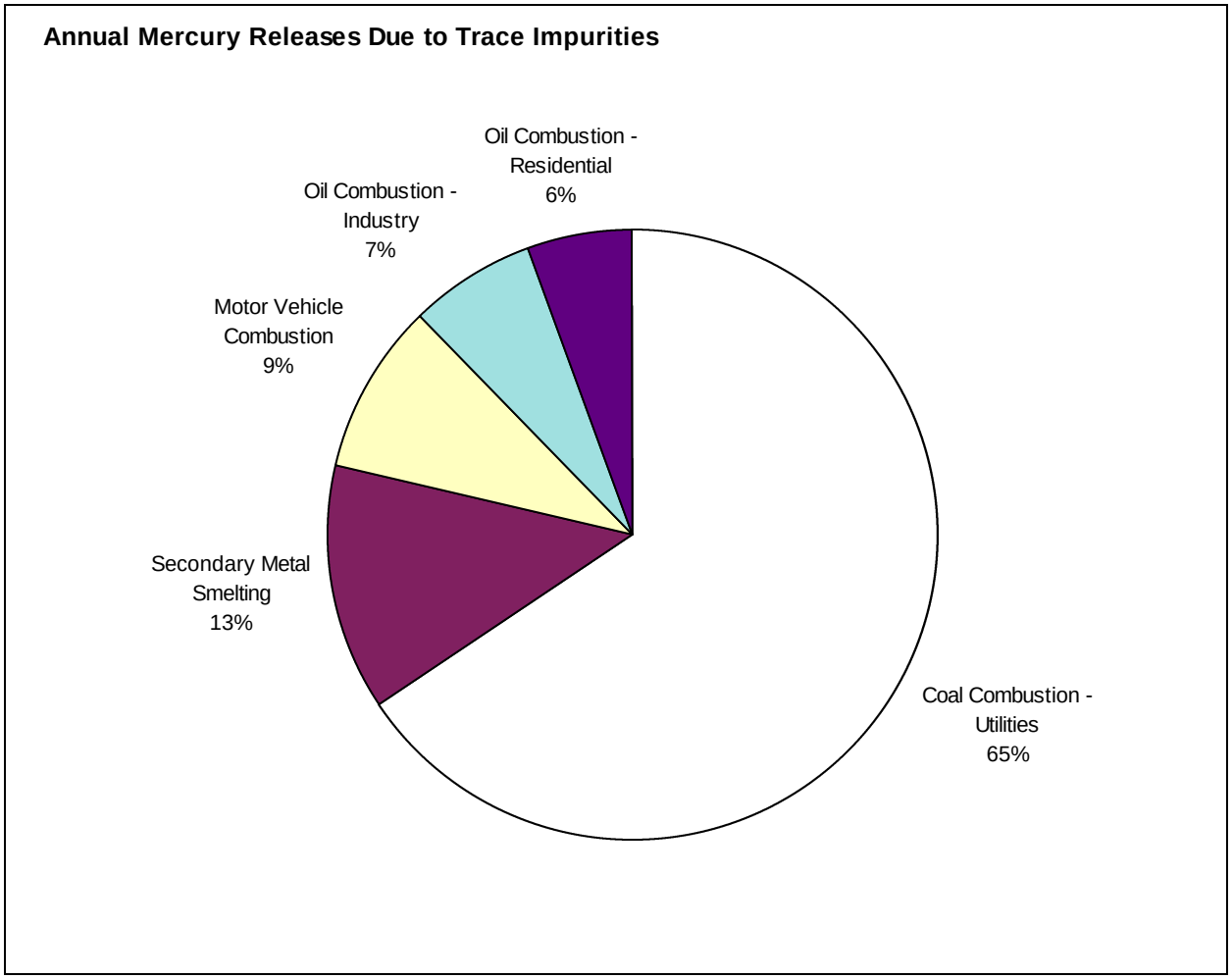
Sector	Amount (lb per yr)	Percent of Total	Releases to Media: Air (lb per yr)	Solid Waste (lb per yr)	Wastewater (lb per yr)
Incinerators	326	35%	326	0	0
Fluorescent Lamps	126	13%	0	126	0
General Industry	102	11%	0	0	102
Dental Facilities	99	11%	0	40	59
Switches - Automotive	72	8%	7	51	14
Thermostats	70	8%	0	70	0
Batteries	53	6%	0	53	0
Households	40	4%	0	0	40
Switches - Lighting	16	2%	0	16	0
Hospitals and Medical Facilities*	7	1%	0	0	7
Switches - Appliances	4	<1%	0	3	1
Crematories	3	<1%	3	0	0
Landfills	1	<1%	0	0	1
Veterinary Facilities	1	<1%	0	1	0
Septage	0	0%	0	0	0
Total for Purposeful Uses (lb per yr)	920		336	360	224
Total for Purposeful Uses (percent)		100%	37%	39%	24%

* The total for this sector includes only wastewater discharges. It should be noted that all of the incinerators in the Greater Milwaukee area are medical waste incinerators. Therefore, to get the total picture of mercury releases from hospitals and Medical Facilities, releases from these two sectors should be combined.



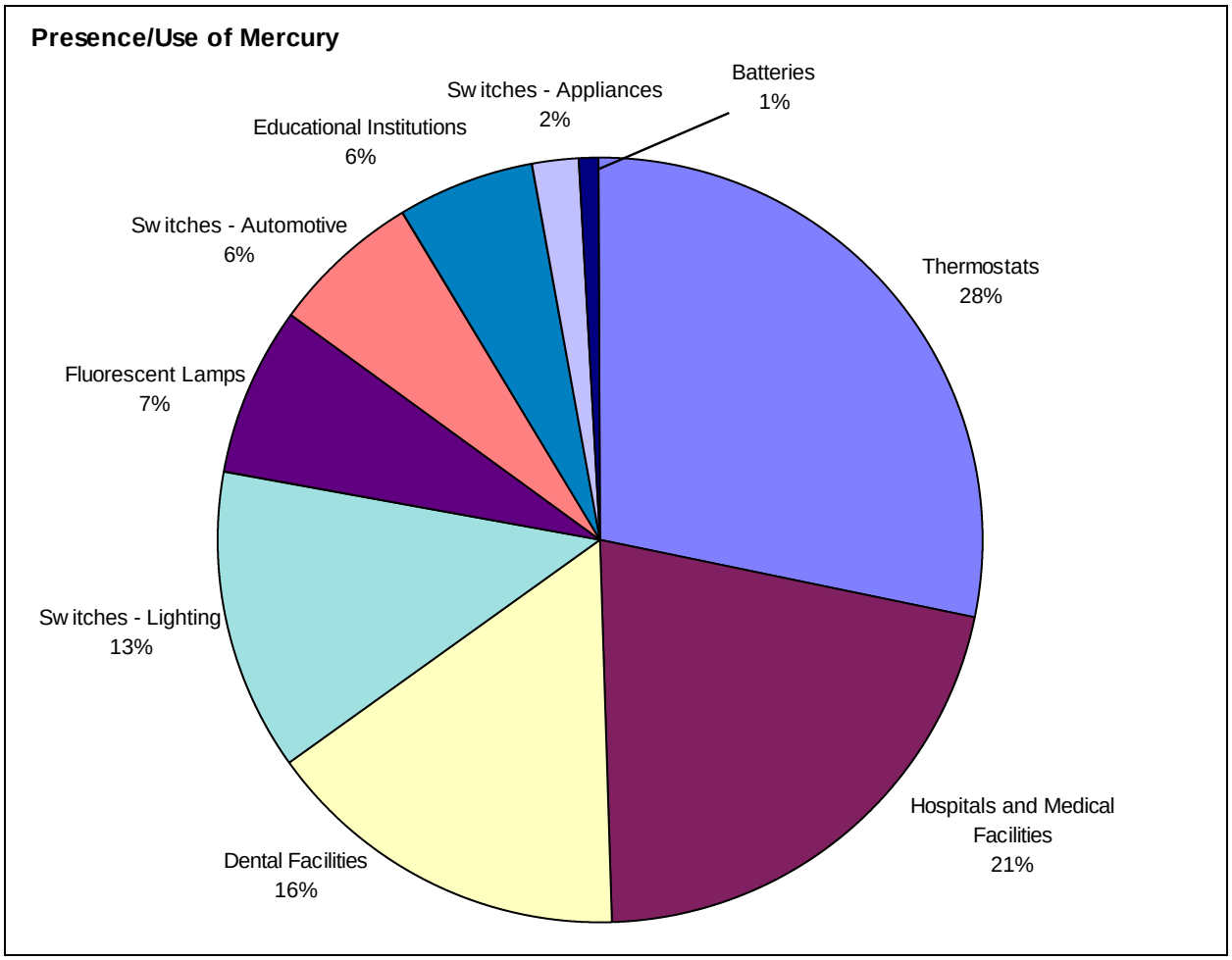
Annual Mercury Releases Due to Trace Impurities

Sector	Amount (lb per yr)	Percent of Total	Releases to Media		
			Air (lb per yr)	Solid Waste (lb per yr)	Wastewater (lb per yr)
Coal Combustion - Utilities	345	65%	276	69	0
Secondary Metal Smelting	69	13%	69	0	0
Motor Vehicle Combustion	48	9%	48	0	0
Oil Combustion - Industry	35	7%	35	0	0
Oil Combustion - Residential	30	6%	30	0	0
Coal Combustion - Industry	0	0%	0	0	0
Lime Production	0	0%	0	0	0
Total for Trace Impurities (pounds)	527		458	69	0
Total for Trace Impurities (percent)		100%	87%	13%	0%



Presence/Use of Mercury

Sector	Amount (pounds)	Percent of Total
Thermostats	2095	28%
Hospitals and Medical Facilities	1560	21%
Dental Facilities	1167	16%
Switches - Lighting	953	13%
Fluorescent Lamps	534	7%
Switches - Automotive	470	6%
Educational Institutions	417	6%
Switches - Appliances	163	2%
Batteries	53	1%
Laboratories	3	<1%
Veterinary Facilities	2	<1%
Total for Presence/Use	7417	100%



Chapter 1 - BACKGROUND

Introduction

The Mercury Reduction Project for the Greater Milwaukee Area is a joint effort of the Pollution Prevention Partnership, Milwaukee Metropolitan Sewerage District (MMSD) and the Wisconsin Department of Natural Resources (DNR). The Mercury Source Sector Assessment was undertaken to help set priorities for developing cooperative mercury education, technical assistance and collection programs. This report is the result of the first phase of the project.

The study area for the Mercury Source Sector Assessment is the service area of the Milwaukee Metropolitan Sewerage District, consisting of all of Milwaukee County and relatively small portions of Waukesha, Ozaukee, Washington and Racine Counties. (See Figure 1.) This area covers 420 square miles and includes 382,000 households. The 1995 service area population of 1,065,000 represents 20.7% of the total Wisconsin population and 0.4% of the total United States population.

Coal-fired power plants, incinerators, some manufacturing processes, hospitals, dental practices, schools and even homes have all been found to release mercury.

Why focus on mercury? Mercury is released to the environment from many sources. It is used in household and commercial products, as well as industrial processes. Coal-fired power plants, incinerators, some manufacturing processes, hospitals, dental practices, schools and even homes have all been found to release mercury. In the home, mercury can be found in electrical switches, thermostats, fluorescent lights, batteries and even some children's toys.

Most of theses sources release relatively small amounts of mercury. The problem arises from the propensity for mercury to build up, rather than break down, in the environment and the ability of minute concentrations (parts per billion or less) to cause serious health and environmental impacts. This problem is exacerbated by the potential for mercury to travel long distances in the atmosphere and then return to the earth. In fact, air deposition accounts for a major portion of the total loading of mercury to the Great Lakes ecosystem.

Mercury is extremely dangerous to both fish and people. When mercury is deposited in lakes or streams, bacteria convert it to methylmercury, which concentrates in the tissue of fish, wildlife and humans who eat the fish. An adult walleye may contain in its body a level of mercury 150,000 times higher than the water it lives in. Due to high mercury levels in fish and the potential health impacts for people who eat the fish, the state of Wisconsin (as well as many other states) issues advisories each year cautioning people to limit their consumption of certain species and sizes of fish.

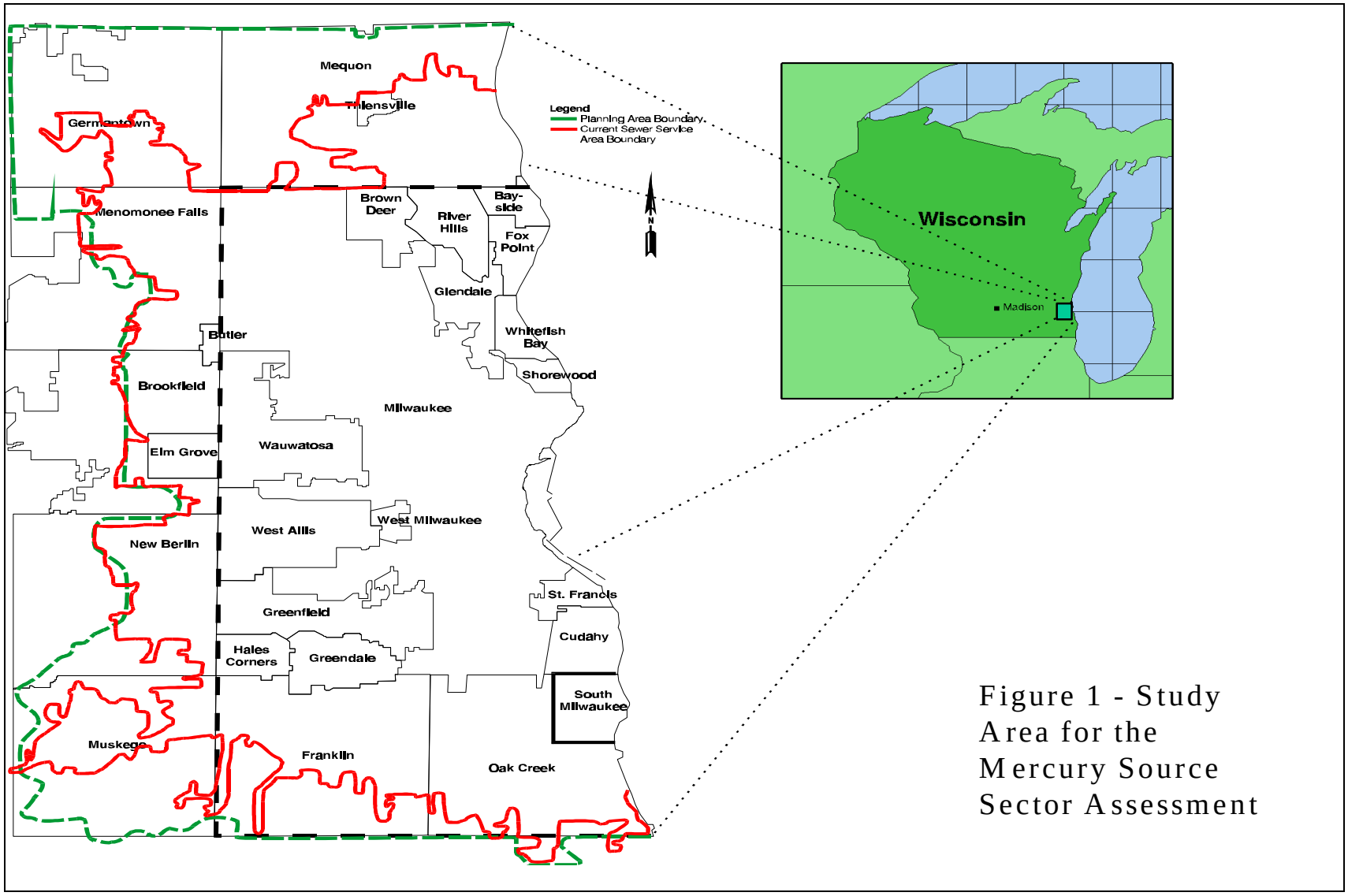


Figure 1 - Study Area for the Mercury Source Sector Assessment

Human exposure to methylmercury can result in long-lasting health effects, especially on fetal development during pregnancy. In addition, mercury poisoning has been linked to nervous system, kidney and liver damage and impaired childhood development. Nervous system disorders include impaired vision, speech, hearing and coordination.
Over the last ten years, the DNR, the U.S. Environmental Protection Agency (EPA) and the International Joint Commission for the Great Lakes have all identified mercury as a priority chemical of concern affecting both the health of people and the degradation of the environment. Each has recognized the need to phase out the use and release of mercury to the greatest extent possible. All have indicated that one of the best ways to achieve further reductions in mercury is through voluntary partnerships focusing on education and technical assistance. These partnerships involve users of mercury, government agencies, trade associations and community organizations working together for the benefit of all.

All have indicated that one of the best ways to achieve further reductions in mercury is through voluntary partnerships focusing on education and technical assistance.

Mercury comes from a wide variety of community sources not regulated by DNR or EPA. For the purposes of this study, "source sector" refers to a category of mercury use, such as a type of equipment that incorporates mercury, a service or industrial category that utilizes mercury in some way, or an activity that uses materials which incidentally contain small amounts of mercury. These include:

1) Processes where mercury is not purposefully used to create a product or provide a service. Instead, mercury is an unwanted trace impurity. For example, small amounts of mercury are found in coal burned to generate electricity and gasoline used in cars.
2) Widespread use of materials or products which contain significant amounts of mercury. Examples include fluorescent lamps, thermostats and electrical switches.
3) Manufacture or use of mercury-containing products for which feasible, economical alternatives are not yet available or for which conversion to available alternatives is not yet widespread. Use of mercury-based dental amalgams is an example of this category.

Some source sectors will be much more amenable to mercury reduction efforts based on education, technical assistance and collection programs than others. This provides the basis for characterizing mercury source sectors later in this report.

Some national and statewide estimates of the relative contributions from the various mercury source sectors are available. However, information necessary to establish an effective community-based mercury program is often unavailable.

In Wisconsin, the DNR is evolving new approaches and policies for the control of mercury and is finalizing a Mercury Source Book for Municipalities to aid in the design

of local reduction programs. The UW Extension has developed some educational materials on mercury reduction at medical facilities. The MMSD promulgated and enforces a local effluent limit for mercury for dischargers to the sewer system. Elsewhere, the Western Lake Superior Sanitary District has completed a Mercury Blueprint for moving toward virtual elimination of the discharge of mercury.

Mercury Reduction Project Description

The goals of the Mercury Reduction Project are:

- Identify and prioritize sources of mercury in the Greater Milwaukee Area;
- Develop cooperative programs for major mercury source sectors to focus education, technical assistance and/or mercury collection opportunities on significant sources of mercury in the community; and
- Significantly reduce the amount of mercury stored and released to the environment in this region.

This report helps address the first goal and sets the stage for developing effective reduction programs, tailored to specific source sectors, during the second phase of the project.

The lead organization for the project is the Pollution Prevention Partnership. The Partnership (formerly called the Greater Milwaukee Toxics Minimization Task Force) brings together representatives of business, industry, environmental groups, universities, government, law firms, engineering firms and others interested in helping to reduce the use and release of toxic and hazardous substances. Their stated mission is to "minimize toxic and other pollutants entering the environment through education and promotion of waste reduction techniques, considering the financial. social and public health impacts of such efforts."

The MMSD provided an intern who did most of the work on the Mercury Source Sector Assessment. The DNR provided the majority of the funding for the first phase of the Mercury Reduction Project. This project could not have been carried out without the assistance of these two agencies.

A Mercury Reduction Project Advisory Committee was created, made up of representatives of the project partners and other members of the community with interest or expertise relating to mercury. A list of advisory committee members is included in Appendix D of this report.

The following activities have been or will be undertaken as part of the Mercury Reduction Project.

Phase 1 Activities:

- Convene the advisory committee to provide input, develop a set of broadly defined measures of success for the project and help set priorities.
- Organize and publicize a Pollution Prevention Tour and Speaker Bureau, which will initially be general in nature, but will focus on mercury during the second phase of the project..
- Undertake a Mercury Source Sector Assessment.
- Use the results of the Source Sector Assessment, as well as other criteria, to develop a priority list of source sectors on which to focus mercury reduction efforts.

Phase 2 Activities:

- Develop and implement outreach programs in cooperation with priority source sectors.
- Operate the Pollution Prevention Tour and Speaker Bureau, and tailor the program to the priority mercury source sectors.
- In conjunction with the Milwaukee Metropolitan Sewerage District and others, help organize and publicize special mercury collection events for appropriate priority source sectors.
- Present awards for successful program participants at a related, well-publicized event.

Mercury Source Sector Assessment Description

The purposes of the Source Sector Assessment are to help provide a data baseline for evaluating the success of the Mercury Reduction Project and to guide decisions about which mercury source sectors to work with in developing cooperative mercury education, technical assistance and collection programs.

In designing both the Mercury Reduction Project and the Source Sector Assessment, we attempted to utilize a broad, ecosystem approach to the mercury issue. An ecosystem approach recognizes that all parts of the environment--air, land, water, plants, animals and people--are connected in complex ways. Activities affecting one part of the environment have the potential to affect all parts of the environment.

Thus, we have attempted to assess all significant sources of mercury, not just those releasing mercury to the sewer system. This is particularly important for mercury, an element which easily moves from one part of the environment to another.

This approach also led us to consider the presence or use of mercury in various sectors, as well as the environmental releases from those sectors. In this report, “use” refers to purposeful use of mercury in processes and/or product. “Presence” refers to the storage of mercury before or after such uses.

Releases of mercury to the environment are summarized in two categories: releases resulting from purposeful uses and releases due to trace impurities. An example of the former is air emissions from medical waste incineration and an example of the latter is trace amounts of mercury in coal used to produce electricity.

It is probable that the second phase of this project will focus on purposeful uses of mercury, because these are more amenable to mercury reduction programs based on education, technical assistance and collection. However, all significant sources were evaluated in the Source Sector Assessment Report in order to provide the "big picture" of mercury presence/use and release in the Greater Milwaukee Area. The focus of this study is also on current uses, stockpiles and releases, as opposed to historical releases which may have to be addressed through remediation efforts.

Twenty-five different sectors were evaluated. For some sectors, estimates were made for both presence/use and release. For other sectors, it made sense to estimate either presence/use or release. The source sectors included in this study are:

- batteries (presence/use and release)
- coal combustion--industry (release)
- coal combustion--utilities (release)
- crematories (release)
- dental facilities (presence/use and release)
- educational institutions (presence/use)
- fluorescent lamps (presence/use and release)
- general industry (release)
- hospitals and medical facilities
- households (presence/use and release)
- incinerators (release)
- laboratories (presence/use)
- landfills (release)
- lime production (release)
- motor vehicle combustion (release)
- municipal wastewater treatment (release)
- oil combustion--industry (release)
- oil combustion--residential (release)
- secondary metal smelting (release)
- septage (release)
- switches--appliances (presence/use and release)
- switches--automotive (presence/use and release)
- switches--lighting (presence/use and release)
- thermostats (presence/use and release)
- veterinary facilities (presence/use and release)

It should be noted that two of these source sectors--households and municipal wastewater

treatment--represent “double accounting” of mercury when considering the list of other source sectors. Thus, these sectors are not included in the release and presence/use totals for all sectors.

The household sector includes thermostats, switches, gasoline combustion and other uses or releases which were also evaluated in other source sector estimates. The household sector was included in this study to illustrate how the average residential household contributes to the use and release of mercury to the environment.

Similarly, the municipal wastewater treatment sector actually represents a “re-release” which includes mercury discharged to the sewer system from industries, hospitals, dental facilities and others. Mercury use and release from many of these sources are estimated in other source sectors on the list. The municipal wastewater treatment sector was included for comparison purposes, as well as to illustrate the fate of some of the mercury released in the Greater Milwaukee Area.

Due to this “double accounting”, neither the household mercury nor the re-release of mercury are included in the total releases or total presence/use calculations which are represented in Tables 1, 2 and 3 and Figures 2, 3, and 4.

Using the Source Sector Assessment

It is important to restate that the purposes of the Mercury Source Sector Assessment are to help provide a baseline for evaluating the success of the Mercury Reduction Project, and to guide decisions about which mercury source sectors to work with in developing cooperative mercury education, technical assistance and collection programs.

The estimates of presence/use and release from the various sectors are just that--estimates. Some of the estimates are better than others. We have attempted to provide subjective indicators (high, medium or low) of the confidence level for each of the factors (information or assumptions) used in the calculations.

The “High” rating is generally assigned to factors that are thought to be within 25% (+/-) of actual values. The “Medium” rating is assigned to factors that are thought to be within 50% (+/-) of actual values. The “Low” rating is assigned to factors that are thought to have greater than 50% (+/-) error ranges.

These confidence level ratings are based on the best professional judgment of the authors and the project advisory committee. Each reader must judge for oneself the quality of the data and assumptions included in each sector assessment.

The quality of the data and assumptions allow for reasonable, relative comparisons among mercury source sectors in order to provide a basis, along with other considerations, for prioritizing source sectors for cooperative mercury reduction

programs. The variations in the quality of the data and assumptions do not allow us to say, with any degree of confidence, that these are the actual amounts of mercury being used and/or released by the various source sectors.

The table(s) for each source sector lists the factors used, the sources of these factors and a confidence levels for these factors. These are followed by the actual calculation of the presence/use or release estimate. When additional, independent information was available, an alternate calculation is also provided. The last portion of each table contains detailed notes about the factors and calculation to help the reader further understand the reasoning behind the estimate. All data are for the year 1995 unless otherwise indicated.

The mercury release tables also include estimates of the amounts of mercury released to air, solid waste and wastewater. The apportioning of releases to the different media are based on available information and best professional judgment. It should be understood that these represent initial fates of releases to the environment. Due to the high degree of mobility of some forms of mercury, their immediate fates often are not their long term fates. For example, mercury in coal burned at electric generating plants is initially released to the atmosphere, but may eventually be returned to land and water surfaces via wet or dry deposition.

For each source sector, we attempted to apply the best available information from reports, trade associations, agency staff and other experts. In some cases the best estimates are determined from specific, local information, sometimes combined with literature values. In other cases, the best that could be done was to apply factors to national or statewide estimates, based on population ratios.

In compiling the tables and developing the estimates for presence/use and releases, we have identified areas where further refinements or additional information would enhance the accuracy of the estimates. We have also identified additional potential source sectors, for which we had little or no information, which may warrant further study in the future. These “Recommendations for Improving Source Sector Estimates” are included in Appendix E.

This Mercury Source Sector Assessment Report can provide a “boilerplate” for similar efforts in other communities or geographical areas. Each community must determine which source sectors are applicable to its area. After determining the appropriate list of source sectors, the assessment would then collect the necessary information to determine the localized factors that were included for the Greater Milwaukee Area in this study. These localized factors, along with the literature values and key assumptions from this assessment, can be incorporated into the sample calculations provided in the tables for each source sector**.**

Obviously, care must be taken to make sure that these values and assumptions do indeed apply to each community’s situation. In any case, this assessment can provide a reasonable starting point for similar efforts in other areas.

This Mercury Source Sector Assessment is composed of four sections: Annual Releases of Mercury, Presence/Use of Mercury, Re-Releases of Mercury from Municipal Wastewater Treatment and Household Contributions of Mercury.

Chapter 2 - ANNUAL RELEASES OF MERCURY

Introduction

In this section, tables are provided for the following 21 source sectors:

- batteries
- coal combustion--industry
- coal combustion--utilities
- crematories
- dental facilities
- fluorescent lamps
- general industry
- hospitals and medical facilities
- incinerators
- landfills
- lime production
- motor vehicle combustion
- oil combustion--industry
- oil combustion--residential
- secondary metal smelting
- septage
- switches--appliances
- switches--automotive
- switches--lighting
- thermostats
- veterinary facilities

Mercury is used in items such as batteries, switches, thermostats and dental amalgams for its properties. Mercury is an excellent electrical conductor and because it is a liquid at room temperature, has the ability to make and break electrical connections by tilting actions in a smooth and efficient manner. It also has expansion properties similar to the natural materials in teeth, thereby not causing undue stresses due to temperature changes in the mouth from hot and cold foods.

Mercury is a naturally occurring element that, because of its ability to amalgamate, or combine, with so many other materials, is found naturally as a trace impurity in several of the fuels that a modern economy uses to obtain energy. This is evident in the mercury releases from coal, oil, gasoline, and diesel combustion.

Releases from these source sectors are grouped into two categories: Mercury Releases from Purposeful Uses, which are summarized in Table1 and Figure 2, and Mercury Releases Due to Trace Impurities, summarized in Table 2 and Figure 3.

Table 1 : Annual Mercury Releases Resulting from Purposeful Uses

Sector	Amount (lb per yr)	Percent of Total	Releases to Media		
			Air (lb per yr)	Solid Waste (lb per yr)	Wastewater (lb per yr)
Incinerators	326	35%	326	0	0
Fluorescent Lamps	126	13%	0	126	0
General Industry	111	12%	0	0	111
Dental Facilities	99	11%	0	40	59
Switches - Automotive	72	8%	7	51	14
Thermostats	70	8%	0	70	0
Batteries	53	6%	0	53	0
Households	40	4%	0	0	40
Switches - Lighting	16	2%	0	16	0
Hospitals and Medical Facilities	7	1%	0	0	7
Switches - Appliances	4	<1%	0	3	1
Crematories	3	<1%	3	0	0
Landfills	1	<1%	0	0	1
Veterinary Facilities	1	<1%	0	1	0
Septage	0	0%	0	0	0
Total for Purposeful Uses (lb per yr)	929		336	360	233
Total for Purposeful Uses (percent)		100%	36%	39%	25%

Figure 2 - Annual Mercury Releases Resulting from Purposeful Uses

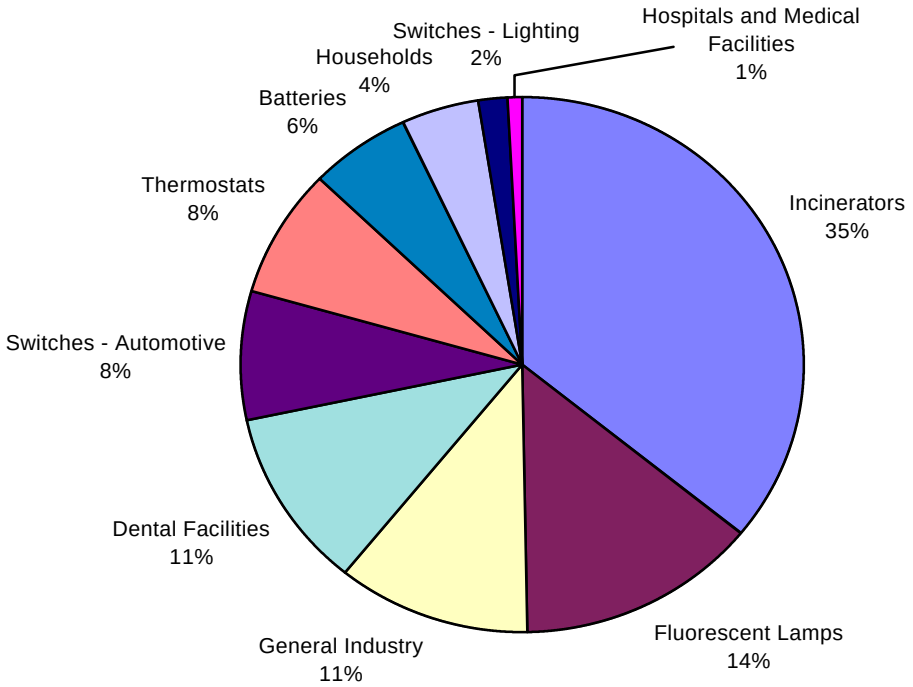
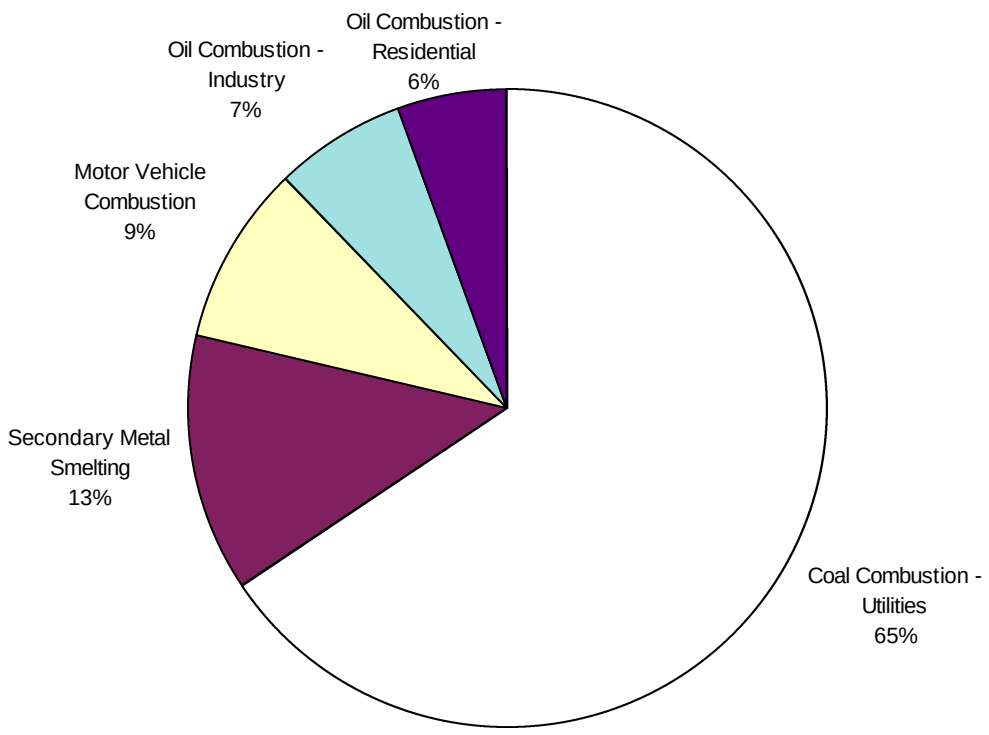


Table 2 : Annual Mercury Releases Due to Trace Impurities

Sector	Amount (lb per yr)	Percent of Total	Releases to Media		
			Air (lb per yr)	Solid Waste (lb per yr)	Wastewater (lb per yr)
Coal Combustion - Utilities	345	65%	276	69	0
Secondary Metal Smelting	69	13%	69	0	0
Motor Vehicle Combustion	48	9%	48	0	0
Oil Combustion - Industry	35	7%	35	0	0
Oil Combustion - Residential	30	6%	30	0	0
Coal Combustion - Industry	0	0%	0	0	0
Lime Production	0	0%	0	0	0
Total for Trace Impurities (pounds)	527		458	69	0
Total for Trace Impurities (percent)		100%	87%	13%	0%

Figure 3 - Annual Mercury Releases Due to Trace Impurities



BATTERIES

Releases

Factors

Factor	Units	Reference	Confidence Level
174	flasks of mercury used by battery industry nationally	Declining Presence of Mercury in Batteries (16)	High
76	pounds of mercury per flask	Declining Presence of Mercury in Batteries (16)	High
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

174 flasks of mercury used by the battery industry x 76 pounds of mercury per flask x 0.00404 MMSD service area fraction of national population = 53 pounds of mercury per year.

Alternate Calculation

131.5 tons of mercury in batteries disposed nationally (EPA Solid Waste Report (6)) x 2000 lb per ton x 0.00404 MMSD service area percent of national population = 1062 pounds per year.

Notes

1. It is assumed that all types of batteries (household, industrial, medical and military) except automotive batteries(which do not contain mercury) are included in this estimate since the 174 flasks are for the entire U.S. battery industry.
2. This estimate is for 1996. The consumption of the 174 flasks was in 1994 and there is an assumed lag time of two years between manufacture and disposal.
3. This estimate does not include imported batteries. The percentage of imported batteries used in this country and the amount of mercury in the imported batteries could not be determined.
4. The High End Estimate is based on the alternate calculation. The difference between the Best Estimate and the High End Estimate may indicate that this source sector needs further investigation.
5. This estimate may be partly "double accounted" with the incinerator sector estimate if medical batteries end up in medical waste incinerators.
6. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimated 2 pounds of mercury released from battery production in 1995 (19). Michigan estimated 495 pounds of mercury in batteries going to municipal solid waste in 1995(9). An estimate based on the Michigan estimate and adjusted by population to the MMSD service area is 57 pounds.

RESULTS

- ***Best Estimate***
  53 lb per yr
- ***High End Estimate***
  1062 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  53 lb per yr
- ***Wastewater***
  0 lb per yr

COAL COMBUSTION - INDUSTRY

Releases

Factors

Factor	Units	Reference	Confidence Level
0	pounds per year	Integrated Toxics Reporting System (20)	Medium

Calculation

No calculation was necessary.

Notes

1. The companies that were identified as having burned coal in the past reported zero emissions of mercury to the air emissions inventory (contained in the Wisconsin Integrated Toxics Reporting System (20)). The three companies are PPG Resins, KK Elevator, and Southeastern Wisconsin Products Corp.
2. The 1995 Wisconsin Estimated Mercury Air Emissions estimates 417 pounds of mercury emissions due to coal combustion by industry in 1995 (19). Minnesota lumps all coal combustion in one category and is not separated into categories for utilities and industries (see Coal Combustion - Utilities for total). Michigan estimates 680 pounds of mercury emissions due to coal combustion by industry in 1994 (9).

RESULTS

- ***Best Estimate***
  0 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

COAL COMBUSTION - UTILITIES

Releases

Factors

Factor	Units	Reference	Confidence Level
95	pounds released in 1995 at WEPCO Valley Plant	Integrated Toxics Reporting System (20)	High
1.4	factor to account for mercury in the Valley Plant ash	Dave Michaud, WEPCO	Medium
155	pounds released in 1995 at WEPCO Oak Creek Plant	Integrated Toxics Reporting System (20)	High
1.2	factor to account for mercury in the Oak Creek Plant ash	Dave Michaud, WEPCO	Medium
26	pounds released in 1995 at Milw. Co. Institutions Plant	Integrated Toxics Reporting System (20)	High

Calculation

95 pounds per year x 1.4 (Valley Plant) + 155 pounds per year x 1.2 (Oak Creek Plant) + 26 pounds per year (Milwaukee County Institutions Plant) = 345 pounds per year

Notes

1. This is the total of the 3 power plants in the MMSD service area for 1995. WEPCO Valley Plant reported 95 pounds, WEPCO Oak Creek Plant reported 155 pounds, and Milwaukee County Institutions Plant reported 26 pounds. All of these reported values are air emissions. To find the total releases, the Valley Plant was multiplied by 1.4 and the Oak Creek Plant was multiplied by 1.2. These factors account for the amounts of mercury released to the solid waste stream (in the ash).
2. No factor is applied to the emissions from the Milwaukee County Institutions Plant due to a lack of controls that would shift the mercury from the air to the solid waste.
3.The reported numbers are based on the concentration of mercury in the coal used and the amount of coal burned.
4. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates total air emissions of mercury from coal combustion by utilities to be 2,135 pounds (19). This estimation used a constant value of 79% of the mercury released to the air and 21% to the ash. Minnesota estimated 2,045 pounds of mercury released due to coal combustion (total for all coal combustion) (14). Michigan estimated between 2,210 and 4,240 pounds of mercury released in 1994 due to coal combustion by utilities (9).

RESULTS

- ***Best Estimate***
  345 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  276 lb per yr
- ***Solid Waste***
  69 lb per yr
- ***Wastewater***
  0 lb per yr

CREMATORIES

Releases

Factors

Factor	Units	Reference	Confidence Level
0.6	grams of mercury per cremation	Dental Amalgam - Environmental Aspects (1)	Medium
2106	cremations per year in Milwaukee County	Medical Examiners Office	High
574	cremations per year in Waukesha County	Medical Examiners Office	High
0.35	fraction of Waukesha County population in MMSD service area	MMSD and Waukesha County Internet site	Medium

Calculation

2106 cremations + 35% of Waukesha County population in the MMSD service area x 574 cremations in Waukesha County per year = 2307 total cremations per year. 0.6 grams of mercury per cremation x 2307 cremations per year / 454 grams per pound = 3 pounds per year.

Notes

1.This estimate is based on 1996 data.
2. The amount of mercury is based on actual measurements from a Swedish study. Because this factor was an average of actual measurements it was used over any other factors that are based on estimates and calculations. It is assumed that this is a reasonable estimate of the amount of mercury released from a cremation in the United States.
3. The High End Estimate is derived by using 1 gram of mercury per cremation (Mercury Sourcebook (23)) in place of 0.6 gram per cremation.
4. The total number of cremations is based on the number performed in Milwaukee County (2106) plus the fraction of Waukesha county that lives in the MMSD service area (35%) times the total number of cremations performed in Waukesha County (574).
5. It is assumed that all of the mercury from dental amalgams volatilizes during cremation.
6. Western Lake Superior Sanitary District staff think that this number is low based on the fact that Americans average more fillings than were measured in the Swedish study. However, since there is no clear basis for changing the value of 0.6 grams, and the High End Estimate is based on 1 gram per cremation, the factor was not changed.
7.The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates 19 pounds of mercury emissions from cremation (19). Minnesota estimates 71 pounds of mercury emissions from cremation in 1995 (14). Michigan estimates 40 pounds of mercury emissions from cremation in 1994 (9).

RESULTS

- ***Best Estimate***
  3 lb per yr
- ***High End Estimate***
  5 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  3 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

DENTAL FACILITIES

Releases

Factors

Factor	Units	Reference	Confidence Level
0.23	grams of mercury per dentist per day	Mercury Sourcebook (23), Michigan Study (3)	Low
760	dentists in Milwaukee County	Wisconsin Dental Association	High
280	dentists in Waukesha County	Wisconsin Dental Association	High
0.35	fraction of Waukesha County population in MMSD service area	MMSD and Waukesha County Internet site	Medium
228	working days per year		High

Calculation

760 dentists in Milwaukee County + 35% of Waukesha County population in the MMSD service area x 280 dentists in Waukesha County = 858 dentists in the MMSD service area. 0.23 grams of mercury (waste amalgam) released per dentist per day x 858 dentists practicing in the MMSD service area x 228 working days per year / 454 grams per pound = 99 pounds per year.

Alternate Calculation

17 old amalgams removed per week per dentist x 0.2 grams Hg per amalgam x 40% lost x 46 weeks per year x 858 dentists / 454 grams per pound = 118 pounds per year. 20 new amalgams placed per week per dentist x 0.2 grams per amalgam x 6% lost x 46 weeks per year x 858 dentists / 454 grams per pound = 21 pounds per year. The sum of these two values is 139 pounds per year.

DENTAL FACILITIES (continued)

Releases

Notes

1. The Mercury Sourcebook (23) estimates 0.1 grams of mercury released per dentist per day. Calculations based on surveys by the Detroit Water and Sewerage District (DWSD) and Western Lake Superior Sanitary District (WLSSD) result in a value of 0.35 grams of mercury released per dentist per day. The average (0.23) of the two values (0.35 and 0.11) was used for this calculation.
2. The High End Estimate is based on the alternate calculation. The basis for the alternate calculation is the survey by the DWSD (20 new amalgams placed per week, 3% of new amalgams lost to sewer, 3% of new amalgams lost to garbage, 17 old amalgams removed per week, 27% of old amalgams lost to sewer, 15% of old amalgams lost to garbage).
3. The mercury in the waste stream is apportioned between the solid waste stream and the wastewater stream based on the reported surveys from DWSD and WLSSD.
4. The factor of 228 working days per year is calculated by 365 days per year minus 104 weekend days minus 13 holidays minus 20 vacation days. The factor of 46 working weeks per year in the Alternate Calculation is calculated by dividing 228 working days per year by 5 working days per week.
5. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates a total of 70 pounds of mercury air emissions due to laboratory and dental use (19). Michigan estimates 60 pounds of mercury in the solid waste stream due to dental amalgam preparation in 1995 (9).

RESULTS

- ***Best Estimate***
  99 lb per yr
- ***High End Estimate***
  139 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  40 lb per yr
- ***Wastewater***
  59 lb per yr

FLUORESCENT LAMPS

Releases

Factors

Factor	Units	Reference	Confidence Level
0.035	grams of mercury per lamp	Mercury Sourcebook (23)	Medium
600000000	lamps manufactured per year nationally	Mercury Containing Lamp Management Report (12)	Medium
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High
786000	lamps recycled in MMSD service area in 1996	survey of Milwaukee area lamp recyclers	Medium

Calculation

(600,000,000 lamps manufactured nationally x 0.00404 MMSD service area fraction of national population) - 786,000 lamps recycled from the MMSD service area = 1,638,000 lamps not recycled. 0.035 grams of mercury per lamp x 1,638,000 lamps not recycled / 454 grams per pound = 126 pounds per year.

Notes

1. This estimate is based on 1996 information.
2. The number of bulbs that are recycled resulted from contacting the major recyclers of bulbs in the Milwaukee area.
3. The factor of 0.035 grams of mercury per bulb is based on the fact that many older bulbs currently being replaced have anywhere from 0.020 grams to 0.055 grams.
4. The High End Estimate is derived by replacing the average value of 0.035 grams of mercury per bulb with an average value of 0.045 grams of mercury per bulb. This value will depend on the actual amount of older bulbs (with mercury contents up to 0.055 grams) being disposed of.
5.The 1995 Wisconsin Estimated Mercury Air Emissions inventory combines electric lamp breakage with mercury switch breakage and estimates a total of 365 pounds of mercury released (19). Minnesota estimates 83 pounds of mercury released from lamp breakage in 1995 (14). Michigan estimates 330 pounds of mercury released to the air from lamp manufacturing and breakage, 0 to 15 pounds of mercury released from light bulb recyclers in 1994 and 2200 pounds of mercury in the solid waste stream from lamp manufacturing and breakage in 1995 (9).

RESULTS

- ***Best Estimate***
  126 lb per yr
- ***High End Estimate***
  162 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  126 lb per yr
- ***Wastewater***
  0 lb per yr

Factors

Factor	Units	Reference	Confidence Level
224	pounds of mercury in influent to treatment plants	MMSD data	Medium
122	pounds of mercury from other sectors	sector calculations	Low

Calculation

224 total pounds of mercury in influent to MMSD - 122 pounds of mercury from other sectors = 102 pounds per year.

Notes

1. The calculation presented above is based on the amount of mercury, going out in various forms, from the two MMSD wastewater treatment plants and the South Milwaukee wastewater treatment plant, (186 pounds) (See Municipal Wastewater Treatment sector) multiplied by a factor (1.205) to account for removals of mercury from the wastewater stream prior to disposal or discharge to obtain the total mercury loading to the treatment plants. This total (224 pounds) minus the estimated amount of mercury discharged to the sewer system from non-industrial sources (122 pounds) is estimated here as the General Industry total (102 pounds). Although there may be other mercury inputs to the sewer system, it is assumed here that the remainder of the mercury is coming from the industrial sector.
2. This estimate is for wastewater only. Releases to air and solid waste from industry, besides those sectors identified elsewhere in this report, have not been quantified.
3. It is difficult to estimate industrial uses and releases of mercury and mercury containing products. It is known that in other communities, feedstock chemicals (NaOH, KOH, H2SO4) have been identified as significant contributors of mercury due to trace impurities. It was not within the scope of this study to identify and quantify the use of these chemicals.
4. MMSD permitted dischargers are required to monitor for mercury. However, the detection levels that have been used to date do not allow for a reasonable estimate of the total mercury discharges for the purpose of this study. It is anticipated that future use of more sensitive analytical procedures may result in the ability to more directly estimate mercury releases from this source sector.
5. In 1995, 166,901 pounds of mercury contaminated material were reported generated onsite in the MMSD service area by the Wisconsin Integrated Toxics Reporting System (9). A major source of this material is Dynex Industries, which recycles fluorescent lamps. They alone reported 121,000 pounds. Another large contributor was Recycle Technologies, Inc. They reported 21,570 pounds of mercury contaminated material. The remaining 24,331 pounds were reported by assorted industries, institutions, labs, schools, hospitals, etc. Although mercury contaminated material is not a direct measurement of mercury, it is an indication of possible mercury presence, use or release.
6. Michigan has five sectors listed under industrial sources (lime manufacturing, cement manufacturing, light bulb recyclers, coke producers, and copper smelting) for an estimated 650 pounds of mercury released to the air.

RESULTS

- ***Best Estimate***
  102 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  102 lb per yr

HOSPITALS AND MEDICAL FACILITIES

Releases

Factors

Factor	Units	Reference	Confidence Level
37000	gallons of wastewater per day per hospital	MMSD monitoring data	Low
0.006	milligrams of mercury per liter	MMSD monitoring data	Low
9	hospitals with consistent mercury detects	MMSD monitoring data	Low
1.1	factor to account for other hospitals		Low

Calculation

37,000 gallons per day x 3.8 liters per gallon x 0.006 milligrams of mercury per liter x 365 days per year x 9 hospitals that detected mercury in the wastewater stream x 1.1 to account for other hospitals / 454,000 milligrams per pound = 7 pounds per year.

Notes

1. This estimate includes only mercury emissions to wastewater. Air emissions of mercury due to medical waste incineration are addressed in the incinerator sector. At this time, we are unable to estimate the amount of mercury released to the solid waste stream that does not end up in an incinerator.
2. MMSD permitted hospitals are required to monitor for mercury. The factors of 37,000 gallons per day and 0.006 milligrams of mercury per liter are based on the MMSD monitoring data. However, the detection levels that have been used to date do not necessarily allow for an accurate estimate of total mercury discharges for the purpose of this study. It is anticipated that future use of more sensitive analytical procedures will result in the ability to better estimate the mercury releases from this source sector.
4. At present detection levels, 9 of the 20 monitored hospitals consistently showed measurable concentrations of mercury. The calculation shown above is based on the average of the flow and concentration data for these 9 hospitals.
5. There are probably significant amounts of mercury residing in the traps and low points of medical facilities piping systems. This mercury is probably slowly released over time, even if there is no mercury presently being added to the system.
6. The Michigan air emissions inventory includes a hospital waste sector under the incineration category and estimates 980 pounds of mercury released in 1994 (9).

RESULTS

- ***Best Estimate***
  7 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  7 lb per yr

INCINERATORS

Releases

Factors

Factor	Units	Reference	Confidence Level
15512	tons of medical waste incinerated in MMSD service area	George Volpentesta and Marvin Patton, Wisconsin DNR	High
0.021	pounds of mercury per ton of medical waste incinerated	see note 4	Medium

Calculation

15512 tons of medical waste incinerated in the MMSD service area x 0.021 lb of mercury per ton of medical waste incinerated = 326 lb per year.

Notes

1. There are only two operating incinerator plants in the MMSD service area, both of which are medical waste incinerators.
2. This estimate is based on 1996 information.
3. The Environmental Guardian incinerator plant in Menomonee Falls has two identical incinerators that each have a capacity of 1700 pounds per hour. 7446 tons of medical waste were incinerated in each in 1996. St. Luke's Hospital incinerated 620 tons of medical waste in 1996. St. Luke's incinerator has a wet scrubber. The wet scrubber may move some of the mercury from air emissions to wastewater emissions and may be included in the estimate for the hospitals and medical facilities sector.
4. The emission factor of 0.021 pounds per ton of medical waste incinerated was derived from permit monitoring data at the Environmental Guardian incinerator : 0.01353 pounds per hour of mercury emissions while 1300 pounds per hour of medical waste were being incinerated.
5. The High End Estimate is derived by using an emission factor of 0.04 pounds of mercury per ton of medical waste incinerated. This factor was provided by DNR staff from an EPA report (7).
6. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimated 602 pounds of mercury released from medical waste incineration and 177 pounds of mercury released due to municipal waste incineration in 1995 (19). Minnesota estimated 36 pounds of mercury released from medical waste combustion and 476 pounds of mercury released from municipal waste combustion in 1995 (14). Michigan estimated 980 pounds from hospital waste incineration, 2,915 pounds from municipal waste incineration, and 280 pounds from hazardous waste incineration in 1994 (9).

RESULTS

- ***Best Estimate***
  326 lb per yr
- ***High End Estimate***
  621 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  326 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

LANDFILLS

Releases

Factors

Factor	Units	Reference	Confidence Level
0.027	pounds of mercury per year per landfill in off gas	Raw Gas Fingerprint Study (15)	Low
44000	gallons of leachate per day per landfill	MMSD monitoring data	Low
0.00086	milligrams of mercury per liter of leachate	MMSD monitoring data	Low
5	landfills discharging leachate to the MMSD system	Wisconsin Solid Waste Landfill Tonnage Rapacity Report	High
1.5	factor to account for gas not captured	Carol Diggelman, Milwaukee School of Engineering	Low

Calculation

0.027 pounds per year x 5 landfill sites in the MMSD service area x 1.5 to account for gas not captured = 0.20 pounds per year. 44,000 gallons of leachate per day per landfill x 3.8 liters per gallon x 0.00086 milligrams of mercury per liter of leachate x 365 days per year x 5 landfills / 454,000 milligrams per pound = 0.58 pounds. Total mercury emissions = 0.20 pounds of mercury from landfill gas + 0.58 pounds of mercury from landfill leachate = 1 pound per year.

Notes

1. The value of 0.027 pounds of mercury per year is from a 1990 landfill gas fingerprint test of Omega Hills landfill (15) which found 0.006 micrograms of mercury in a 9.2 liter sample for a concentration of 0.65 nanograms per liter. The flowrate of landfill gas was 1,239 dry standard cubic feet per minute.
2. This data is from the largest landfill in the MMSD service area. Since the other landfills are smaller, they will most likely emit less mercury. However, it is unclear if the amount of mercury in this gas is representative of other landfills.
3. The factor of 1.5 to account for gas not captured reflects the fact that some gas escapes through the cover of a landfill without being drawn in to the collection system.
4. The values of 44,000 gallons of leachate per day per landfill and 0.00086 milligrams of mercury per liter of leachate are averages from MMSD monitoring data. Although this data is specific to the Waste Management Landfills it is used as a basis for calculations for the other landfills as well, since there is no data for these other landfills.
5. It is possible that there are additional landfills not discharging leachate to the MMSD system that are releasing landfill gas.
6. Minnesota estimates 881 pounds of mercury released to the air annually from landfills (14).

RESULTS

- ***Best Estimate***
  1 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  <1 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  <1 lb per yr

LIME PRODUCTION

Releases

Factors

Factor	Units	Reference	Confidence Level
0	pounds per year		Medium

Calculation

No calculation was necessary.

Notes

1. A search by SIC of Yellow Pages on disc (17) and by the DNR indicated that there are no lime producers in the MMSD service area.
2. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates 128 pounds of mercury air emissions from lime production statewide (19). Michigan estimates 170 pounds of mercury air emissions due to lime production in 1994 (9).

RESULTS

- ***Best Estimate***
  0 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

MOTOR VEHICLE COMBUSTION

Releases

Factors

Factor	Units	Reference	Confidence Level
231	pounds of mercury released per year	Wisconsin Estimated Mercury Air Emissions (19)	Low
0.207	MMSD service area fraction of state population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

231 pounds of mercury released per year statewide x 0.207 MMSD service area fraction of state population = 48 pounds per year

Alternate Calculation

13,000 miles traveled per vehicle per year x 4,281,803 vehicles registered in Wisconsin in 1995 x 4.6E-09 pounds of mercury per vehicle mile traveled x 0.207 MMSD service area fraction of state population = 53 pounds per year.

Notes

1. The value of 4.6E-09 lb mercury per vehicle mile traveled is an overall number which assumes 15% diesel vehicles and 85% gasoline vehicles. This factor was provided by DNR staff from an EPA report (7).
2. Although the average of 13,000 miles per vehicle is actually an auto average, the number is applied to all vehicles (autos, trucks, RV's, buses and motorcycles) for the purpose of the alternate calculation.
3. The high end result is based on the alternate calculation.
4. There is a high degree of uncertainty associated with this sector. Some states have included this sector in their mercury inventories and others have not.
5. The 1995 Wisconsin Estimated Mercury Air Emissions estimate for mercury emissions from gasoline combustion was 231 lb (19). Minnesota estimates 30 pounds of mercury released from petroleum refining in 1995 (14), but does not list gasoline combustion as a source of mercury air emissions.

RESULTS

- ***Best Estimate***
  48 lb per yr
- ***High End Estimate***
  53 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  48 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

OIL COMBUSTION - INDUSTRY

Releases

Factors

Factor	Units	Reference	Confidence Level
171	pounds per year statewide mercury emissions	Wisconsin Estimated Mercury Air Emissions (19)	Medium
0.207	MMSD service area fraction of state population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

171 pounds of mercury released statewide per year x 0.207 MMSD service area fraction of state population = 35 pounds per year.

Notes

1.The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates 171 pounds of mercury released from industrial oil combustion (19). Minnesota estimates 659 pounds from all oil combustion in 1995 (14). Michigan estimates 20 pounds of mercury released from industrial oil combustion in 1994 (9).

RESULTS

- ***Best Estimate***
  35 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  35 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

OIL COMBUSTION - RESIDENTIAL

Releases

Factors

Factor	Units	Reference	Confidence Level
146	pounds per year statewide mercury emissions	Wisconsin Estimated Mercury Air Emissions (19)	Medium
0.207	MMSD service area fraction of state population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

146 pounds of mercury released statewide per year x 0.207 MMSD service area fraction of state population = 30 pounds per year.

Notes

1. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates 146 pounds of mercury released to the air from residential oil combustion (9). Minnesota estimates 659 pounds of mercury released to the air from all oil combustion in 1995 (14). Michigan estimates 175 pounds of mercury released to the air from residential oil combustion in 1994 (9).

RESULTS

- ***Best Estimate***
  30 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  30 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

SECONDARY METAL SMELTING

Releases

Factors

Factor	Units	Reference	Confidence Level
69	pounds per year	Wisconsin Integrated Toxics Reporting System (20)	Medium

Calculation

No calculation was necessary since there was only one smelter with a reported release of mercury.

Notes

1.There is only one smelter in the area, The Delta Group, that reported emissions of mercury for 1995.
2. This value is reported to the DNR for the air emissions inventory, which is included in the Wisconsin Integrated Toxics Reporting System (20). The Delta Group is monitored for wastewater discharges of mercury, however, the high detection limit does not allow for a reasonable estimate of mercury releases to the wastewater stream.
3. There is one other smelter, Wabash Industries, but it did not report any emissions and a conversation with the DNR contact for Wabash revealed that their process does not involve mercury.
4. The 1995 Wisconsin Estimated Mercury Air Emissions estimates 69 pounds of mercury emissions from Secondary Metal Smelting (19).

RESULTS

- ***Best Estimate***
  69 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  69 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

SEPTAGE

Releases

Factors

Factor	Units	Reference	Confidence Level
0	pounds per year	MMSD	High

Calculation

No calculation was necessary.

Notes

1. MMSD has not received any septage into its system for several years.
2. The South Milwaukee Wastewater Treatment Plant does accept septage but has not performed any mercury testing on it. Therefore, there is no basis for estimating the amount of mercury in the septage stream.

RESULTS

- ***Best Estimate***
  0 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  0 lb per yr
- ***Wastewater***
  0 lb per yr

SWITCHES - APPLIANCES

Releases

Factors

Factor	Units	Reference	Confidence Level
0.01	mercury switches per appliance	see note 3	Low
0.35	appliances discarded per household per year	Discarded Household Appliance Study (4)	Medium
382000	households in MMSD service area	MMSD	High
1.4	grams of mercury per switch	see note 4	Medium
480000	gas-pilot ranges in use nationwide	Appliance Recycling Information Center	Medium
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

0.35 appliances discarded per household per year x 382,000 households in the MMSD service area x 0.01 mercury switches per appliance x 1.4 grams of mercury per appliance switch / 454 grams per pound = 4 pounds of mercury per year.

Notes

1. The factor of 0.35 appliances discarded per household per year includes all types of appliances, including washers, refrigerators, ranges, air conditioners, microwave ovens, etc. The reason for the low factor for mercury switches per appliance is because only washers, chest freezers and gas-pilot (as opposed to electronic start) ranges contain mercury switches.
2. The Discarded Household Appliances study estimates 1,333,500 washers, 809,500 freezers (assumption is half of these are chest freezers) in use in Wisconsin. The Appliance Recycling Information Center estimates that 480,000 gas-pilot (as opposed to electronic start) ranges are in use nationwide. The factor of 5% of washers having mercury switches is based on information that there were washers manufactured with mercury switches, but that it was a minimal amount. The factors of 24% of chest freezers having mercury switches and all gas-pilot ranges having mercury switches are based on information from the Appliance Recycling Information Center.
3. The factor 0.01 mercury switches per appliance was calculated by : first, adding up 1) the estimated number of washers in use (1,333,500) multiplied by the percent of these that are assumed to have mercury switches (5%), 2) the estimated number of chest freezers in use (809,500/2) multiplied by the percent of these that are estimated to have mercury switches (24%), and 3) the estimated number of gas-pilot ranges (1,939) to obtain 165,754 mercury switches; this sum (165,754) was then divided by the total number of appliances (14,076,000) in this study.
4. The factor of 1.4 grams of mercury per switch is calculated by (1,333,500 washers x 5% x 2 grams + 809,500 freezers x 50% x 24% x 1 gram + 1,939 gas pilot ranges x 100% x 4 grams) / 165,754 = 1.4 grams average.
5. The amounts of mercury that enter each media are quantified for this sector by assuming that the process is similar to recycling of autos and that the mercury will be released in a similar manner (10% to air, 20% to wastewater and 70% to solid waste).

RESULTS

- ***Best Estimate***
  4 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  <1 lb per yr
- ***Solid Waste***
  3 lb per yr
- ***Wastewater***
  <1 lb per yr

SWITCHES - AUTOMOTIVE

Releases

Factors

Factor	Units	Reference	Confidence Level
0.8	grams of mercury per switch	Mercury Sourcebook (23)	Medium
300000	automobiles shredded in Wisconsin in 1996	Paul Koziar, DNR	Medium
0.3	portion of state total in MMSD service area	Paul Koziar, DNR	Medium
0.43	switches per automobile	Automobile Shredder Residue Report (13)	Medium
1.06	factor to account for vehicles not shredded	Mercury Sourcebook (23)	Medium

Calculation

0.8 grams of mercury per switch x 300,000 automobiles crushed in Wisconsin x 30% crushed in the MMSD service area x 0.43 switches per automobile x 1.06 factor to account for the automobiles that are not shredded / 454 grams per pound = 72 pounds per year.

Notes

1. The portion attributed to the service area (30%) is larger than the MMSD service area percentage of state population (20.7%) because the auto recycling facility in MMSD's service area likely receives autos from areas outside the MMSD service area in addition to those from within the service area.
2. 94% of all automobiles in Wisconsin are recovered for recycling (Mercury Sourcebook (23)). The fate of the other 6% is unknown but is a possible release to the environment and thus the 1.06 factor was included in the calculation.
3. The amounts released to each media are estimated for this sector according to the following assumptions. Some mercury will probably be volatilized (10%) due to the heat generated during shredding operations. Some mercury may enter the wastewater stream (20%) by rainfall carrying the mercury into storm sewers. Finally, most of the mercury will remain with the metal (70%), at which point the fate is unclear, but is assumed to end up in solid waste. These percentages are estimates based on professional judgment.
4. The high end estimate for this sector is calculated by assuming that all the switches would contain the maximum amount of mercury found in switches (1.5 grams) instead of the average value (0.8 grams).
5. Michigan estimates 190 to 240 pounds of mercury in automotive switches in the solid waste stream in 1995 (9).

RESULTS

- ***Best Estimate***
  72 lb per yr
- ***High End Estimate***
  136 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  7 lb per yr
- ***Solid Waste***
  51 lb per yr
- ***Wastewater***
  14 lb per yr

SWITCHES - LIGHTING

Releases

Factors

Factor	Units	Reference	Confidence Level
1.93	tons of mercury disposed of nationally per year in lighting switches	EPA Solid Waste Report (6)	Low
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

1.93 tons of mercury disposed of in lighting switches per year nationally x 0.00404 MMSD service area fraction of national population x 2000 pounds per ton = 16 pounds per year.

Notes

1. This estimate is assumed to include residential, commercial, industrial and institutional uses of mercury containing lighting switches.
2. Michigan estimates 140 pounds of mercury from light switches in solid waste in 1995 (20).

RESULTS

- ***Best Estimate***
  16 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  16 lb per yr
- ***Wastewater***
  0 lb per yr

THERMOSTATS

Releases

Factors

Factor	Units	Reference	Confidence Level
3	grams of mercury per thermostat	Mercury Sourcebook (23)	Medium
2619000	thermostats disposed nationally per year	EPA Solid Waste Report (6)	Medium
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

3 grams of mercury per thermostat x 2,619,000 thermostats disposed of nationally per year x 0.00404 MMSD service area fraction of national population / 454 grams per pound = 70 pounds per year.

Notes

1. The High End Estimate is estimated by using 3.5 grams of mercury per thermostat (this assumes that approximately 1 in 6 thermostats has two switches instead of only one) in place of 3 grams of mercury per thermostat (all thermostats having only one switch). It is known that some thermostats have two mercury switches, however, it is not known how many.
2. Honeywell has started thermostat collection programs in other states, but not yet in Wisconsin.
3. Michigan estimates 605 pounds of mercury from thermostats in solid waste in 1995 (9).

RESULTS

- ***Best Estimate***
  70 lb per yr
- ***High End Estimate***
  82 lb per yr

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  70 lb per yr
- ***Wastewater***
  0 lb per yr

VETERINARY FACILITIES

Releases

Factors

Factor	Units	Reference	Confidence Level
3	thermometers broken per year	see note 1	Low
5	grams of mercury per thermometer	see note 2	Low
36	veterinary facilities in the MMSD service area	search by SIC of telephone directory on disc (17)	High

Calculation

3 thermometers broken per year x 5 grams of mercury per thermometer x 36 veterinary facilities in the MMSD service area / 454 grams per pound = 1 pound per year.

Notes

1. The average of 3 thermometers broken per veterinary facility is based on an informal telephone survey in which 10 veterinary offices in the MMSD service area were called and asked about the breakage of mercury thermometers.

2. 5 grams of mercury per thermometer is an estimate based on the fact that lab thermometers have 10 grams of mercury in them and that veterinary thermometers are smaller than lab thermometers.
3. This estimate includes only releases from thermometer breakage. It does not include mercury in medications or other uses, as there was no basis for estimating these.
4. The informal survey did not include questions about the disposal methods for broken thermometers. It is assumed that all of the mercury from broken thermometers will end up in the solid waste stream.

RESULTS

- ***Best Estimate***
  1 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  0 lb per yr
- ***Solid Waste***
  1 lb per yr
- ***Wastewater***
  0 lb per yr

Chapter 3 - PRESENCE/USE OF MERCURY

Introduction

In this section, tables are provided for the following 11 source sectors:

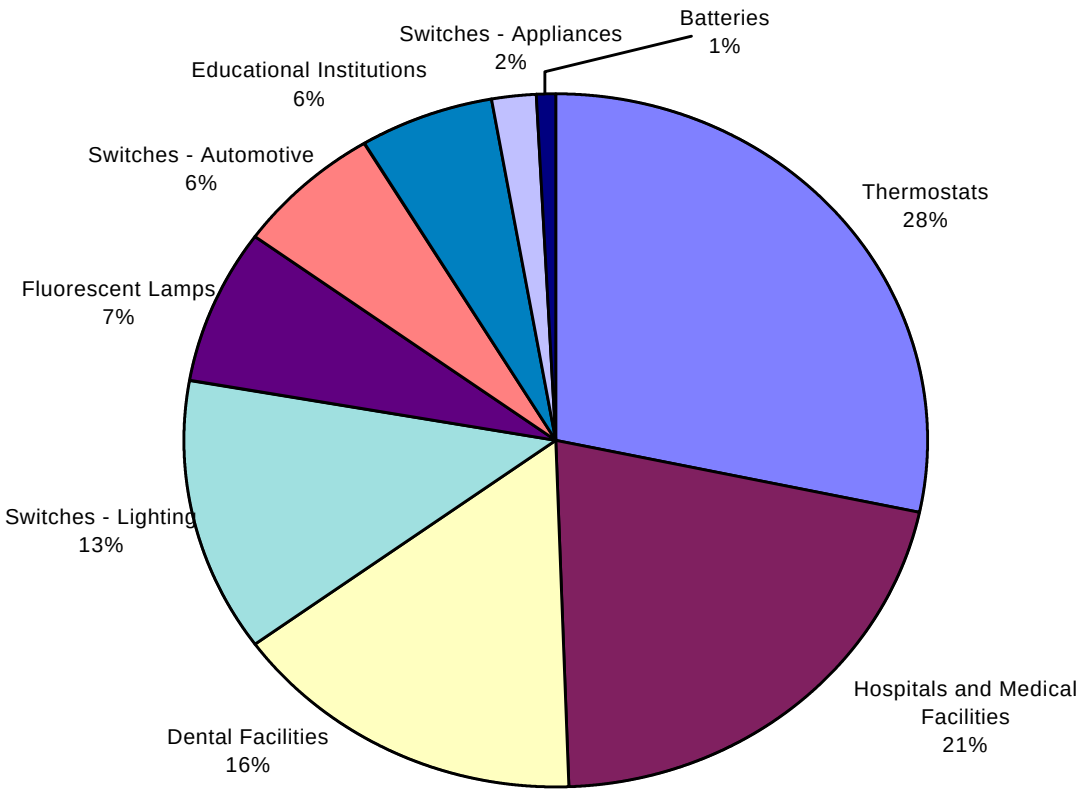
- batteries
- dental facilities
- educational institutions
- fluorescent lamps
- hospitals and medical facilities
- laboratories
- switches--appliances
- switches--automotive
- switches--lighting
- thermostats
- veterinary facilities

The results from these source sectors are summarized in Table 3 and Figure 4.

Table 3 : Presence/Use of Mercury

Sector	Amount (pounds)	Percent of Total
Thermostats	2095	28%
Hospitals and Medical Facilities	1560	21%
Dental Facilities	1167	16%
Switches - Lighting	953	13%
Fluorescent Lamps	534	7%
Switches - Automotive	470	6%
Educational Institutions	417	6%
Switches - Appliances	163	2%
Batteries	53	1%
Laboratories	3	<1%
Veterinary Facilities	2	<1%
Total Presence/Use	7417	100%

Figure 4 Presence/Use of Mercury



BATTERIES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
174	flasks of mercury used by battery industry nationally	Declining Presence of Mercury in Batteries (16)	High
76	pounds of mercury per flask	Declining Presence of Mercury in Batteries (16)	High
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

174 flasks of mercury used by the battery industry x 76 pounds of mercury per flask x 0.00404 MMSD service area fraction of national population = 53 pounds.

Notes

1. It is assumed that all types of batteries are included in this result since the 174 flasks are for the entire U.S. battery industry.
2. This estimate is for 1995. The consumption of the 174 flasks was in 1994 and there is an assumed lag time of 1 year between manufacture and use.
3. This result does not include imported batteries. The percentage of imported batteries used in this country and the amount of mercury in the imported batteries could not be determined.
4. The estimate for presence/use for batteries is the same as that for releases because the average lifetime for batteries is assumed to be one year.

RESULTS

- ***Best Estimate***
  53 lb
- ***High End Estimate***
  N. A.

DENTAL FACILITIES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
3.4	pounds of bulk mercury per dentist	Michigan Mercury Collection (3)	Medium
765	dentists in Milwaukee County	Wisconsin Dental Association	High
280	dentists in Waukesha County	Wisconsin Dental Association	High
0.35	fraction of Waukesha County population in MMSD service area	MMSD and Waukesha County Internet site	Medium
0.4	fraction of dentists that have bulk mercury	See Note 4	Low

Calculation

760 dentists in Milwaukee County + 35% of Waukesha County population in the MMSD service area x 280 dentists in Waukesha County = 858 dentists. 3.4 pounds of mercury average per dentist x 858 dentists x 40% of dentists that have bulk mercury = 1167 pounds of bulk mercury.

Notes

1. The Wisconsin Dental Association indicates that no dentists are currently using bulk mercury - all are using the pre-encapsulated mixes, however, many have bulk mercury in storage.
2. The focus of this calculation is the amount of bulk mercury in storage in dental offices. This calculation does not include the amount of mercury in pre-encapsulated amalgam mixes.
3. 1350 pounds of bulk mercury was collected from 400 dentists in the Michigan collection program. This is an average of 3.4 pounds per dentist. Staff of the Western Lake Superior Sanitary District (WLSSD) said that in the dental offices that they have worked with, they have seen a range from less than 1 pound to 11 pounds of mercury in an office and that an average of 3.4 pounds seemed reasonable
4. The number of dental facilities that have mercury (assumed 40% in this calculation) was determined based on discussions with Jim Cornwell of Mercury Waste Solutions, Dr. Michael Costello of the Greater Milwaukee Dental Association, and Tim Tuominen (WLSSD). Jim Cornwell thought that 3.4 pounds of mercury per dentist was high. He thought an overall average of 2 pounds per dentist was better. Dr. Costello noted that he had some mercury at his office that was probably a couple of pounds. Tim Tuominen said that 40% of offices with bulk mercury and 60% of offices with no mercury seemed to be a reasonable estimate.
5. The High End Estimate was derived by assuming that 60% of dental facilities have 3.4 pounds of mercury and 40% have no mercury.

RESULTS

- ***Best Estimate***
  1167 lb
- ***High End Estimate***
  1750 lb

EDUCATIONAL INSTITUTIONS

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
339	elementary, middle and high schools	search by SIC of telephone directory on disc (17)	High
5	Colleges and Universities	search by SIC of telephone directory on disc (17)	High
27	other schools	search by SIC of telephone directory on disc (17)	High
0.45	fraction of schools that have mercury	Mercury Waste Solutions, Inc.	Low
2.5	pounds of mercury per school	Mercury Waste Solutions, Inc.	Low

Calculation

339 elementary, middle and high schools + 5 colleges and universities + 27 other schools = 371 educational institutions. 371 educational institutions in the MMSD service area x 45% that will have mercury x 2.5 pounds of bulk mercury per school = 417 pounds.

Alternate Calculation

5 Colleges and Universities x 100 pounds + 366 elementary, middle and high schools x 45% that will have bulk mercury x 2.5 pounds of bulk mercury per school = 912 pounds

Notes

1. This estimate is based on two factors (45% of schools that have mercury and 2.5 pounds of mercury per school) that are based on past experience with a limited number of schools (Mercury Waste Solutions).
2. This estimate is based on bulk mercury only. There may be numerous devices in schools that contain mercury, but there is no basis for estimating either the number of these devices or the amount of mercury in the devices. Thus, it is recognized that there is probably a significant amount of additional mercury in schools, but no method to estimate that amount.
3. This estimate does not include common mercury containing devices such as fluorescent lamps, electrical switches, thermostats, etc., that may be contained in other sectors of this assessment.
4. The alternate calculation is based on information from the director of the University of Wisconsin - Milwaukee's Department of Environmental Health, Safety and Risk Management, in combination with the information for schools from Mercury Waste Solutions.
5. The high end estimate is based on the alternate calculation.

RESULTS

- ***Best Estimate***
  417 lb
- ***High End Estimate***
  912 lb

FLUORESCENT LAMPS

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
0.025	grams of mercury per lamp	Mercury Sourcebook (23)	Medium
600000000	lamps manufactured per year	Mercury Containing Lamp Management Report (12)	Medium
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High
4	year average lifespan	EPA Solid Waste Report (6)	Medium

Calculation

0.025 grams of mercury per lamp x 600,000,000 lamps manufactured per year x 0.00404 MMSD service area percent of national population x 4 year average lifespan / 454 grams per pound = 534 pounds.

Notes

1. The value of 0.025 grams of mercury per lamp is based on bulbs currently in use having between 0.010 and 0.055 grams of mercury.

RESULTS

- ***Best Estimate***
  534 lb
- ***High End Estimate***
  N. A.

HOSPITALS AND MEDICAL FACILITIES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
0.25	pounds of mercury per hospital bed	see note 1	Medium
5460	hospital beds in the MMSD service area	Milwaukee Business Journal Book of Top 25 Lists (10)	Medium
3	large clinic groups	see note 2	Medium
32	pounds of mercury per clinic group	see note 3	Low
1.1	factor to account for other hospitals		Low

Calculation

0.25 pounds of mercury per hospital bed x 5324 hospital beds in the MMSD service area x 1.1 to account for other hospital beds + 3 large clinic groups in the MMSD service area x 32 pounds of mercury per clinic group = 1560 pounds.

Notes

1. The 0.25 pounds of mercury per bed factor was determined using data from a survey of two area hospitals (Froedtert Memorial and Childrens Hospital) by the Milwaukee County Department of Public Works (Mercury Contamination Investigation (2)). Froedtert was listed as having 530 glass thermometers, 405 blood pressure cuffs, and 16 manometers and sphygmomanometers. Childrens Hospital was listed as having 47 glass thermometers, 51 dilators, and 45 manometers. Thermometers have about 10 grams of mercury, blood pressure cuffs were assumed to have 50 grams, manometers and sphygmomanometers were assumed to have 330 grams and dilators were assumed to have 1000 grams. Totaling this up yields 102 kilograms of mercury. Dividing this by a total of 912 beds between the two hospitals results in approximately 0.25 pounds of mercury per bed. There are other sources of mercury listed in the Department of Public Works survey that are not quantifiable at this time.
2. A discussion with a representative from the Medical Managers Group Association yielded the three largest clinic groups in our area - the Medical College of Wisconsin, the Aurora Health Group and the Milwaukee Medical Clinic. 32 pounds of mercury per clinic group was calculated from information in the Department of Public Works survey (2). The Medical College of Wisconsin participated in the survey and listed 437 glass thermometers and 10 manometers and sphygmomanometers. Using the same amounts of mercury as in note 1 results in 32 pounds of mercury. This was assumed to be representative of a large clinic group.
3. A search of a telephone directory on disc (17) revealed 21 hospitals, 23 clinics, 10 nursing homes and 29 medical doctors offices in the MMSD service area. Nursing homes and doctors offices will most likely have some mercury in them, however, at this time, there is no basis for estimating mercury in these sources.

RESULTS

- ***Best Estimate***
  1560 lb
- ***High End Estimate***
  N. A.

LABORATORIES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
7	thermometers per testing lab	see note 3	Low
10	grams of mercury per laboratory thermometer	Mercury as a Global Pollutant (18)	Medium
1	mercury standard solution per lab	see note 3	Low
1	gram of mercury per solution	see note 3	Medium
22	testing labs in the MMSD service area	DNR Lab certification program	High

Calculation

(7 thermometers per lab x 10 grams of mercury per thermometer + 1 mercury standard solution x 1 gram of mercury per solution) x 22 labs in the MMSD service area / 454 grams per pound = 3 pounds

Notes

1. This estimate is based on 1997 information.
2. This estimate is based on testing laboratories only since there was no quantifiable data for mercury used in any other type of laboratory.
3. An informal telephone survey of four testing laboratories, two dental laboratories, the Wisconsin Dental Laboratory Association, two medical laboratories, and one non-destructive testing laboratory revealed : 1) a range of 5 to 20 thermometers at testing labs with an average of 7, and 2) 1 mercury solution per testing lab with a strength of 1000 ppm and an average of 1 liter of solution. No other information was obtained which would suggest additional quantifiable amounts of mercury in testing or other laboratories.
4. Because of the differences in sizes and types of laboratories, an average amount of mercury used in a lab can be a misleading number.

RESULTS

- ***Best Estimate***
  3 lb
- ***High End Estimate***
  N. A.

SWITCHES - APPLIANCES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
0.7	washers per household	Discarded Household Appliances Study (4)	Medium
0.05	mercury switches per washer	Appliance Recycling Information Center	Low
2	grams of mercury per washer switch	Mercury Sourcebook (23)	Medium
0.43	freezers per household	Discarded Household Appliances Study (4)	Medium
0.5	fraction of freezers that are chest freezers		Low
1	gram of mercury per freezer switch	Appliance Recycling Information Center	Medium
480000	gas-pilot ranges in use nationwide	Appliance Recycling Information Center	Medium
0.00404	MMSD service area fraction of national population	Appliance Recycling Information Center	High
4	grams of mercury per gas-pilot range switch	Appliance Recycling Information Center	Medium

Calculation

((0.70 washers per household x 5% of washers that have a mercury switch x 2 grams of mercury per washer switch + 0.43 freezers per household x 50% of freezers that are chest freezers x 24% of chest freezers that have a mercury switch x 1 gram of mercury per chest freezer switch) x 382,000 households in the MMSD service area + (480,000 gas-pilot ranges x 0.00404 MMSD service area fraction of national population x 4 grams of mercury per gas-pilot range switch)) / 454 grams per pound = 163 pounds.

Notes

1. This calculation is based on mercury switches in washers, chest freezers and gas-pilot ranges. Upright freezers and refrigerator/freezer combinations are not believed to have mercury switches because there is no tilting action which would activate a mercury switch.
2. Mercury switches have been used in furnaces to switch off gas if the pilot light goes out and in space heaters to shut off the heater if the heater would turn over, however, we have not found any data to estimate these uses.
3. 70% of households have a washer and 42.5% of households have a freezer (Discarded Household Appliances(4)). The fraction of freezers that are chest freezers is assumed to be 50%.
4. The number of gas-pilot (as opposed to electronic start) ranges, 480,000 in use nationally, all of which use a mercury switch, was provided by the Appliance Recycling Information Center.
5. The amount of mercury per freezer switch and per range switch is from information provided by the Appliance Recycling Information Center. The amount of mercury per washer switch is based on information in the Mercury Sourcebook (23).

RESULTS

- ***Best Estimate***
  163 lb
- ***High End Estimate***
  N. A.

SWITCHES - AUTOMOTIVE

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
0.43	average number of switches per automobile	Automobile Shredder Residue Report (13)	Low
2398351	registered automobiles in Wisconsin	Wisconsin Energy Statistics (24)	High
1	gram of mercury per switch	Mercury Sourcebook (23)	Medium
0.207	MMSD service area fraction of state population	MMSD, Wisconsin Energy Statistics (24)	High

Calculation

0.43 switches per auto x 2,398,351 registered autos in Wisconsin x 1 gram per switch x 0.207 MMSD service area fraction of state population / 454 grams per pound = 470 pounds.

Notes

1. Older autos (the ones being crushed at present) will have less mercury in them than the average registered automobile because of the addition of mercury switches for Anti-lock Braking Systems (ABS) and Ride Control (used in the late 1980's and early 1990's).
2. The factor of 1 gram per switch average is greater than that used for the release calculation because the switches for ABS have approximately 3 grams of mercury, and the switches for Ride Control have approximately 2 grams of mercury each, as compared to the hood and trunk light switches which have an average of 0.8 grams of mercury.

RESULTS

- ***Best Estimate***
  470 lb
- ***High End Estimate***
  N. A.

SWITCHES - LIGHTING

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
118	tons of mercury in use in lighting switches nationally	EPA Solid Waste Report (6)	Low
0.00404	MMSD service area fraction of national population	MMSD and Wisconsin Energy Statistics (24)	High

Calculation

118 tons of mercury in use nationally x 0.00404 MMSD service area fraction of national population x 2000 pounds per ton = 953 pounds.

Notes

1.The factor of 118 tons in use nationwide is based on an average annual production rate of 1 million of these switches, containing 3.85 tons of mercury, since 1960. It is assumed that 10% of switches (0.385 tons of mercury) are disposed after 10 years (from 1970 on), 40% of switches (1.54 tons of mercury) are disposed after 30 years (from1990 on) and 50% of switches (1.925 tons of mercury) are disposed after 50 years (from 2010 on) (EPA Solid Waste Report(6)). 118 tons remaining in use is calculated by keeping a running total of mercury used and increasing it by 3.85 tons per year starting from 1960 and then subtracting out 0.385 tons per year disposed of annually from 1970 to 1990 (10% disposed after 10 years) and 1.925 tons per year from 1991 to 1995 (10% disposed after 10 years plus 40%disposed after 30 years) (EPA Solid Waste Report(6)).
2. This estimate is assumed to include residential, commercial, industrial and institutional uses of mercury containing switches, but does not include automotive switches.

RESULTS

- ***Best Estimate***
  953 lb
- ***High End Estimate***
  N. A.

THERMOSTATS

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
0.83	portion of thermostats containing mercury	EPA Solid Waste Report (6)	Medium
382000	households in MMSD service area	MMSD	High
3	grams of mercury per thermostat	Mercury Sourcebook (23)	Medium
1	thermostat per household		Medium

Calculation

83% of thermostats are mercury containing x 382,000 households in the MMSD service area x 3 grams of mercury per thermostat / 454 grams per pound = 2,095 pounds of mercury.

Notes

1. This estimate is based on 1997 information.
2. The factor of 83% of thermostats having mercury is derived from data in the EPA Solid Waste Report (6).
3. The data assumes that in 1985, 5% of thermostats were electronic and that this increases by 1% each year. In 1997 this would be 17% electronic thermostats.
4. The High End Estimate is calculated by using 3.5 grams of mercury per thermostat (this assumes that approximately 1 in 6 thermostats has two switches instead of only one) in place of 3 grams of mercury per thermostat (all thermostats having only one switch). It is known that some thermometers have two mercury switches, however, it is not known how many.
5. This calculation does not include industrial and commercial thermostats, as there is not a basis for calculating how many thermostats would be in a typical facility.

RESULTS

- ***Best Estimate***
  2095 lb
- ***High End Estimate***
  2444 lb

VETERINARY FACILITIES

Presence/Use

Factors

Factor	Units	Reference	Confidence Level
5	thermometers per veterinary facility average	see note 1	Low
5	grams of mercury per thermometer	see note 2	Low
36	veterinary facilities in the MMSD service area	search by SIC of telephone directory on disc (17)	High

Calculation

5 thermometers per veterinary facility x 5 grams of mercury per thermometer x 36 veterinary facilities in the MMSD service area / 454 grams per pound = 2 pounds

Notes

1. The average of 5 thermometers per veterinary facility is based on an informal telephone survey in which 10 veterinary offices in the MMSD service area were called and asked about the number of mercury thermometers in their offices. The average was 4.6 thermometers per vet with a range of 0 to 15. Two of the offices had replaced all of their mercury thermometers with mercury free replacements.
2. 5 grams of mercury per thermometer is an estimate based on the fact that lab thermometers have 10 grams of mercury in them and veterinary thermometers are smaller than laboratory thermometers.

RESULTS

- ***Best Estimate***
  2 lb
- ***High End Estimate***
  N. A.

Chapter 4 - RE-RELEASES OF MERCURY FROM MUNICIPAL WASTEWATER TREATMENT

Introduction

In this section, a release table is provided for the Municipal Wastewater Treatment source sector. This source sector represents “re-release” which includes mercury discharged to the sewer system from industries, hospitals, dental facilities and others. Mercury use and releases from many of these sources are estimated in other source sectors. The municipal wastewater treatment sector was included for comparison purposes, as well as to illustrate the fate of some of the mercury releases in the Greater Milwaukee Area.

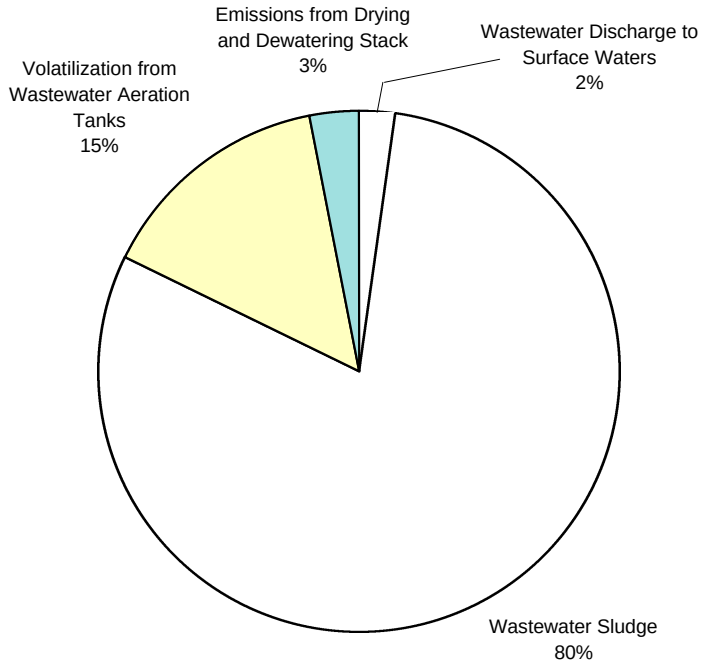
This source sector includes mercury released due to : wastewater discharge, sludge, volatilization from aeration operations and volatilization from the sludge drying and dewatering process.

Detailed calculations for mercury in municipal wastewater treatment are provided in Appendix B. Re-releases are summarized in Table 4 and Figure 5.

Table 4 : Re-Releases of Mercury from Municipal Wastewater Treatment

Sector	Amount (pounds)	Percent of Total
Wastewater Discharge to Surface Waters	5	2%
Wastewater Sludge	179	80%
Volatilization from Wastewater Aeration Tanks	33	15%
Emissions from Drying and Dewatering Stack	7	3%
Total Re-Releases	224	100%

Figure 5 - Re-Rleases of Mercury from Municipal Wastewater Treatment



MUNICIPAL WASTEWATER TREATMENT

Re-Releases

Factors

Factor	Units	Reference	Confidence Level
186	pounds of mercury in wastewater sludges	see Appendix B	Low
0.83	fraction of total influent mercury in sludges	Quantification of Total Mercury Discharges from POTW's (22)	Low
0.02	fraction of total influent mercury in effluent	Quantification of Total Mercury Discharges from POTW's (22)	Low
0.15	fraction of total influent mercury volatilized during aeration operations	Quantification of Total Mercury Discharges from POTW's (22)	Low

Calculation

87 pounds of mercury in Milorganite + 61 pounds of mercury in Agrilife + 28 pounds of mercury in filter press cake + 7 pounds of mercury in MMSD dryer stack gases + 3 pounds of mercury in South Milwaukee sludge = 186 pounds per year. 186 pounds of mercury in the sludge / (83% sludge removal efficiency) = 224 pounds per year. 224 pounds per year x 15% of influent mercury volatilized in aeration operations = 33 pounds per year. 224 pounds per year x 2% of influent mercury discharged in effluent = 5 pounds per year.

Notes

1. These values are based on the amount of mercury from MMSD and South Milwaukee treatment plant sludge (186 pounds). MMSD sludge includes Milorganite, Agrilife and filter press cake.
2. The amount of mercury in the sludge = 87 pounds (Milorganite) + 61 pounds (Agrilife) + 28 pounds (filter press cake) + 3 pounds (South Milwaukee sludge) = 179 pounds. Individual calculations for each of these sludges are provided in Appendix B.
3. The sludge removal efficiency of 83% and the 2% of total influent mercury discharged in the effluent are estimates based on the information in Quantification of Total Mercury Discharges from Municipal Wastewater Treatment Plants to Wisconsin Surface Waters (22). The remainder (15%) of the mercury is assumed to volatilize during aeration operations.
4. The total amount of mercury emissions to air (49 pounds) equals the mercury volatilized during aeration operations (42 pounds) plus the mercury volatilized during drying and dewatering which is emitted through the dryer stack (7 pounds).
5. Very low amounts of mercury, such as are in the effluent of a wastewater treatment plant, require a very low detection level to achieve sufficient accuracy in calculating total mercury releases. In the future, when low detection levels can be achieved, this sector may be estimated through direct means instead of the method used above.
6. The 1995 Wisconsin Estimated Mercury Air Emissions inventory estimates 292 pounds of mercury released to the air from wastewater sludge incineration and land spreading (19). Minnesota estimates 334 pounds of mercury released from sewage sludge incineration in 1995 (14). Michigan estimates 65 pounds of mercury released from sewage incineration in 1994 (9).

RESULTS

- ***Best Estimate***
  224 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  40 lb per yr
- ***Solid Waste***
  179 lb per yr
- ***Wastewater***
  5 lb per yr

Chapter 5 - HOUSEHOLD MERCURY

Introduction

The household sector was included in this study to illustrate how the average residential household contributes to the use and release of mercury to the environment. The household sector includes thermostats, switches, gasoline combustion and others which were also evaluated in other source sector estimates. The idea is to provide a sense of how our daily activities, as well as devices and products in our homes, contribute to the overall picture of mercury release and use.

Tables are provided for both releases and presence/use of mercury in households.

The following types of releases from households are included in the estimate of mercury releases from households:

- batteries
- coal combustion to produce electricity
- fluorescent lamps
- gasoline combustion in motor vehicles
- heating oil combustion
- appliance switches
- automotive switches
- thermostats
- volatilization from dental amalgams
- wastewater discharged to sewers

Mercury releases from households are summarized in Table 5 and Figure 6.

The following occurrences or uses of mercury are included in the estimate of presence/use of mercury in households:

- automobile switches
- batteries
- chest freezers
- dental amalgams
- fluorescent lamps
- gas-pilot ranges
- light switches
- thermometers
- thermostats
- washing machines

Mercury presence/use in households is summarized in Table 6 and Figure 7.

Table 5 : Annual Mercury Releases from Households

Sector	Amount (lb per yr)	Percent of total
Electricity Consumption	122	32%
Thermostats	70	18%
Switches - Automotive	45	12%
Wastewater Discharges	40	10%
Oil Combustion	33	9%
Gasoline Combustion	30	8%
Batteries	28	7%
Fluorescent Lamps	7	2%
Dental Amalgams	4	1%
Switches - Appliances	4	1%
Total Household Releases	383	100%

Figure 6 - Annual Mercury Releases from Households

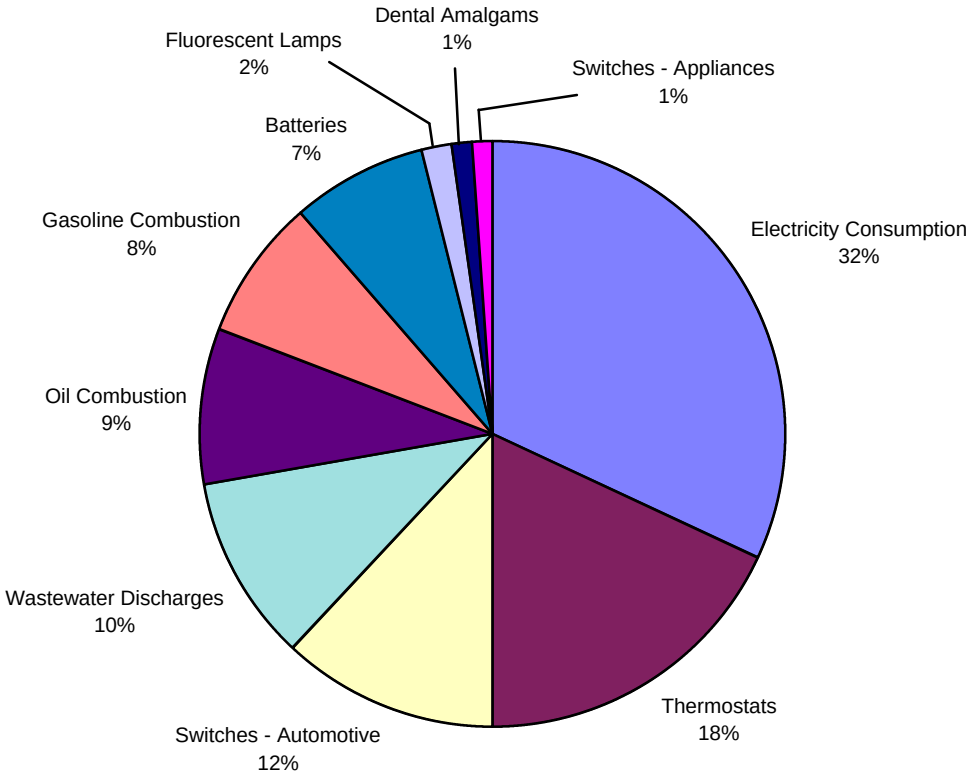
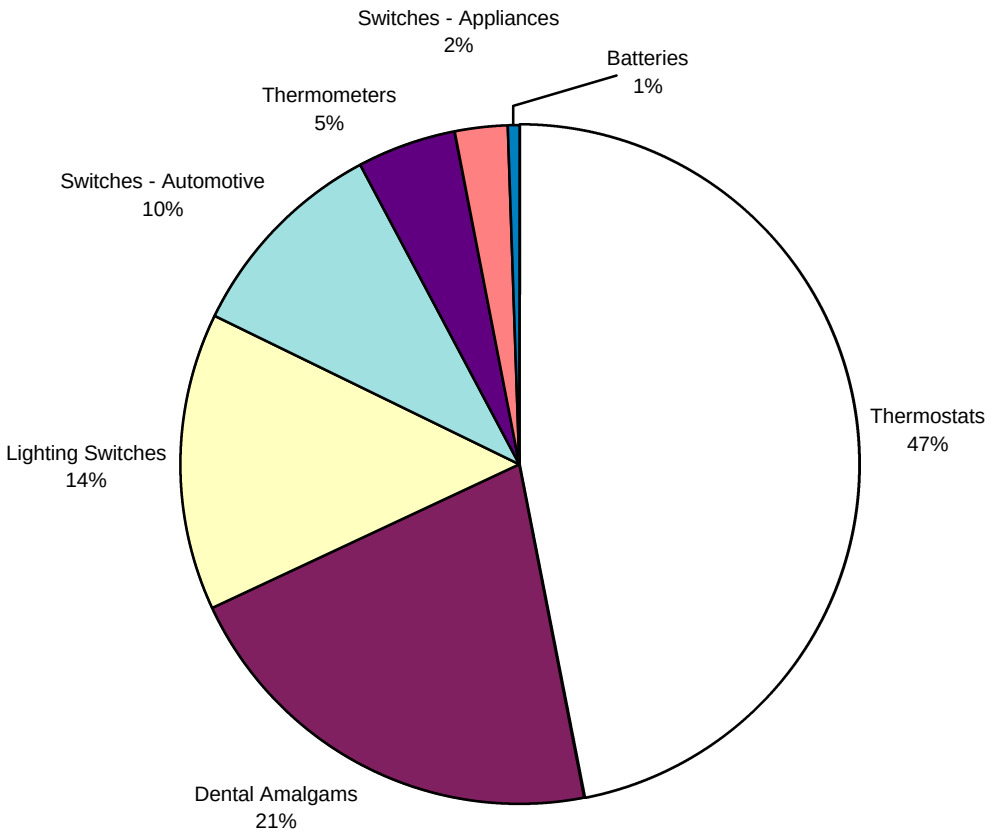


Table 6 : Presence/Use of Mercury in Households

Sector	Amount (pounds)	Percent of total
Thermostats	2095	47%
Dental Amalgams	942	21%
Lighting Switches	631	14%
Switches - Automotive	446	10%
Thermometers	210	5%
Switches - Appliances	109	2%
Batteries	28	1%
Fluorescent Lamps	21	<1%
Total Presence/Use	4483	100%

Figure 7 - Presence/Use of Mercury in Households



Factors

170	pounds of mercury released statewide from oil combustion
1950000	households in the state of Wisconsin
1.23	automobiles per household
13,000	miles driven per year per automobile
4.9E-09	pounds of mercury released per vehicle mile traveled
0.18	micrograms of mercury per liter of household wastewater
258	liters of wastewater per person per day
2.79	persons per household
4.54E+09	micrograms per pound
70	pounds of mercury released from thermostat disposal per year
382000	households in the MMSD service area
0.35	appliances discarded per household per year
0.01	mercury switches per appliance discarded
1.4	grams of mercury per appliance switch
3.69E-08	pounds of mercury released per kWh of electricity consumed
8,650	kWh of electricity consumed per household per year
5	micrograms of mercury released per person per day from the amalgams in their mouth
142	pounds of mercury released statewide from batteries per year
1	fluorescent lamp per household
0.035	grams of mercury per lamp
0.43	switches per automobile
0.8	grams of mercury per automobile switch
8	year average life for an automobile

Calculation

170 pounds of mercury released statewide from oil combustion / 1,950,000 households in Wisconsin = 0.000087
+ 1.23 automobiles per household x 13,000 miles driven per year per automobile x 4.9E-09 pounds of mercury released per vehicle mile traveled = 0.000078
+ 0.18 micrograms of mercury per liter of household wastewater x 258 liters of wastewater per person per day x 2.79 persons per household x 365 days per year / 454,000,000 micrograms per pound = 0.000104
+ 70 pounds of mercury released per year in the MMSD service area from disposal of thermostats / 382,000 households in the MMSD service area = 0.000183
+ 0.35 appliances discarded per household per year x 0.01 mercury switches per appliance x 1.4 grams of mercury per appliance switch / 454 grams per pound = 0.000011
+ 3.69E-08 pounds of mercury released per kilowatt hour of electricity consumed x 8,650 kilowatt hours of electricity consumed per household per year = 0.000319
+ 5 micrograms of mercury released per person per day from the amalgams in their mouth x 2.79 persons per household x 365 days per year / 454,000,000 micrograms per pound = 0.000011
+ 142 pounds of mercury released statewide from household batteries per year / 1,950,000 households in Wisconsin = 0.000073
+ 1 fluorescent lamp per household x 0.035 grams of mercury per lamp / 454 grams per pound = 0.000077
+ 1.23 automobiles per household x 0.43 mercury switches per automobile x 0.8 grams of mercury per automobile switch / 8 years average life per automobile / 454 grams per pound = 0.000116

= 0.001 pounds of mercury released per household per year.

382,000 households in the MMSD service area x 0.001 pounds of mercury released per household = 383 pounds of mercury released per year.

HOUSEHOLDS (continued)

Releases

Notes

1. The total of 383 pounds release from households per year cannot be added to the results from other source sectors to get a total for releases. All of the components have also been accounted for in other source sector estimates.
2. The factors of 1,950,000 households in Wisconsin, 1.23 automobiles per household, 13,000 miles driven per automobile per year, and 8,650 kWh of electricity per household per year are from Wisconsin Energy Statistics 1996 (4). The factor of 3.69E-08 pounds of mercury per kWh was calculated by dividing the total amount of mercury released due to electricity production statewide by the amount of electricity consumed statewide by end users for the year. The amount of electricity consumed statewide by end users was also from Wisconsin Energy Statistics 1996 (4).
3. The factor of 170 pounds of mercury released statewide from oil combustion and the total amount of mercury released statewide due to electricity production are from Mercury in Wisconsin's Environment (7).
4. The factor of 4.9E-09 pounds of mercury per vehicle mile traveled was obtained from DNR staff, who obtained it from EPA report (7).
5. The factor 5 micrograms of mercury released per day per person from dental amalgams was based on several Internet site discussing the fate of mercury in dental amalgams.
6. The factors of 382,000 households and 2.79 persons per household are from MMSD.
7. The order of contribution from largest to smallest of the various identified releases along with the medium to which they are allocated are : (1) electricity consumption - air, (2) thermostats - solid waste, (3) switches - automobiles - solid waste, (4) wastewater - wastewater, (5) oil combustion - air, (6) gasoline combustion - air, (7) batteries - solid waste, (8) fluorescent lamps - solid waste, (9) switches - appliances - solid waste, (10) dental amalgams - air.

RESULTS

- ***Best Estimate***
  383 lb per yr
- ***High End Estimate***
  N. A.

AMOUNTS TO INDIVIDUAL MEDIA

- ***Air***
  189 lb per yr
- ***Solid Waste***
  154 lb per yr
- ***Wastewater***
  40 lb per yr

HOUSEHOLDS *Presence/Use*

Factors

0.5	thermometers per household
0.5	grams of mercury per thermometer
0.25	mercury light switches per household
3	grams of mercury per light switch
142	pounds of mercury used statewide in household batteries
1.23	automobiles per household
0.43	mercury switches per automobile
1	grams of mercury per automobile switch
2	fillings per person
0.2	grams of mercury per small filling
2.79	persons per household
1	fluorescent lamps per household
0.025	grams of mercury per fluorescent lamp
0.70	washers per household
0.05	mercury switches per washer
2	grams of mercury per washer switch
0.83	thermostats per household
3	grams of mercury per thermostat
480000	gas-pilot ranges nationwide
0.404%	MMSD service area percent of national population
4	grams of mercury per gas-pilot range switch
0.21	freezers per household
0.24	mercury switches per chest freezer
1	grams of mercury per freezer switch
382000	households in the MMSD service area
1950000	households in the state of Wisconsin

Calculations

(0.5 thermometers per household x 0.5 grams of mercury per thermometer) = 0.25
+ 0.25 mercury light switches per household x 3 grams of mercury per light switch = 0.75
+ 142 pounds of mercury in batteries in use statewide x 454 grams per pound / 1,950,000 households in the state of Wisconsin = 0.033
+ 1.23 automobiles per household x 0.43 mercury switches per automobile x 1gram of mercury per switch = .53
+ 2 fillings per person x 2.79 persons per household x 0.2 grams of mercury per filling = 1.12
+ 1 fluorescent lamp per household x 0.025 grams of mercury per fluorescent lamp = 0.025
+ 0.7 washers per household x 0.05 mercury switches per washer x 2 grams of mercury per washer switch = 0.07
+ 0.21 chest freezers per household x 0.24 mercury switches per chest freezer x 1gram of mercury per freezer switch = 0.05
+ 0.83 mercury thermostats per household x 3 grams of mercury per thermostat = 2.49
+ 480,000 gas-pilot ranges nationwide x 0.404% MMSD service area percent of national population / 382,000 households in the MMSD service area x 4 grams of mercury per gas-pilot range switch = 0.02
= total of 5.3 grams of mercury per household. 382,000 households in the MMSD service area x 5.3 grams of mercury per household / 454 grams per pound = 4483 pounds.

Notes

1. This result can not be added to the other results for a total or compared directly to the others in the Presence/Use category. Most of this result is already counted for in other sectors.
2. Some of these factors are estimates based on the amounts of mercury calculated in other sectors and not necessarily on direct measurements.
3. This result represents a typical household averaged for the entire state of Wisconsin. Where significant portions of an area are either rural or urban (such as is the case for the MMSD service area), the amounts of mercury in a typical residence may by significantly different than what is calculated here.
4. The order of contribution from largest to smallest of the various identified Presence/Uses are : (1) thermostats, (2) amalgams, (3) light switches, (4) auto switches, (5) thermometers, (6) freezer switches, (7) washer switches, (8) fluorescent lamps, (9) batteries, (10) gas-pilot ranges.
5. There are other known sources of mercury that were unable to be quantified at this time. Some are mercury switches in furnaces, mercury in shoes, and mercury in games.

RESULTS

- ***Best Estimate***
  4483 lb
- ***High End Estimate***
  N. A.

APPENDICES

APPENDIX A-1

1995 Wisconsin Estimated Mercury Air Emissions

Estimated Mercury Air Emissions				
Wisconsin - 1995				
		Mercury Emissions (lbs/yr)		% of State Total
Originating from ENERGY PRODUCTION				
Coal - Utility		2,135		34.1%
Industrial/Commercial		417		6.7%
Oil - Industrial/Commercial		171		2.7%
Residential		146		2.3%
Refuse Derived Fuel - Utility		260		4.2%
Gasoline & Diesel - Mobil Sources		231		3.7%
Wood		26		0.4%
	Subtotal	3,386		54.1%
Originating from PURPOSEFUL MERCURY USE				
Medical Waste Incineration		602		9.6%
Municipal Waste Incineration		177		2.8%
Wastewater Sludge Incineration & Land Spreading		292		4.7%
Electric Lamp & Mercury Switch Breakage		365		5.8%
Laboratory & Dental Use		70		1.1%
Hg-containing Apparatus Manufacturing		37		0.6%
Secondary Metal Smelting		69		1.1%
Cremation		19		0.3%
Battery Production		2		0.0%
	Subtotal	1,633		26.1%

APPENDIX A-1 (continued)

Originating from INCIDENTAL RELEASE				
Chlor-alkali Production		1,114		17.8%
Lime Production		128		2.0%
	Subtotal	1,242		19.8%
	Total	6,261		100.0%

Notes: Only anthropogenic categories which are quantifiable have been included.

Mercury emissions from landfill volatilization have not been quantified.

Mercury is no longer used in paints, turf products or pigment in the U.S.

Significant digits of inventory values are not indicative of the accuracy of the estimates.

Refuse derived fuel was previously not included in the inventory.

APPENDIX A-2

Mercury Emissions Inventory for Minnesota

Mercury Emissions Inventory FOR MINNESOTA
Interim update 3/24/97
Prepared by Edward Swain, MPCA

	notes	confidence	1990 pounds mercury	l995 pounds mercury
Associated with Energy Production				
coal	1994 data for 1995	medium	2,007	2,045
wood	1995 not updated	low	615	615
natural gas	1994 data for 1995	low	562	628
oil	1994 data for 1995	medium	514	659
petroleum refining	estimated for 1995	medium	87	30
Subtotal associated with energy			3,785	3,977
Percent of total .			36%	68%
Largely Resulting from the Purposeful Use of Mercury				
Latex Paint Volatilization		low	3,000	0
Municipal Solid Waste Combustion	high	1,497	476	
Landfill volatilization	1995 not updated	low	881	881
Medical Waste Combustion		high	516	36
Sewage sludge Incineration		high	365	334
Fluorescent Lamp Breakage		medium	330	83
Fungicide Volatilization		low	86	0
Cremation		high	49	71
Hazardous Waste incineration		medium	5	5
Subtotal associated with purposeful use of mercury			6,729	1,885
Percent of total			64%	32%
		TOTAL =	10,514	5,863
	Percent Reduction 1990 to 1995:		44%	

Data needed on Emissions Incidental to other Activities:

Concrete Production
Taconite Processing
Asphalt Production
Soil Roasting
Volatilization from soil
Volatilization from surface water
Use of biomass: forest products (paper), fish

APPENDIX A-3

1994 Estimate of Anthropogenic Mercury Air Emissions in Michigan

Emission Source (number of sources within Michigan)	Mercury Emissions (lbs/year)	% of State Total
FUEL COMBUSTION		
Coal combustion		
Electric Utilities	2,210-4,240	41%
Residential	NA	NA
Industrial/Commercial	680	6.50%
Oil Combustion		
Electric Utilities	10	<1%
Residential	175	1.70%
Industrial/Commercial	20	<1%
Wood Combustion		
Electric Utilities	10	<1%
Residential	10'	<1%
Industrial/Commercial	10	<1%
Natural Gas Combustion	NA	NA
Petroleum Refining	NA	NA
TOTAL FOR FUEL COMBUSTION	3,125-5,155	
INCINERATION		
Sewage (18)	65	<1%
Hospital Waste (148)	980	9.40%
Municipal Waste (5)	2,915	28%
Hazardous Waste Incineration (3)	280	2 7%
TOTAL FOR INCINERATION	4,240	I
INDUSTRIAL SOURCES		
Lime Manufacturing (6)	170	1.60%
Cement Manufacturing (4)	465	4.50%
Light bulb Recyclers (1)	0-15	<1%
Coke Producers (1)	NA	NA
Copper Smelting (1)	0	0%
TOTAL FOR INDUSTRIAL SOURCES	650	
AREA SOURCES		
Cremation (41)	40	<1%
Lamp Manufacturing/Breakage	330	3 2%
TOTAL FOR AREA SOURCES	370	
TOTAL MERCURY AIR EMISSIONS	8,385-10,415	100%

APPENDIX A-4

1995 Estimate of Mercury in the Municipal Solid Waste Stream

1995 ESTIMATE of MERCURY in the MUNICIPAL\COMMERCIAL SOLID \WASTE STREAM	
Batteries	495
Lamp Manufacturing/Breakage	2,200
Paint Residues/Pigments	0
Dental Amalgam Preparation	60
Laboratory Use	60
Thermostats	605
Light Switches	140
Electrical Switches (Automotive)	190-240
Total for Municipal Solid Waste Stream	**3,750-3,800**

APPENDIX B

Detailed Calculations for Municipal Wastewater Treatment Source Sector

Mercury Emissions for Jones Island Dewatering and Drying Facility Wet ESP System Exhaust Stack S11.

Data

Date of Test	April 13, 1995
Volume Flow rate	32,456,454 standard cubic feet per hour on a dry basis
Mercury Concentration	0.0256×10^{-9} pounds per dry standard cubic foot

Calculation

32,456,454 standard cubic feet per hour on a dry basis x 24 hours per day x 365 days per year x 0.0256×10^{-9} pounds per dry standard cubic foot = 7 pounds per year.

Mercury Quantities in Milorganite

Data

Mercury concentration in Milorganite
1995 - 0.97 milligrams per kilogram (average for the year)

Amount of Milorganite shipped out per year
1995 - 47,151 tons

Calculation

47,151 tons per year x 0.95 to obtain dry weight of Milorganite x 909 kg per ton x 0.97 milligrams of mercury per kilogram of Milorganite / 454,000 milligrams per pound = 87 pounds per year.

APPPENDIX B (continued)

Mercury Quantities in Agrilife

Data

Average Mercury concentration in Agrilife
1995 - 4.2 milligrams per kilogram

Amount of Agrilife shipped out in 1995
1995 - 7,285 tons on a dry weight basis

Calculation

7,285 tons x 909 kilograms per ton x 4.2 milligrams of mercury per kilogram of Agrilife / 454,000 milligrams per pound = 61 pounds per year.

Mercury Quantities in filter press cake

Data

Average Mercury concentration in dried cake
1995 - 3.2 mg/kg

Amount of dried cake produced in 1995
1995 - 4,325 tons on a dry weight basis

Calculation

4,325 tons x 909 kilograms per ton x 3.2 milligrams of mercury per kilogram of dried cake / 454,000 milligrams per pounds = 28 pounds per year.

APPENDIX B (continued)

Mercury Quantities from South Milwaukee sludge

Data

Mercury Concentration

2.1 milligrams of mercury per kilogram of dry solids (this is a single 1997 value).

Amount of Sludge Produced

250,000 gallons per month (1995 data)

Calculation

250,000 gallons of sludge per month x 12 months per year x 6 pounds of dry solids per 100 pounds of sludge x 1 cubic meter per 264.2 gallons x 1000 kg per 1 cubic meter of sludge x 2.1 milligrams of mercury per kilogram of dry solids / 454,000 milligrams per pound = 3 pounds of mercury per year.

APPENDIX C

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APPENDIX D-1

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APPENDIX D-2

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APPENDIX E

Recommendations for improving the Source Sector Assessment

Information required to refine and improve the confidence of the estimates for source sectors in this assessment.

Batteries - Detailed study of battery use, disposal and recycling possibilities in Wisconsin or in the Greater Milwaukee Area, including household, medical, military and industrial uses of batteries that contain mercury. Information on the importing of batteries, including the types, quantities and amounts of mercury contained in each type.

Coal Combustion--Industry - Further confirmation that there are no industries in the Greater Milwaukee Area that are burning coal.

Coal Combustion--Utilities - Evaluation of the pollution control equipment in place at the three WEPCO power plants including amounts of mercury removed in each type of equipment and the fate of the mercury that is captured by the pollution control equipment.

Crematories - Studies performed in the United States that measure the mercury being released during cremation, or information as to the average number and sizes of amalgams in the population and the fraction of mercury that is volatilized during cremation.

Dental Facilities - A compendium of all studies of mercury waste from dental facilities including the amounts generated and their fates. Survey of local dental facilities as to the amounts of bulk mercury being held.

Educational Institutions - Survey of area educational facilities about their uses of mercury for education, demonstration, laboratory, or other purposes.

Fluorescent Lamps - Additional information on current trends in fluorescent lamps including: 1) amounts of mercury in different types of lamps, 2) production quantities of different types of lamps, 3) fate of mercury in lamps that are not recycled and 4) uses of fluorescent lamps in the home.

General Industry - Feedstock chemical quantities used in the Greater Milwaukee Area and the concentration of mercury in these chemicals. Uses of mercury containing devices such as switches, lamps, manometers, batteries, etc. Mercury wastewater monitoring data utilizing analytical teechniques with the best possible detection levels.

Hospitals and Medical Facilities - Quantities of mercury in various devices (including thermometers, sphygmomanometers, barometers, batteries, etc.) and solutions, along with surveys of the uses of these devices and solutions. Wastewater monitoring data with low detection levels and high sampling rates to allow for accurate calculation of mercury discharge quantities. Information about waste disposal practices in hospital facilities. A survey of local clinics, nursing homes, and doctors offices for use of mercury containing devices.

Households - This sector can be refined as information is obtained about other sectors which relate to household uses of mercury.

Incinerators - Larger number of stack gas tests to determine a more accurate emission factor.

Information on the use of pollution control equipment and the fate of any mercury that is captured by the pollution control equipment.

Laboratories - A survey of area laboratories for use of mercury containing devices and solutions. Monitoring data to identify releases of mercury to the wastewater stream.

Landfills - Studies on landfill gas which identify mercury quantities in relation to the age and type of the landfill.

Municipal Wastewater Treatment - Monitoring data with low detection levels that would allow for direct estimation of the mercury being discharged in the effluent.

Motor Vehicle Combustion - Further studies to identify the quantity of mercury in fuels and the fate of that mercury.

Oil Combustion--Industry - More data on the concentration of mercury in fuel oil and the quantities of oil burned in the Greater Milwaukee Area.

Oil Combustion--Residential - Same as Oil Combustion--Industrial.

Secondary Metal Smelting - Information which identifies the sources of mercury in secondary metal smelting. Monitoring data to help quantify the mercury removed in scrubbing operations at their facilities.

Septage - Data on septage accepted by the South Milwaukee sewage treatment plant, including mercury concentrations and volumes.

Switches--Appliances - Information which specifically identifies the types and amounts of mercury switches in various appliances, disposal methods for the various appliances, and the fate of the mercury in the switches.

Switches--Automotive - Additional information on 1) the types of switches in automobiles by make, model and year and 2) the fate of mercury released from shredding of automobiles which contain mercury switches.

Switches--Lighting - Additional information on the types of switches that contain mercury and the quantity of mercury in these switches. Use and disposal rates of mercury containing switches.

Thermostats - Information on the types and numbers of thermostats in homes and industries in the Greater Milwaukee Area.

Veterinary Facilities - A survey of local veterinary facilities for information about the use and disposal of mercury containing devices and medicines.

Source sectors which were not quantified in this report (due to lack of information) which could be investigated in the future.

Lawn Care Facilities - Nurseries, golf courses and other places which may have stocks of old pesticides which contain mercury.

Floor Coverings - Polymers in floor coverings which contain mercury.

Trickling Filters - Old wastewater trickling filter plants which may have contained mercury in the center columns of trickling filters.

Electrical Apparatus Manufacturers - Mercury may still be used in the manufacture of some switches and other electrical devices.

Neon Lamps - Mercury is used in the manufacture of neon lamps.

Ceremonial Uses of Mercury - Some ethnic communities in the area use mercury for ceremonial purposes and mercury is known to be sold at shops called "botanicas."

Wood Combustion - Wood has minute amounts of mercury that are released when it is combusted, similar to coal and oil combustion.

Miscellaneous Burning - Mercury may be present in various items that are burned as a means of waste disposal in areas that allow open burning, or do not enforce open burning rules.

Piping Systems - The piping systems of any building that at some time housed an industry, hospital or institution that used mercury. The traps, low spots, and other parts of the system can potentially contain significant amounts of mercury.

Paint Outgassing - Mercury that was used as fungicides in old paints may be slowly released from the paint on the inside and outside walls of older buildings and houses.

Other Appliances - Mercury was also used in switches in other appliances besides those evaluated in this assessment (e.g. furnaces and space heaters).