MERCURY IN HOSPITAL CLEANING PRODUCTS

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EXECUTIVE SUMMARY

To enable wastewater treatment plant discharges to meet strict regulatory standards some agencies are beginning to regulate selected mercury-containing products at their sources. Hospitals, which on average contribute approximately 8 percent of the total influent mercury to wastewater treatment plants, could have great potential for achieving measurable reductions of mercury in wastewaters. Current Federal and State activities for minimizing the mercury content of wastewater include US Bill S351 to phase out mercury thermometers; the American Hospital Association pledge to establish "virtual elimination of mercury-containing waste from the health care industry waste stream by the year 2005"; and documentation required by the State of Maine showing the mercury content of all products offered for sale or use in a hospital, unless the concentration in the product is less than 200 parts per trillion.

A mass balance approach was used to estimate the relative contribution of mercury in cleaning products to the total mercury load from hospitals. The mercury concentration in hospital wastewater is in the range 4 to 4.6 micrograms per liter (µg/L) and may include waste from broken equipment (where approximately 20 percent of the spilled mercury is reportedly discharged to wastewater), laboratory chemicals (e.g., Zenker's Fluid, reported to contain mercury at 37.5 grams per liter), medicinal wastes (e.g., preservatives such as Thimerasol), amalgam from dental clinics (mercury load contribution of 138 g/dental office/day), human waste-amalgam (up to 67 µg/person/day), dietary waste (1.4 µg/person/day), cleaning products (0.108 to 0.258 µg/patient/day), dirt and dye from laundry processing and mercury settled in wastewater sumps and traps.

The total mass of laundry detergent, bleach, dishwashing detergent, shampoo, soap and drain cleaner contributes between 64.90 µg and 154.75 µg of mercury to the average hospital effluent per day. This is equivalent to 0.0032 - 0.0077 percent of the average total hospital wastewater mercury contribution. A conservative sensitivity analysis in which both the estimated mass and

concentration of cleaning products used within hospitals were increased ten-fold indicated that the relative contribution of cleaning products to mercury in hospital wastewaters was 0.33-0.78 percent of the average total hospital wastewater mercury contribution.

1.0 INTRODUCTION

This Report has been prepared by West Environmental Services & Technology, Inc., (WEST) pursuant to a request from the Soap and Detergent Association (SDA) to develop an estimate of the relative contribution of cleaning products to the mercury content of hospital wastewaters.

1.1 ORGANIZATION OF REPORT

The Report is organized into five sections. Information regarding the context of the research is presented in Section 1.0. Section 2.0 presents a review of gray literature (*i.e.*, industry or consulting reports that have not undergone peer review), archival journals and electronic sources to estimate the concentration of mercury-containing products in hospital wastewaters. An evaluation of the analytical methods and quality assurance of the referenced papers is provided in Section 3.0. An estimate of the amount of mercury in hospital wastewaters and the relative contribution from cleaning products is presented in Section 4.0.

1.2 BACKGROUND

Domestic wastewater and municipal wastewater treatment plants account for less than 1 percent of the total mercury entering the environment.[1] The largest sources of mercury to Publicly Owned Treatment Works (POTWs) include discharges from dental offices (~36 percent relative contribution of mercury influent load), domestic sources (human wastes, household products and laundry graywater; ~ 20 percent relative contribution of mercury influent load) and hospitals (~ 8 percent relative contribution of mercury influent load).[2] Household washing product contribution to the net mercury load to municipal wastewater has been reported as 0.5 percent or less.[3] Increased understanding and concerns about the effects of mercury exposure on both human health and aquatic life have led to development of water and fish tissue criteria for protecting human health and aquatic species (Table 1-1).

The mercury sources considered to have the greatest potential for achieving measurable reductions of mercury in wastewaters are dental offices and hospitals.[2] Contributions of mercury from human wastes are considered uncontrollable and household products are only considered controllable to the extent that their availability can be restricted through product bans and/or legislation to reduce their mercury content.[2]

To establish "virtual elimination of mercury-containing waste from the health care industry waste stream by the year 2005" the American Hospital Association signed a Memorandum of Understanding with the United States Environmental Protection Agency (USEPA) Office of Prevention, Pesticides and Toxics (OPPT), in 1998.[4] Current methods used to reduce the sources of mercury from hospitals include: (*i*) the phase-out of products to which mercury has been added and their replacement with non-mercury containing alternatives;[5] and (*ii*) documentation of the mercury content of all products offered for sale or use in a hospital, unless the concentration is less than 200 parts per trillion,[6] equivalent to 200 nanograms per kilogram (ng/kg). Documentation of the mercury content of products is designed to assist hospitals in making informed decisions on the products purchased so that efforts can be made to reduce the mercury content of wastes from the health care industry.

The sources of mercury in hospital wastewaters include potable water supply, medical equipment breakage, laboratory chemicals, medicinal wastes, amalgam from dental clinics, human amalgam and dietary waste and "historic mercury" retained in wastewater sumps and traps. Cleaning products used in hospitals may contain trace mercury levels from the caustic soda used in production of soap or from chemicals that may contain traces of mercury as an impurity. This Study assesses the mercury content of cleaning products and their relative contribution to hospital wastewaters.

2.0 SOURCES OF MERCURY IN HOSPITAL WASTEWATER

2.1 LITERATURE SCREENING STUDY

To identify mercury-containing products used in hospitals and their contribution to hospital wastewater loadings approximately 50 articles were reviewed.[1-50] Sources included archival and gray literature, electronic sources and personal communications. The quality of the reviewed data is evaluated in Section 3.2.

2.2 MERCURY PRODUCTS USED IN HOSPITALS

Mercury-added products used in hospitals include electrical equipment, fever thermometers, blood pressure measurement devices and medical tubes. Mercury from medical equipment may enter wastewater if mercury from broken equipment is discharged to sinks and drains.[7] Products entering hospital wastewater as an active ingredient, a contaminated ingredient or a preservative include: laboratory chemicals, medicinal wastes, amalgam from dental clinics, human amalgam and dietary waste and cleaning products. Dirt and dye from laundry processing and mercury settled in wastewater sumps and traps can also be mercury sources. Mercury-containing products used within hospitals are described below and depicted on Figure 2-1.

2.3 ELECTRICAL EQUIPMENT

Thermostats are reported to contain 3,000 to 6,000 milligrams (mg)[8] per component and fluorescent lamps an average of 55 mg[5] of mercury per component. Button cell batteries used in pacemakers and hearing aids are reported to range between 5 and 25 mg of mercury each.[9] Approximately 88 percent of these batteries are disposed of in landfills.[10] It has been estimated that 12 percent of the mercury in these batteries is released to the atmosphere.[10] Mercury from electrical components are not considered a source in hospital wastewaters and is not discussed further in this study.

2.4 MEDICAL EQUIPMENT

2.4.1 Thermometers

Mercury fever thermometers, which each contain approximately 0.5 to 1.0 gram (g) of mercury are currently used in hospitals,[9] but are being phased out as part of a mercury reduction source control plan described in US Senate Bill S351 Mercury Reduction Act of 2002.[11] Laboratory thermometers can contain 2 to 10 grams of mercury[12]. A study by Colquitt in 1998 revealed that nurses were responsible for 98 percent of thermometer breakages in hospitals and they occurred at a rate of one breakage every 2.5 days.[13] The mass of mercury spilled from thermometers without spill clean up was estimated at 7.2 kg/hospital/year.[14] A UCLA medical center study found that broken thermometers accounted for over 55 percent of mercury spill incidents.[12]

Twenty percent of the spilled mercury from fever thermometers is reportedly discharged to wastewater when the spill is cleaned up by washing the area; ten percent of the spilled mercury is lost through volatilization.[10] The replacement of mercury-containing fever thermometers with non-mercury alternatives in hospitals, as well as improved spill response procedures aims to minimize the mass of mercury entering wastewater from this source.[15]

2.4.2 Blood Pressure Measurement Devices

Blood pressure measuring devices such as sphygmomanometers are reported to contain 70 to 90 grams of mercury per unit.[12] To obtain optimum performance, manufacturers recommend that the mercury in sphygmomanometers be removed and filtered at regular intervals.[16] Over 50 percent of hospital sphygmomanometers are reported to leak mercury.[14] Spill incidents are reported at approximately 9.0 kilograms (kg) of mercury spilled per hospital per year.[13] The mass of mercury entering hospital wastewater from this source depends on spill response procedures, but if estimated at 20 percent of the spilled mercury[10], this source contributes approximately 0.06 kg to 1.8 kg of mercury/hospital/year.

2.4.3 Medical Tubes

Mercury is used as a weight on the bottom of esophageal dilators (also called Maloney or Hurst Bougies), Cantor Tubes and Miller Abbott Tubes (used to clear intestinal obstructions or to trace the gastrointestinal tract), and Feeding Tubes. The mass of mercury entering hospital wastewater from this source depends on the size of the tube, the number of medical tubes broken and the clean-up procedures applied. Between 1991 and 2000 in the United States, 59 incidents were reported in which these devises burst and released mercury inside patients.[17] A single set of Bougie Tubes can contain up to 454 grams of mercury.[12] The mass of mercury entering hospital wastewater from this source, if estimated at 20 percent of the spilled mercury,[10] is approximately 91 grams per spill. The replacement of mercury-containing medical tubes with mercury-free alternatives in hospitals aims to minimize the mass of mercury entering wastewater from this source.

2.4.4 Dental Amalgam

Despite the introduction of new types of materials, dental amalgam, which contains approximately 50 percent mercury by weight, is the most popular material used for restoring teeth.[18] The mass of mercury in one amalgam restoration ranges between 0.27 milligrams (mg) and 1.35 mg.[19] The mercury load contribution to municipal wastewater from dental offices is estimated at 56 mg/dentist/day[2] or 138 g/dental office/day.[19] Not all hospitals have dental offices, although some may have a clinic within the hospital affiliated with dental practices.[16] The amount of dentistry performed in a hospital will influence the mass loading of mercury in hospital wastewaters.

2.5 HUMAN EXCRETION

The average human excretion of mercury from amalgam-filled teeth is estimated to range between 17.2[2] and 67 µg/person/day.[20] Dietary excretion of mercury is estimated at 1.4

µg/person/day.[2] Fish and shellfish consumption are the major sources of mercury in the diet, contributing mercury at an estimated 7 µg/person/day.[20] Mercury in medicines, water, fruits and vegetables are additional dietary sources.

2.6 POTABLE WATER

Municipal potable water delivered to hospitals has been reported to contain less than 4 nanograms per liter (ng/L) of mercury.[20] The United States Environmental Protection Agency (USEPA) has set the maximum contaminant level (MCL) at 2 µg/L because it believes that, given present technology and resources, this is the lowest level to which water treatment plants can reasonably be required to remove mercury should it occur in drinking water.[21]

2.7 LABORATORY CHEMICAL PRODUCTS

Mercury-containing compounds used in hospital laboratories include reagents (mercuric iodide, mercuric sulfate, Mercurochrome and Immu-sal), sterilizing agents (mercuric chloride and Mercurochrome), preservatives (Thimerosal), stains (Gram's Iodine, Golgi's and mercuric chloride) and fixatives (Zenker's Solution, B5, Helly, Shardin, and mercuric chloride).[22]

Two commonly used formulations of mercuric chloride fixatives used in histopathology laboratories are Zenker's Fluid and B5 Solution.[23] Zenker's Fluid is reported to contain mercury at 37.5 grams per liter (g/L)[38] and B5 Solution is reported to contain 148.4 µg/L.[24] The supernatant from using B5 solution that could be discharged to wastewater was reported to contain 25 mg/L and 260 mg/L of mercury on two separate occasions.[23] The mass of mercury entering hospital wastewaters from laboratory chemical products will depend on the quantity and type of chemical products disposed with hospital wastewaters.

2.8 CLEANING PRODUCTS

2.8.1 Cleaning Surfaces

In health care facilities, the cleaning of surfaces is important for infection control and basic sanitation. Health care facilities often use materials that contain low-level disinfectants for this task. These materials often have antibacterial, anti-fungal and anti-viral properties.[25] The source of the mercury in cleaning products can be impurities from the production of caustic soda used in the formulation of soap or the addition of chemicals that may contain mercury as an impurity (such as sodium hydroxide or sulfuric acid).[5] A summary of the reported concentrations of mercury in selected cleaning products is presented in Table 2-1.

2.8.2 Laundry

Disinfectants are used in hospital laundries for infection control. Sterilization follows disinfection for materials used in surgical settings.[25]. The concentrations of mercury in laundry detergents have been reported to range from 1.478 µg/kg[20] to less than 25 µg/kg.[26] The increasing number of short patient stays in hospitals is generating larger quantities of laundry. As a result, approximately half of the hospitals now use an outside laundry service.[25] Utilizing outside laundry services will reduce the mass of mercury in laundry detergent being released from hospitals.

2.8.3 Washing Products

Washing products include products used for personal hygiene, such as soap, shampoo and dishwashing detergents. The reported concentrations of mercury in soap range from approximately 0.0027 µg/kg[8] to 7.908 µg/kg,[20] excluding the data reported at less than 25 µg/kg.[26] The mass of mercury entering hospital wastewaters from washing products will be

determined by the number of patients in the hospital and the mass of product used per washing event (Table 4-1).

2.9 HOSPITAL WASTEWATER

The mercury concentration in hospital wastewater has been reported at 4 µg/L,[27] 4.39 µg/L,[2] and 4.6 µg/L.[28] The average volume of wastewater discharged per hospital has been reported at 120,000 gallons per day based on the average of 39 hospitals.[2] Hospital laundry wastewater flows can vary from a few hundred gallons per day to many thousands of gallons per day.[29] Research laboratory facilities in hospitals can range from one to two laboratory sinks that produce tens of gallons each day, to hundreds of sinks generating wastewater volumes in excess of fifty thousand gallons per day.[29]

3.0 EVALUATION CRITERIA

The data presented in Section 2.0 were evaluated using minimum quality assurance/quality control criteria that included: USEPA approved analytical methodologies; detection limits low enough to compare with data quality objectives; measurements of certified reference materials that were not statistically different from their assigned values; analytical precision of 20 percent or less relative standard deviation; and analytical blanks that were not significantly different from zero, or data that was blank corrected.

3.1 SAMPLE PREPARATION AND ANALYSIS

Preparation of solid samples for mercury analysis requires sample digestion during which care must be taken to minimize mercury losses due to volatilization.[30] Cold Vapor Atomic Absorption Spectrometry (CVAAS) is one of the most popular techniques for mercury analysis. Other techniques include Mercury Atomic Absorption Spectrometry (HGAAS) and Inductively-Coupled Plasma (ICP).[30] Some analytical methods recognized by the USEPA for total mercury analysis include USEPA Method 245.1[31] and 245.2[32] that have a method detection limit (MDL) of 200 nanograms per liter (ng/L), USEPA Method 1631[33] that has a MDL of 0.5 ng/L and Draft USEPA Method 245.7[34] that has a MDL of 1.8 ng/L. The limit of detection is described as "that concentration which gives an instrument signal significantly different from the blank or background signal."[35] Low level mercury analytical techniques such as USEPA Methods 1631 and 245.7, require sample collection using the "clean hands, dirty hands techniques," as provided in USEPA Method 1669.[36]

3.2 QUALITY OF REVIEWED DATA

Section 2.0 revealed that spilled mercury from medical equipment and laboratory chemicals were the major sources of mercury in hospital wastewater. An assessment of the quality of reviewed data for hospital wastewater and cleaning products are described in the following sections.

Reviews of the quality of other sources of mercury are not included in this section because hospital wastewater concentrations are considered to reflect all the sources of mercury from the hospital.

3.2.1 Hospital Wastewater

The average mercury concentration in 39 hospital wastewaters has been reported to be 4.39 µg/L.[2] Only data obtained using USEPA Method 1631 or a modified version of USEPA Method 245.1, which had a detection limit lower than 5 ng/L was used in determining the mean concentration.[2] Sampling and analytical quality control information was not provided in the report, and was not available on request.

The wastewater concentration of mercury from hospitals was reported by MWRA[24] as approximately 4 µg/L based on USEPA Method 245.2. A method detection limit of 0.2 µg/L and a relative standard deviation of approximately 20 percent were the minimum requirements for reporting mercury concentrations by MWRA.[24] MWRA reported that certified reference material information was not built into their data base.[37]

EIP Associates reported the average concentration of mercury from hospital wastewater as 4.6 µg/L. Analytical methods and quality control information could not be provided by EIP Associates.[38] The mercury concentration of 4.6 µg/L was obtained by calculating the arithmetic average of wastewater from 46 hospitals using data supplied by Palo Alto Regional Water Quality Control Plant (RWQCP) in 1996.

As the three separate studies vary by only 0.6 µg/L, the results are considered representative of mercury concentration in hospital wastewaters

3.2.2 Cleaning Products

The concentration of mercury in cleaning products reported by AMSA[20] were performed by employees of Hampton Roads Sanitation District (HRSD) using Draft US EPA Method 245.7. The method detection limit (MDL) was reported as 2.0 ng/L, which was approximately 400 times lower than the minimum mercury concentration HRSD measured in cleaning products. As the method detection limit is defined as "the blank signal plus three standard deviations of the blank",[35] there is no evidence of mercury contamination of laboratory reagents or vessels. Analytical duplicates and measured concentrations of certified reference materials were performed by HRSD in order to assess random and systematic errors.[39] Analytical precision was less than 20 percent for duplicated analyses of soap and detergent products. Analytical recovery ranged between 82 percent and 129 percent depending on the analytical batch.

A sample decomposition method shown to minimize the losses of mercury[40] was used by Jenkins and Russell.[3] Reported concentrations of mercury in soaps and detergents were less than 25 µg/kg, which was the MDL using atomic absorption spectrometry. The MDL of 25 µg/kg suggests contamination of reagents and vessels, or interference of the mercury signal by other components (e.g., matrix effects) that may not have been corrected with a method of standard additions, or its equivalent. Analytical duplicates did not differ by more than 20 percent relative difference indicating acceptable precision. The concentration of mercury in powder laundry detergent was reported at less than 25 µg/kg by Jenkins[26] using the same sample digestion and analytical methodology as Jenkins and Russell.[3] Covart Laboratories Incorporated,[41] who originally analyzed the data presented by Jenkins and Russell, was unable to locate the certified reference material information from 1994 as project codes were unknown for the reported data.

Table 2-1 contains data presented by MWRA/MASCO[8] for comparison of mercury containing cleaning products, but is not used in the mass balance as limited information was available on analytical methods and quality control. In addition, MWMRA/MASCO data was greater than

20-fold lower in concentration than the AMSA[20] data, so would not have provided a conservative estimate for the mass balance.

4.0 ESTIMATE OF MERCURY FROM HOSPITAL WASTEWATER

A mass balance was developed to estimate the relative contribution of mercury in cleaning products to the total mercury load from hospitals. The amount of wastewater produced per patient per day has been given as 200 gallons, while 600 patients have been calculated to be in the average hospital per day. These estimates were developed based on the average hospital wastewater discharge of 120,000 gallons described in Section 2.9.

4.1 MERCURY IN HOSPITAL EFFLUENT

The reported average mercury concentration in hospital wastewater[2] of 4.39 µg/L, based on a wastewater flow of 120,000 gallons, is equivalent to a mercury loading of 1.99 g/day (or 3.32 mg of mercury per patient per day based on 600 patients).

4.2 CLEANING PRODUCT CONSUMPTION

The mass of cleaning products used per capita per day has been taken from AMSA[20] and Jenkins.[3] AMSA calculated product consumption rates using information from the American Dietetic Association and United States Department of Agriculture, among other sources.[20] Jenkins calculated product consumption rates using information from cleaning product companies including Lever Brothers™, Procter and Gamble™ and Clorox™[3,26]. Due to differences in consumption rates between the two sources, a range of cleaning product consumption rates was determined (Table 4-1).

4.3 MERCURY FROM CLEANING PRODUCTS

The mercury input to wastewater from cleaning products was estimated by multiplying the mass of product used per patient per day by the mass of mercury in the product. The total mass of laundry detergent, bleach, dishwashing detergent, shampoo, soap and drain cleaner contribute

between 64.90 and 154.75 µg of mercury to hospital effluent per day. Laundry detergent and bleach represent approximately 75 percent of the mercury contribution from cleaning products (Figure 4-1).

4.4 CLEANING PRODUCTS MERCURY CONTRIBUTION TO HOSPITAL WASTEWATER

The total mass of mercury from hospital wastewater is calculated at 1,990,000 µg/day based on 200 gallons of wastewater produced per hospital patient and 600 patients per day. The mass of mercury in cleaning products is calculated at 64.90 to 154.75 µg/hospital/day based on 200 gallons of wastewater produced per hospital patient and 600 patients per day. The mass of mercury from sources other than cleaning products is therefore between 1,989,846 µg/day and 1,989,935 µg/day. The total cleaning product mercury contribution to hospital wastewater is calculated at between 0.0032 and 0.0077 percent.

4.4.1 Sensitivity Analysis

A sensitivity analysis was performed to identify the variability in results that could not be determined without further research and chemical analysis. Maintaining the mass of mercury discharged per hospital per day at 4.39 µg/L, the hospital bed number (ranging from 100 to 600 patients) and volume of wastewater discharged per day (ranging from 25 to 300 gallons) were substituted in the equation used to derive the data presented in Table 4.1. Product consumption rates were based on data provided by either AMSA[20] or Jenkins.[3]

The number of patients per hospital did not influence the percentage of mercury cleaning product contribution to total hospital load. Although the total mass of mercury in hospital wastewater increased with number of patients (assuming the mass of wastewater produced per day remains constant) so did the mass of cleaning products used per patient, so the ratio between the two remained constant.

As the volume of wastewater produced per day per patient decreased, the relative contribution of mercury from cleaning products increased. The worst-case scenario assumed that 25 gallons of wastewater was produced per patient per day and the mass of mercury discharged per hospital per day was 4.39 µg/L. Given this scenario the contribution of mercury from cleaning products to total hospital load was calculated at 0.03 to 0.06 percent.

The mass of cleaning products used per capita per day was determined from household consumption data. However, the quantity of cleaning products purchased in a hospital is a function of hospital size: patient number, product utilization or both. Hospital inventories, patient census and floor plans would be required to address this data gap. In the absence of this data, such a sensitivity analysis was conducted.

The product consumption rate was multiplied by 10 to account for more rigorous cleaning within the hospital and the mercury content of products was multiplied by 10 to account for specialized cleaning products used within hospitals. When the mercury content and mass of product used were both multiplied by 10 (for an overall factor of 100), the mercury from cleaning products to total hospital load was calculated at 0.33 to 0.78 percent (assuming 600 patients and 200 gallons of wastewater produced per patient per day).

5.0 CONCLUSIONS

Hospital wastewater contributes approximately 1.99 g of mercury per day to POTW influent and accounts for approximately 8 percent of POTW influent sources. The total mass of laundry detergent, bleach, dishwashing detergent, shampoo, soaps and drain cleaner contribute between 64.90 µg and 154.75 µg of mercury to hospital effluent per day. Laundry detergent and bleach represent approximately 75 percent of the mercury contribution from cleaning products. The relative contribution of cleaning products to mercury in hospital wastewaters is calculated at between 0.0032 and 0.0077 percent of the hospital wastewater mercury contribution. A conservative sensitivity analysis which multiplied both the estimated mass and concentration of cleaning products used within hospitals by a factor of 10, revealed the relative contribution of cleaning products to mercury in hospital wastewaters at between 0.33 and 0.78 percent of the hospital wastewater mercury contribution.

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TABLE 1-1
MERCURY WATER QUALITY CRITERIA
Mercury in Hospital Cleaning Products

Basis of Criteria	Concentration ng/L
California Toxics Rule Saltwater Criterion	25
California Department of Health Services Primary MCL[1] Goal	2000
California Ocean Plan Marine Aquatic Life Protection (Instantaneous Maximum)	400
USEPA Drinking Water Health Advisory	2000
USEPA Fish Tissue Methyl Mercury-based Criterion (Rivers and Streams)	17-18[2]
USEPA Fish Tissue Methyl Mercury-based Criterion (Lakes)	7.5-7.8[2]
Great Lakes Initiative Human Health Criterion	3.1
Great Lakes Initiative Wildlife Criterion	1.3
Proposed Maine Freshwater Chronic Criterion	0.2

[1]MCL = Maximum Contaminant Level

[2] Projected total mercury criteria calculated from the national fish tissue residue criteria for methylmercury using, as default values, draft bioaccumulation factors, trophic level-specific fish consumption rates and dissolved methyl-to-total mercury translators (Walker, 2002)

TABLE 2-1
MERUCRY CONTAINING CLEANING PRODUCTS USED WITHIN HOSPITALS
Mercury in Hospital Cleaning Products

Use	Product	Form	Brand	Mercury Concentration		
				AMSA (2000)	Jenkins (1998)	MWRA/ MASCO
				µg/kg	µg/kg	µg/kg
Cleaning Products	Laundry Detergent	Powder	--	1.478	< 25	--
		Liquid	--		< 25	--
	Liquid Fabric Softener	--	--	--	< 25	--
	Bleach	Powder	--	6.170	< 25	--
		Liquid	--		< 25	--
	Hand Dishwashing Detergent	Liquid	--	1.320	< 25	--
			Joy	--	--	<0.01
			Ivory	--	--	0.061
	Dishwasher Detergent	Powder/Liquid	--	1.478	< 25	--
			Sunlight	--	--	< 0.011
			Sparkleen	--	--	0.0086
	Shampoo	Liquid	--	0.835	--	--
	Soap	--	--	7.908	--	--
		Solid	Dove	--	--	0.0027
		Solid	Murphy's Oil	--	--	< 0.012
		Solid	Soft Cide (Baxter)	--	--	8.1
	Surface Cleaner	Powder	Ajax	--	--	0.17
		Powder	Commet Cleaner	--	--	0.15
		--	Lysol direct	--	--	< 0.011
		--	Soft Scrub	--	--	< 0.013
	Drain Cleaners	--	--	4.230	--	--

TABLE 4-1
ESTIMATED CLEANING PRODUCT MERCURY CONTRIBUTION TO HOSPITAL WASTEWATER
Mercury in Hospital Cleaning Products

Product	Mercury Concentration	Mass of Product Used	Mass Balance of Cleaning Product Contribution to Hospitals			Mercury cleaning product contribution to total hospital load of 1.99 g/day
	ng/kg	g/patient/day	ng/patient/day	µg/hospital/day	ng/L/day	%
Total Mercury in Hospital Wastewater	--	--	3.32.E+06	1.99E+06	4.39E+03	--
Cleaning Products						
Laundry Detergent	1478	14.33 - 32.88	21.18 - 48.59	12.71 - 29.16	0.03 - 0.06	0.0006 - 0.0015
Bleach	6170	7.40 - 23.48	45.64 - 147.09	27.38 - 88.26	0.06 - 0.19	0.0014 - 0.0044
Dishwashing Detergent	1320	6.57 - 7.48	8.67 - 9.87	5.20 - 5.92	0.01	0.0003
Dishwasher Detergent	1478	3.13 - 16.44	4.63 - 24.30	2.78 - 14.58	0.01-0.03	0.0001 - 0.0007
Shampoo	835	16.77	14.00	8.40	0.02	0.0004
Soap	7908	0.99	7.80	4.68	0.01	0.0002
Drain Cleaners	4230	1.48	6.26	3.75	0.01	0.0002
Total Mercury in Cleaning Products	--	50.67 - 99.52	108.18 - 257.91	64.90 - 154.75	0.15 - 0.33	0.0032 - 0.0077

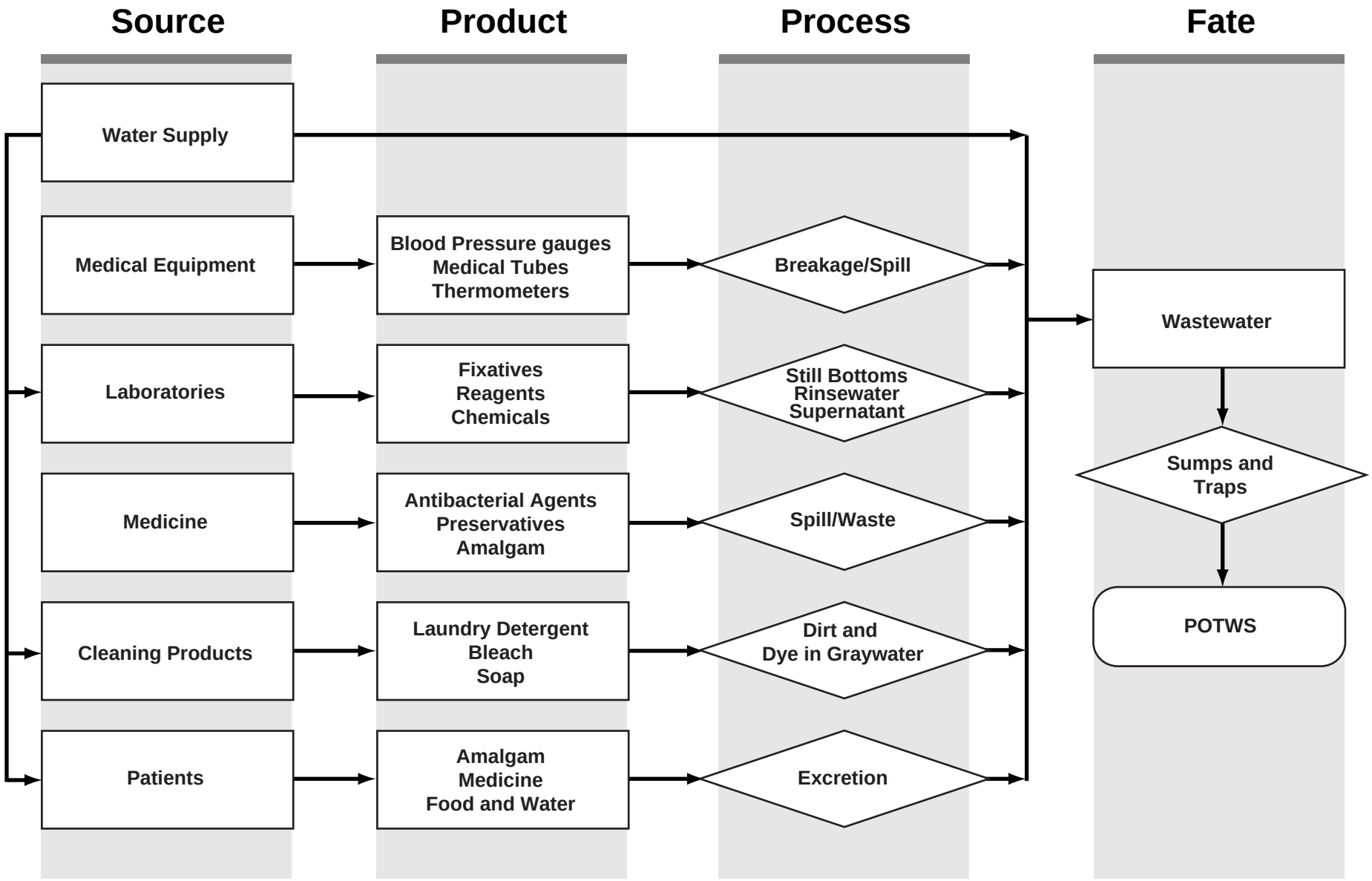

Figure 2-1	**CONCEPTUAL MERCURY SOURCE, FLOWS AND SINKS IN HOSPITALS**	WEST Environmental Services & Technology
September 2003	Mercury in Hospital Cleaning Products	

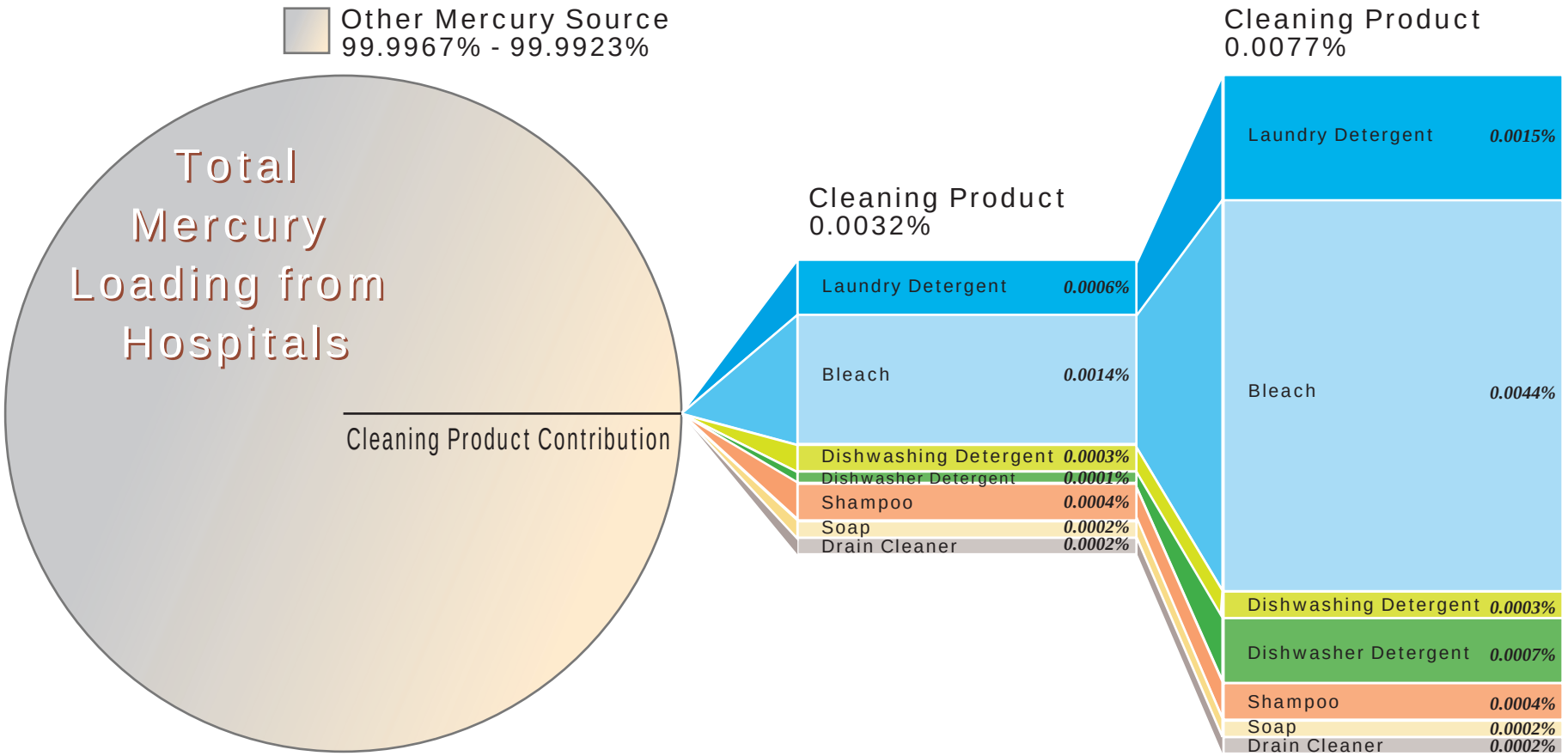

Figure 4-1	**MERCURY CONTRIBUTION FROM HOSPITAL CLEANING PRODUCTS**	WEST Environmental Services & Technology
September 2003	Mercury in Hospital Cleaning Products	