MERCURY IN MAINE

A STATUS REPORT

FEBRUARY 2002

PREPARED FOR:

THE JOINT STANDING COMMITTEE
OF THE MAINE LEGISLATURE HAVING
JURISDICTION OVER NATURAL RESOURCES

PHOTO COURTESY MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

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MERCURY IN MAINE

A STATUS REPORT

This report serves two purposes. First, it updates the "Initial Evaluation and Recommendations on Mercury in Maine" (herein called the 1997 Mercury in Maine Report) submitted to the Maine Legislature in January 1998 as Appendix A to the 1997 Annual Report of the Maine Land and Water Resources Council. Second, it addresses the mercury reporting requirements set forth in Section 6 of "An Act to Reduce the Release of Mercury into the Environment from Consumer Products" enacted in May 2000 as PL 1999, c. 779.

Section IV of this report parallels the format of the Strategies and Preliminary Action Plan in section IV(C) of the 1997 Mercury in Maine report. Specifically, this report restates the "Proposed Actions" under each of the ten strategies in the 1997 report, describes "Actions Taken" for the period 1998 to 2001, and sets forth "Future Actions" for 2002 and beyond.

Section II of this report briefly summarizes the effects of mercury on people and wildlife. Section III identifies the principal sources of mercury releases to the environment in Maine and elsewhere, and thus responds to the reporting requirements of PL 1999, c.779 that call for the Department to conduct an inventory of mercury releases into the environment and identify the sources of the releases, including natural sources.

Section V of this report addresses other reporting requirements of PL 1999, c. 779. In section 6 of that bill, the Legislature required the DEP to report by January 15, 2002 on the following:

- A summary of regional efforts to reduce mercury releases;
- An assessment of the feasibility of reducing mercury pollution from crematoriums; and
- An assessment of the economic impact of the ban on disposal of low-mercury lamps, including infrastructure development, training and education.

I. EXECUTIVE SUMMARY

Mercury can impair childhood development when pregnant women or young children are exposed to the metal at very low concentrations. Recent surveys conducted in Maine and nationally indicate that 10 – 20% of women of childbearing age have blood levels of mercury considered too high for a developing fetus.

Mercury is also toxic to wildlife, diminishing the ability of loons and potentially other species to reproduce. At current mercury levels in the environment, population modeling predicts Maine's loon population is unsustainable.

The chief pathway of both human and wildlife exposure is the consumption of fish, in which mercury in the environment becomes concentrated. Other potential human exposure pathways include residential and school/workplace exposure due to spills/breakage of mercury-added products, or due to the use of certain mercury-added products such as dental amalgam and certain consumer products (i.e., pharmaceuticals, antiseptics).

While some mercury is released to the environment from natural sources, most releases are the result of human activities. These releases are chiefly to air subsequently deposited to land or water. The mercury deposited in the northeast originates from in-state, regional, national, and global sources. In-state and regional sources historically accounted for slightly less than half (47%) of the northeast's mercury deposition.

Under the auspices of the New England Governor's Conference and the Eastern Canadian Premiers (NEGC/ECP), Maine and the other New England states committed in 1998 to a goal of 50% mercury emissions reduction by 2003. A formal assessment of whether this goal has been achieved will be prepared later in 2002, but preliminary analyses indicated that it will be achieved largely through emissions reductions from municipal waste combustors, medical waste combustors, and the closure of Maine's HoltraChem chlor-alkali facility in Orrington. Maine's contribution to these regional reductions includes an emissions reduction of 94% from its four municipal waste combustors.

In August 2001, NEGC/ECP committed to further reductions in mercury emissions, setting a 75% emissions reduction target by 2010 (as compared to the 1998 baseline). Preliminary analyses indicate the bulk of these reductions will come from coal combustion sources, sewage sludge incinerators, and the reduction of use/disposal of mercury-added products. In Maine, DEP intends to determine the quantity of emissions from its three known industrial users of coal, and evaluate whether such emissions comply with upcoming limits imposed by current state law and whether additional limits may be appropriate. In addition, DEP intends to achieve further reductions associated with mercury-added products through a variety of regulatory, educational, technical assistance, municipal grant and other mechanisms specified in this report.

As noted above, slightly more than half of mercury deposition in the northeast comes from sources outside of the region. Accordingly, DEP will continue to devote significant attention, individually

and through its various state regional and national environmental associations, to addressing the national and global aspects of mercury in the environment. Toward this end, DEP will pursue national and international policies that include the following five elements:

1) Aggressive reductions of mercury emissions from coal-fired power plants and other significant sources;
2) Minimize use of mercury in products;
3) Creation of a stewardship approach for safely managing excess mercury supplies;
4) Development and deployment of a sound technology for the safe disposal of mercury wastes; and
5) Development and implementation of a strategy for substantially decreasing the global supply and demand for mercury.

Finally, DEP will continue its research and data gathering activities aimed at better understanding the dimensions of the challenge posed by mercury in the environment. Such activities will include continuation and enhancement of the Mercury Deposition Network instate and within the region so that historical/geographic trends can be identified and the impact of local, regional, and other emissions reductions efforts can be ascertained. Other state research activities contemplated as funding allows include additional work on potential wildlife impacts of mercury in Maine, collecting emissions data and updating regional emission inventories through NEGC/ECP, characterizing the types of commercial and industrial boilers burning residual oil, and evaluating the effectiveness of the mechanisms used to communicate fish advisories to those Maine citizens particularly at risk.

II. BASIS FOR CONCERNS ABOUT MERCURY IN MAINE

Human Exposure to Mercury and Heath Concerns

Every human being has at least some mercury in his or her body. This is unavoidable with a naturally occurring element that has been present at trace levels in air, water, and soil since prehistoric times. Now, however, there are also many opportunities for significantly increased exposure to mercury due to human activity. At this point in time, surveys, both here in Maine as well as nationally, indicate that 10 – 20 percent of women of childbearing age have blood levels of mercury considered too high for the safety of a developing fetus.[1,2 3]

Pathways and Exposure Levels

The most significant pathway for human exposure is consumption of contaminated fish. Mercury released to the atmosphere is deposited on land and, more significantly, in rivers, lakes and streams. In the aquatic environment, this primarily inorganic mercury undergoes a bacterial transformation into the more toxic methylmercury that is taken up and retained by organisms in the food chain. Through the progression up the food chain, the levels of methylmercury magnify. This process, known as bioaccumulation or biomagnification, is the reason why predatory fish can have levels of methylmercury a million times greater than the concentration of mercury in the waters in which they live. Figure 1 shows a typical pattern of mercury biomagnification.

Humans eating those fish, as corroborated by studies of blood samples[4], are thus exposed to the form of mercury that poses the most significant hazard to human health. Maine currently has fish consumption advisories because mercury levels are too high in fish for safe human consumption. These high mercury levels in fish are a direct result of ambient mercury levels in lakes and rivers that bioaccumulate to levels unsafe for consumption by certain risk groups.

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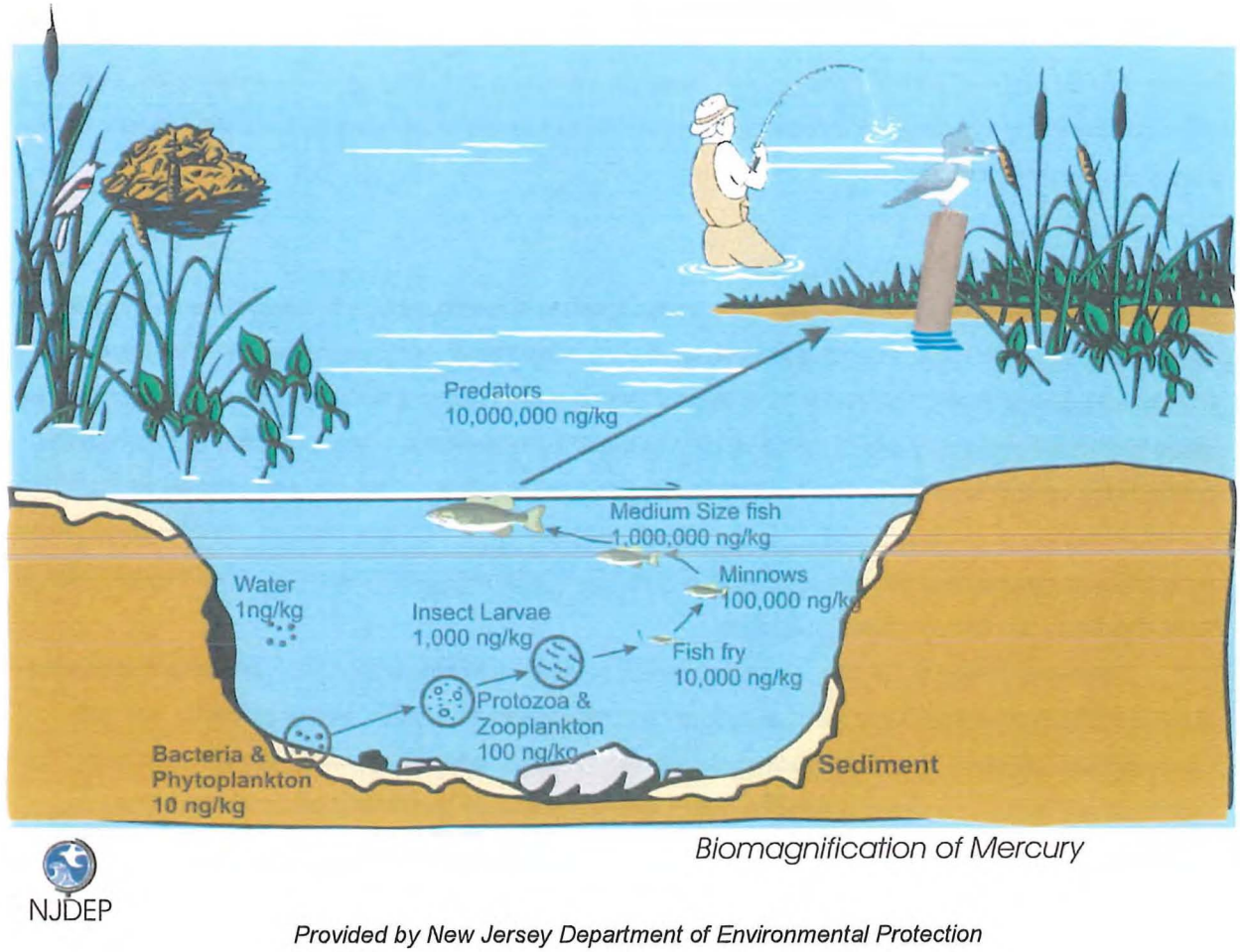
[1] Maine Bureau of Health, Unpublished data.

[2] "Blood and Hair Mercury Levels in Young Children and Women of Childbearing Age – United States, 1999", Morbidity and Mortality Weekly Report, March 02, 2001, Vol. 50 (8): 140-143. (hereinafter cited as MMRW, 50(8):140-143).

[3] The 10-20 percent is based on measured blood mercury levels above what would be expected given a mercury exposure of 0.1 μg/kg/day. In response to a congressional mandate, the USEPA requested the National Academy of Science's National Research Council (NRC) to review available epidemiological studies and evaluate the public health protectiveness of the Agency's 1995 estimate of a tolerable daily intake of mercury. The USEPA refers to their tolerable daily intake as a "*reference dose*". A *reference dose* is formally defined as a lifetime daily dose that poses a negligible risk of any deleterious response even among sensitive individuals. The numerical value of USEPA's 1995 reference dose was 0.1 micrograms of methylmercury per kilogram of body weight per day (0.1 μg/kg/day), or about 6 to 7 micrograms per day for an adult.

[4] Mercury Study Report to Congress, United States Environmental Protection Agency, EPA-425/R-97-006, December , 1997.

Figure 1. Typical Pattern of Mercury Biomagnification



Provided by New Jersey Department of Environmental Protection

Eating fish, however, is not the sole pathway. The workplace can provide opportunity for exposure. In Maine, there was potential worker exposure to elemental mercury vapors at the now closed HoltraChem chlor-alkali plant. Workers may also be exposed in other operational facilities due to fluorescent bulb breakage and at the many dental practices that use mercury amalgam restorations.

Exposure to elemental mercury vapors can occur in the home when mercury thermometers or fluorescent light bulbs are broken, or mercury escapes from other sources in the home such as thermostats or light switches.[5] Some studies – though small in sample size – have suggested that perhaps 10 percent of residential homes could have indoor air mercury vapor levels exceeding the

[5] A. Carpi and YF Chen. Gaseous elemental mercury as an indoor air pollutant. *Environ. Sci. Technol.*, Vol. 35:4170-4173, 2001.

USEPA reference concentration of 0.3 micrograms per cubic meter.[6,7] For such homes, inhabitants spending most of their time indoors could have daily exposures in excess of 5 to 6 micrograms of elemental mercury per day.

An increasing number of reported metallic mercury spills in schools prompted the Agency of Toxic Substances and Disease Registry, part of the U.S. Public Health Service, to issue a national alert warning of such exposures.[8] In Maine, state agencies have responded to mercury spills in several schools and medical practices over the past few years. In one school, a student took perhaps a teaspoon of mercury from a classroom barometer and discarded it in a water fountain. The school removed the water fountain, but in the process contaminated the floor and the mercury was subsequently tracked throughout the school. Air levels of 10 to 25 micrograms per cubic meter of air were detected soon after the spill, representing potential exposures in excess of 50 micrograms of mercury per day had it not been for quick efforts to bring in a professional hazardous waste team to clean up the mercury spill.

For those of us with amalgam fillings in our teeth, there is exposure to mercury vapors released from mercury present in these fillings. Dental amalgams are 40 to 50 percent metallic mercury by weight, with silver, tin and copper representing the other metals present. Mercury vapors can be released from dental amalgams and subsequently inhaled and absorbed into the body. There has been a long running controversy over the safety of mercury exposures associated with dental amalgam fillings.[9]

Measurements of mercury in blood among individuals with and without amalgam restorations and of subjects before and after amalgams were removed indicate exposures in the range of 1 to 5 micrograms per day.[10] Government sponsored scientific reviews on the health effects of mercury exposure resulting from the use of dental amalgam have concluded that the available data do not demonstrate a health hazard for the majority of individuals exposed to commonly encountered levels.[11,12,13] Nevertheless, some European countries and Canada have either restricted use of amalgams or recommend limited use as a precautionary measure, citing a need to minimize human exposure to all forms of mercury and to reduce the release of mercury into the environment.[14] U.S. Public Health Agencies have yet to make similar recommendations.

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6 A. Carpi and YF Chen. Gaseous elemental mercury as an indoor air pollutant. Environ. Sci. Technol., Vol. 35:4170-4173 (2001).
7 PJ Hudson et al., in Pediatrics (1987).
8 ATSDR (1997). National Alert: A warning about continuing patterns of metallic mercury exposure. June 26, 1997 (www.atsdr.cdc.gov/alerts/970626.html).
9 "The Mercury in Your Mouth", *Consumer Reports*, May 1991.
10 ATSDR Toxicological Profile for Mercury, p. 440.
11 ATSDR Toxicological Profile for Mercury, p. 293.
12 Dental Amalgam: A scientific review and recommended public health service strategy for research, education and regulation. Department of Health and Human Services, Public Health Service. Washington DC. 1993; Dental Amalgam and Alternative Restorative Materials. An Update Report to the Environmental Health Policy Committee. Working Group on Dental Amalgam, Department of Health and Human Services, Public Health Service. Washington DC. October 1997.
13 The Safety of Dental Amalgam. Health Canada, Ottawa, Canada. August, 1996.
14 ATSDR Toxicological Profile for Mercury, p. 293.

Pharmaceuticals can also be a source of exposure to mercury. Some contact lens solutions, nasal sprays, and other products contain organic mercury compounds to inhibit microbial growth, as do the once commonly used topical antiseptics, mercurochrome and tincture methiolate.[15] Until very recently, the mercury containing compound thimerosal was routinely used as a preservative in children's vaccines.[16]

Human Health Concerns

Past methylmercury poisoning episodes, such as those that occurred from consumption of contaminated fish in Minamata and Nigata, Japan, and those related to consumption of contaminated grain in Iraq, have documented all too well that this chemical can be very toxic to the human nervous system. During the 1950s and 1960s, the poisonings in Japan from eating highly contaminated fish resulted in severe neurological damage (e.g. seizures, cerebral palsy) and sometimes death in both adults and children.[17] The fetus was identified as particularly sensitive to the toxic effects of methylmercury, based on the observation of severe effects on infants whose mothers had only mild effects or were asymptomatic.

Studies of the Iraqi grain-poisoning incident of 1971 to 1972 provided information about the dose-response relationship for less severe, though still clinically apparent, effects from fetal exposure to methylmercury. The relationship suggested that fetal exposures associated with maternal hair mercury levels[18] as low as 10 to 20 ppm were associated with motor retardation (e.g., delayed walking) and abnormal clinical neurological exams (e.g., increase in muscle tone and deep tendon reflexes).[19] (As a point of reference, typical hair mercury levels among U.S. women are below 1 ppm.[20]) Neither the Japan nor Iraq poisoning incidents provided information about potentially more subtle nervous system effects from exposures associated with maternal hair levels less than 10 ppm.

Over the past several years, a lot of attention has been given to identifying what level of exposure to methylmercury can be considered safe. Attention has largely focussed on results from studies of fish eating populations from New Zealand, the Faroe Islands (North Atlantic Ocean), and the Seychelles

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15 ATSDR (1999) Toxicological Profile for Mercury, at pp: 473-474.
16 "Thimerosal in Vaccines – an Interim Report to Clinicians", American Academy of Pediatrics, 1999.
17 GL Myers and PW Davidson. "Prenatal Methylmercury Exposure and Children: Neurologic, Developmental, and Behavioral Research". Environmental Health Perspectives, Vol. 106, Sup. 3:841-847, 1998.
18 Prenatal methylmercury exposure has often been estimated by measuring the total mercury content of a segment of the mother's hair that was growing during pregnancy. Methylmercury enters the hair follicles in direct proportion to its level in the blood, and is subsequently incorporated into the hair shaft. By measuring mercury in short segments of hair, the exposure history for the entire pregnancy can be determined. See, for example, Myers and Davidson (11) and Cernichiari E. et al., "Biological Monitoring of Mercury in the Seychelles Study", NeuroToxicology, Vol. 16(4):613-628 , 1995.
19 Myers and Davidson, 1998.
20 MMRW, 50(8):140-143.

Islands (Indian Ocean).[21] Two of the studies, the New Zealand and Faroe Island studies, reported increasing deficits in cognitive functions with increasing mercury exposure.[22,23] The Seychelles study has not reported any consistent mercury related effects on cognitive functions despite very similar mercury exposures.

While there is much understandable focus on public health concerns raised by methylmercury exposure from fish, exposure to elemental mercury can also be of concern. Like methylmercury, elemental mercury (also called metallic mercury) is toxic to the nervous system. But while exposure to methylmercury is primarily dietary, exposure to elemental mercury is primarily from inhalation of vapors.

Studies of workers with years of exposure to mercury vapors in the manufacture of chlor-alkali, fluorescent tubes, and acetaldehyde have provided the basis for deriving ambient air levels considered to pose a negligible risk of a deleterious effect, referred to as a *Reference Concentration* or *Minimal Risk Level*. These studies have reported effects on the adult nervous system (e.g., increases in hand tremors, increases in subjective memory disturbances, increase reporting of heart palpitations, slight decrease in pulse rate variations) associated with chronic occupational exposures to mercury vapors above 25 micrograms per cubic meter.[24]

Mercury's Effects on Wildlife

In 1997 and 1998, the BioDiversity Research Institute (BRI), a non-profit institute in Freeport Maine, obtained a grant from the Maine Outdoor Heritage Fund to research the effects of mercury on loons. Results indicated that 21-40% of Maine loons had egg blood or feather mercury levels exceeding

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[21] These studies are notable in several respects. They have chronic mercury exposures considerably lower (average exposures resulting in 4 – 6 ppm mercury in maternal hair) than the high levels associated with the Japan and Iraq poisonings, and therefore are considered more appropriate for investigating the potential effects from expected exposures for the U.S. population. The studies employed sophisticated objective tests of cognitive and neurophysiological functions, considered better able to detect more subtle effects on the developing nervous system (e.g., deficits in fine motor, language, memory or visuospatial skills, as well as more global cognitive functions such as IQ). Indeed, effects measured were so subtle that they could not be detected in isolation for any given child, but were assessed as shifts in the average responses of groups of individuals. These studies also followed relatively large populations of mother-infant pairs prospectively, meaning they have considerable statistical power to see any effects associated with maternal hair levels less than 10 ppm.

[22] P Grandjean et al., "Cognitive Deficit in 7-Year-Old Children with Prenatal Exposure to methylmercury", Neurotoxicology and Teratology, Vol 19(6):417-428 (1997).

[23] KS Crump el al., "Influence of Prenatal Mercury Exposure Upon Scholastic and Psychological Test Performance: Benchmark Analysis of a New Zealand Cohort", Risk Analysis, Vol 18(6), 701-713 (1998).

[24] USEPA derived a reference concentration of 0.3 micrograms per cubic meter of air based on these studies and applying a cumulative safety factor of 30-fold after adjusting from an occupational exposure setting to a residential setting. ("Elemental Mercury: Reference Concentration for Chronic Inhalation Exposures", Integrated Risk Information Systems, U.S. Environmental Protection Agency, July 7, 2001.) ATSDR similarly derived a Minimal Risk Level value of 0.2 micrograms per cubic meter of air. (Reference ATSDR Toxicological Profile for Mercury. 1999. Appendix A: A-3.)

safe limits predicted from laboratory studies. Consequently, in 1999 and 2000, the Department funded follow-up studies by BRI to determine if loons were experiencing actual effects. The results documented a 37% reduction in the number of fledged young loons from the 30% of the adults that had high levels of mercury, indicating a reduction of about 10% in the population. Population modeling predicts that, with this level of impact, Maine's loon population is not sustainable.

In 2000, prompted by reports of diminished populations of mink and otter in parts of Maine, DEP, working with DIFW and BRI, initiated studies of mercury contamination in mink and otter obtained from trappers. Results showed that animals from the Flagstaff Lake area, St. John River, and some other areas of Maine had significantly higher levels than other areas. Concentrations of mercury in fur of 30% of mink and 62% of otter exceeded safe levels estimated from laboratory studies, but sample sizes are small and more data are needed.

In 2000, in consultation with DIFW and the University of Maine, studies of mercury contamination in black terns and sharptailed sparrows also began. Concentrations of mercury in eggs of both species also exceeded estimated safe levels. Studies of both mammals and sharptailed sparrows continued in 2001.

III. MERCURY IN MAINE'S ENVIRONMENT

Discharges to Air

National, regional, and state research indicate that air emissions are the most significant pathway for mercury contamination of Maine's environment. Mercury present in the atmosphere is washed out via precipitation. The mercury present in precipitation that falls over Maine's lakes, streams, and watersheds may have had its origins in other continents, the US, New England, or Maine. Consequently, DEP has focused research and regulatory attention on the major air emission sources in the state and region.

Mercury is released to the environment from natural processes (e.g. volcanoes, forest fires) and human activities (also known as anthropogenic sources). Current estimates from the scientific literature indicate that over two-thirds of the global mercury emissions are from human sources.[25] Sediment studies confirm substantial increases in mercury accumulation rates from pre-industrial to modern times.

During the past few years, numerous studies have been completed to identify the major sources of mercury in the United States and to gain an understanding of their impact on the environment. Three major reports are of particular importance to Maine and are discussed in further detail below. While estimating emissions is important, it is estimates of deposition, and the sources causing that deposition, that have more direct relevance for determining the impacts of mercury from human activities on fish and wildlife. Therefore, this section will first discuss emissions in the nation, the region, and Maine, and then will discuss how those emissions influence deposition. National and regional deposition modeling results will be discussed, as well as recent findings for monitored deposition in Maine.

National Mercury Study

EPA's Mercury Study Report to Congress[26] indicates that in 1994, approximately 158 tons of mercury were emitted nationally from anthropogenic sources. Combustion of waste and fuel was responsible for 87% of these emissions. These sources include medical and municipal waste facilities, utilities, and commercial/industrial boilers.

Nationally, the larger sources of mercury from combustion are utility boilers, which are responsible for 33% of the nation's annual emissions. Municipal waste combustors (MWCs) are responsible for 19%, commercial and industrial boilers 18%, and medical waste incinerators 10%. Manufacturing sources (e.g. chlor-alkali, Portland cement, and pulp and paper) are responsible for approximately 10% of the total national emissions.

Since that time, air emissions from municipal and medical waste facilities have since been controlled to a great extent, although work continues to remove products from the waste stream to

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[25] Mason, R. and W. Fitzgerald, 1996, "The Global Mercury Cycle: Oceanic and Anthropogenic Aspects", in W. Baeyens et al. (eds.) *Global and Regional Mercury Cycles: Sources, Fluxes and Mass Balances*, 85-108. Kluwer Academic Publishers, Netherlands.

[26] Mercury Study Report to Congress, Vol. 1, Executive Summary, USEPA. OAQPS & ORD, Research Triangle Park, N.C. Dec. 1997.

achieve further reductions. Because of the reductions in the waste sector, the relative contribution of fossil fuel combustion to mercury emissions nationally has concurrently increased.

Northeast Study

Recognizing that EPA's emissions inventory for the Northeast was not as refined as each state's inventory, the Northeast states embarked in 1995 upon a more in-depth study, which was released in February 1998. The Northeast States/Eastern Canadian Provinces Mercury Study[27] ("Northeast Mercury Study") was a multi-media effort that involved three interstate organizations - the Northeast Interstate Water Pollution Control Commission (NEIWPCC), the Northeast States for Coordinated Air Use Management (NESCAUM), and the Northeast Waste Management Officials' Association (NEWMOA) - as well as the eastern Canadian provinces, and Environment Canada. NEIWPCC, NESCAUM, and NEWMOA are regional associations of state environmental agencies for water, air and waste respectively, and represent the New England states, and/or New York and New Jersey (depending on the association).

The Northeast Mercury Study, among other activities, compiled a northeast (New England, New York, and New Jersey) air emissions inventory for mercury, and with EPA's assistance used the emissions to model source-specific contribution to deposition in the northeast.

Emissions in the Northeast were approximately 18 tons in 1998. Approximately 45% of the emissions were emitted by municipal waste combustors, 7% by manufacturing (chlor-alkali, mercury product recycling, and cement and lime production), 18% by non-utility fuel combustion,13% by utilities, 11% other waste combustion (sewage sludge and medical waste) and 6% area sources (product use and disposal).

Comparing national emissions to northeast emissions reveals some important differences. Nationally, utilities are responsible for the largest source of mercury emissions (33%), while in the northeast, utility emissions are one-third of that amount. Municipal waste combustion in the northeast was more significant, contributing more than two times the national percent contribution for this source; however, this source has been substantially reduced (approximately 85-95% in the northeast) due to air emission controls that took effect in December 2000.

The Northeast Mercury Study is intended to be a resource for information for the state and provincial governments as they continue to address the mercury issue and coordinate their efforts. The Study was used as a foundation for the regional Mercury Action Plan developed by the Northeast Governors and the Eastern Canadian Premiers. As announced in 1998, the NEGC/ECP set a goal of 50% reduction in mercury emissions by 2003. Largely through improved source reduction, waste segregation, emission controls, the closure of municipal and medical waste incinerators, and the closure

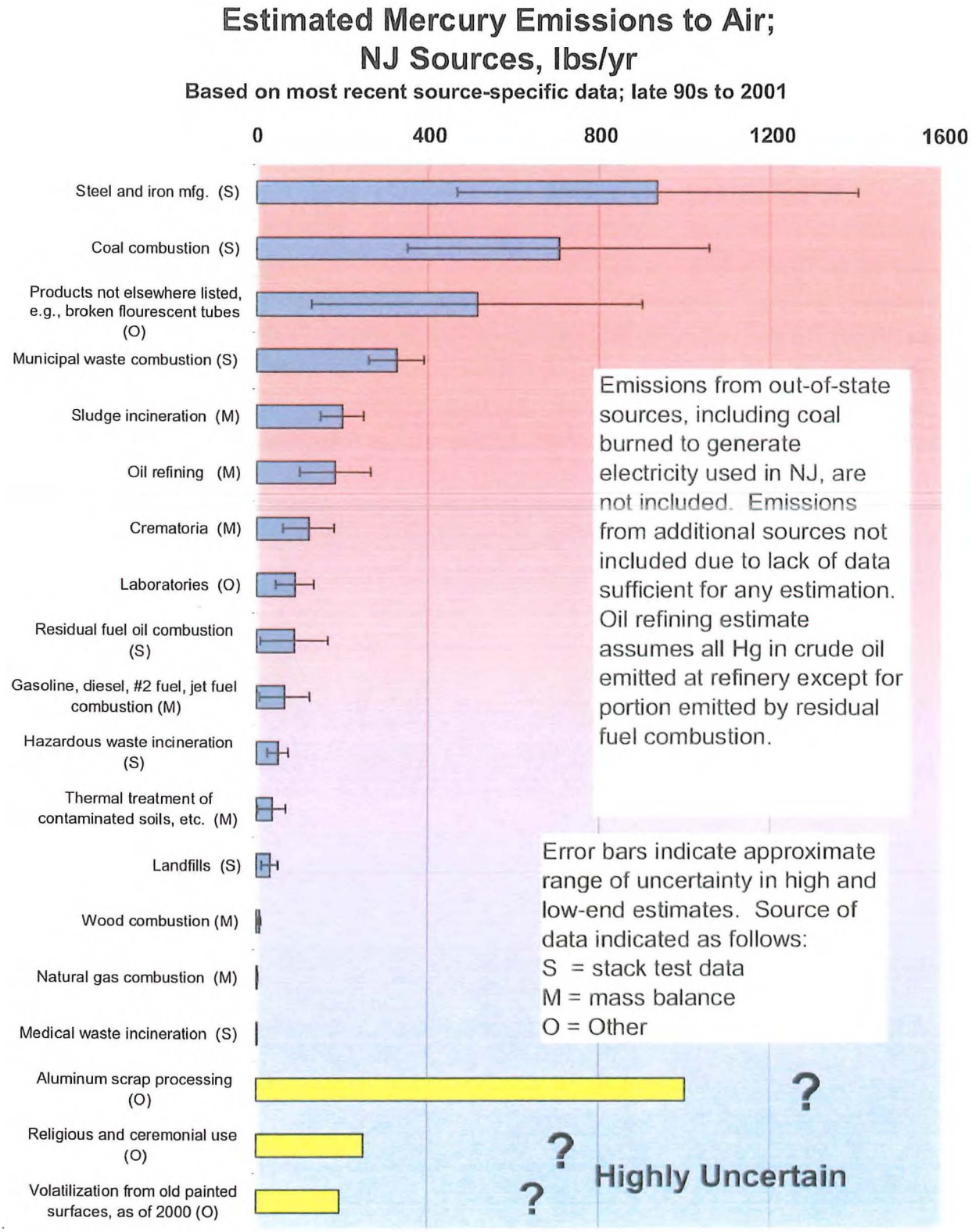
[27] Northeast States/Eastern Canadian Provinces Mercury Study. February 1998. Northeast States for Coordinated Air Use Management, New England Interstate Water Pollution Control Commission, Northeast Waste Management Officials Assoc. and the Canadian Ecological Monitoring Assessment Network.

of the HoltraChem facility, NEGC/ECP believes it will achieve this objective. NEGC/ECP is currently preparing its official assessment of the progress toward meeting the 2003 goal. The assessment will be finalized in the summer of 2002.

In August 2001, NEGC/ECP committed to achieving a 75% reduction in mercury emissions from the 1998 baseline by the year 2010. Pursuant to this second objective, the NEGC/ECP intends to undertake a current and detailed emissions inventory to guide its work. This inventory will be prepared during 2003 and 2004.

With time, it has become apparent that certain source categories of significance were not accounted for in the original national and regional inventories. For example, New Jersey has just recently released a comprehensive mercury emissions inventory. Figure 2 is a graphic illustration of New Jersey's sources as prepared by that state's mercury task force. Four of the top five source categories involve the use/management of mercury-added products. Particularly striking are the iron and steel sector emissions, a source category not in the original inventories, discovered by New Jersey to be the largest source of mercury emissions in that state. The iron and steel sector emissions are principally the result of smelting scrapped automobiles that contain mercury switches to make recycled steel.

Figure 2.


Estimated Mercury Emissions to Air;
NJ Sources, lbs/yr
Based on most recent source-specific data; late 90s to 2001
0
400
800
1200
1600
Steel and iron mfg. (S)
Coal combustion (S)
Products not elsewhere listed, e.g., broken flourescent tubes (O)
Municipal waste combustion (S)
Sludge incineration (M)
Oil refining (M)
Crematoria (M)
Laboratories (O)
Residual fuel oil combustion (S)
Gasoline, diesel, #2 fuel, jet fuel combustion (M)
Hazardous waste incineration (S)
Thermal treatment of contaminated soils, etc. (M)
Landfills (S)
Wood combustion (M)
Natural gas combustion (M)
Medical waste incineration (S)
Aluminum scrap processing (O)
Religious and ceremonial use (O)
Volatilization from old painted surfaces, as of 2000 (O)
Emissions from out-of-state sources, including coal burned to generate electricity used in NJ, are not included. Emissions from additional sources not included due to lack of data sufficient for any estimation. Oil refining estimate assumes all Hg in crude oil emitted at refinery except for portion emitted by residual fuel combustion.
Error bars indicate approximate range of uncertainty in high and low-end estimates. Source of data indicated as follows:
S = stack test data
M = mass balance
O = Other
?
?
?
Highly Uncertain

Maine Emission Inventory

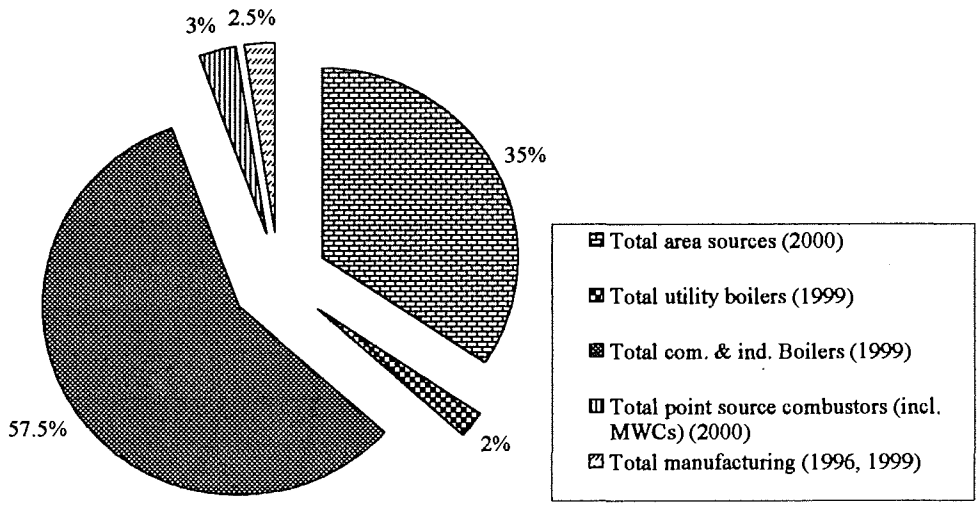
In 1996, the Maine DEP Air Bureau began developing an inventory of air emissions of mercury in Maine, which was ultimately used (in part) for the Northeast Study.[28] The emissions of mercury were estimated primarily by using USEPA "emission factors". Emission factors are developed using emission test data from specific sources to determine how much mercury is emitted per ton of waste or fossil fuel burned. Emission factors are not available for all air emission sources, so emissions can not be quantified for these sources.

The DEP did not use emission factors for two sources for which other data sources are available. For HoltraChem, the chlor-alkali plant, DEP relied on the company's report to the EPA Toxic Release Inventory. For municipal waste combustors (also referred to as resource recovery facilities, or waste-to-energy plants), DPE relied on stack tests performed by the facilities to quantify their emissions of mercury (and other pollutants).

Based on this analysis, the DEP estimated total emissions in 1992 of 2786 pounds per year. The major sources of mercury in Maine were area sources, chlorine production, municipal waste combustion, and commercial/industrial boilers. Those emissions, by 2001, were reduced by nearly half (i.e. 1467 pounds), due to closure of HoltraChem and municipal waste combustion controls. Area sources and commercial/industrial boilers are now the most significant sources.

Figure 3.

2001 Mercury Emissions to the Air in Maine



[28] Maine Mercury Inventory for the Years 1991-1992. January 1998. Maine Department of Environmental Protection, Bureau of Air Quality. Douglas Saball and Ellen E. Parr Doering.

Table 1 identifies Maine sources of mercury air emissions in 2001, and gives estimates of the pounds of mercury emitted from each source category. Most mercury emissions generated in Maine now result from fuel combustion. The largest contributors in this category are commercial and industrial boilers burning petroleum products and wood, at 57.5% of the total mercury emissions in Maine. The second significant category of mercury emissions is the area sources, accounting for 35% of Maine's total emissions. Residential fuel use (oil and wood) is the most important of these, accounting for approximately half of the area source emissions.

Emissions due to mercury-containing products are the next highest source. Mercury in products typically is released to the environment when the product is broken, used inappropriately, or disposed or otherwise managed at the end of the product's useful life. Product-related emissions of mercury are not only due to area sources; while substantially reduced MWC emissions are still due to disposal of mercury-containing products. Therefore, in Maine it is estimated that approximately 15% of mercury emissions are due to mercury-containing products, not including product discharges to water and to land via sludge management.

Table 1.

2001 Legislative Update of Mercury Emissions to the Air in Maine

	Pounds	Percentage	
EMISSION SOURCE	**Mercury 2000**		**Data Year**
Volatilization of other products (including electric lamp breakage)	93.00	6.34	DEP NJ to ME population.
Landfills	6.00	0.41	DEP NJ to ME population.
Paint usage, off gassing	36.00	2.45	DEP NJ to ME population.
Laboratory usage	0.003	0.00	2000 Census data
Dental preparation	0.003	0.00	2000 Census data
Crematories (1 gram/ cremation)	11.60	0.79	1999 DEP inventory
Mobile sources	62.49	4.26	1999 DOT
Wood stoves	126.79	8.64	1999 DOE
Residential boilers; coal	0.26	0.02	1999 DOE
Residential boilers; distillate oil	130.80	8.91	1999 DOE
Back Yard Burn-barrels (BYB)	45.17	3.08	1999 DEC report emission factor applied to DEP 1996 data grown to 2000 with BLS growth factors and '96 as base year calculation.
Total area sources	**512.12**	34.90	
Utility boilers, wood	Not Used according to DOE	0.00	1999 DOE
Utility boilers; coal, Bituminous	Not Used according to DOE	0.00	1999 DOE
Utility boilers; natural gas	Not Used according to DOE	0.00	1999 DOE
Utility boilers; oil, distillate	27.00	1.84	1999 DOE
Utility boilers; oil, residual	4.00	0.27	1999 DOE
Total utility boilers	**31.00**	2.113	
Commercial & ind. boilers, wood	85.75	5.84	1999 DOE
Com. & Ind. boilers; coal, bituminous	9.79	0.67	1999 DOE
Com. & Ind. boilers; natural gas	1.56	0.11	1999 DOE
Com. & Ind. boilers; oil, distillate #1, #2	67.50	4.60	1999 DOE
Com. & Ind. Boilers; oil, residual	679.69	46.33	1999 DOE
Com. & Ind. Boilers; paper mills lime kilns	0.29	0.02	1996 DEP
Total com. & ind. boilers	**844.59**	57.56	
Municipal waste incinerators (MERC)	3.70	0.25	Test data 1999
Municipal waste incinerators (PERC)	7.44	0.51	8/2000 report
Municipal waste incinerators (MMWAC)	7.03	0.48	12/2000 report
Municipal waste incinerators (RWS)	25.40	1.73	11/2000 report
Total MWC	**43.58**	2.97	
Medical waste incinerators	0.000007	0.00	1999 DEP
Incinerators, solid waste	0.00	0.00	1996 DEP
Total Point Source Combustors (incl. MWCs)	**0.000007**	0.00	
Chlor-alkali production	0.00	0.00	Closed 8/2000
Cement production	35.00	2.39	Test data 1998
Asphalt production	0.20	0.01	1999 DOE
Brick Manufacturing	0.72	0.05	1996 DEP
Total Manufacturing	**35.92**	2.45	
Total Estimated Mercury Emissions for Maine	**1467.21**	100.00	

Deposition of Mercury

While emissions inventory data are helpful to identify sources contributing to mercury contamination in the environment, it is deposition of those emissions that cause the direct health concern to humans and wildlife. For any given location, deposition of mercury from the air to land and water surfaces will be comprised of contributions from local sources, regional sources, national sources, and global sources.

The National Mercury Study used a computer simulation (i.e. modeling) to determine where air emissions are depositing on the earth's surface. This simulation indicated that the northeast was one of three areas in the U.S. that have the highest amount of mercury deposition. This same model was used for the Northeast Mercury Study, which found that deposition overall in the Northeast is due to Northeast sources (47%), other U.S. sources (30%), and global background (23%). It is unknown how much of this "global background" is due to U.S. sources originally. The study also found that 42% of the anthropogenic deposition in the Northeast was due to municipal waste combustors emitting in the Northeast. Approximately 17% of Northeast man-made deposition is due to municipal waste combustors that emit outside of the Northeast. The third most significant source of northeast mercury deposition (9%) was utilities outside of the region. The relative importance of municipal waste combustors has now changed due to emission reductions achieved in that sector. As a consequence, the utility sector emissions have increased in importance.

Deposition can be determined in one of two general ways: monitoring or modeling. DEP is conducting mercury monitoring (wet deposition) at four sites in Maine: Bridgton, Greenville, Acadia, and Freeport. Precipitation amount and the mercury concentration in that precipitation, are collected weekly at each of these four Mercury Deposition Network sites. Deposition is calculated as the product of precipitation amount and concentration.

In the first report on Mercury in Maine to the Legislature, these sites had only recently been established and therefore little data was available. The only tool available at that time to estimate deposition in Maine was modeling. Modeling estimated that Maine deposition was highest, due to regional transport, in southern Maine. Monitoring data are now available, and while still not complete, do indicate that the modeling data are generally accurate.

Data from Mercury Deposition Network sites in New Hampshire and Atlantic Canada was examined with Maine data, to see how Maine data compared regionally (see Appendix A). For 1998-2000, Freeport and Acadia had approximately 25% greater deposition than other sites in the region. It is not yet known why deposition at these sites is significantly higher. While ozone is believed to oxidize mercury, which is the form of mercury that is washed out with precipitation, peak deposition at these sites did not occur at peak ozone levels, which typically occur in the summer months.

Global Contribution to Mercury Deposition in Maine

International mercury emissions are also part of the problem. There is no worldwide emissions inventory available, but the United Nations is in the process of developing one. As a surrogate for emissions, DEP reviewed available information on global mercury production. In 2000, worldwide mercury mining production was estimated at 1,640 metric tons, principally by Spain, Kyrgyzstan, Algeria, and China. A large portion of this global production is used in the worldwide chlor-alkali industry. Energy production from coal in Russia and the developing economies of Asia may increase mercury emissions from those activities.[29]

The United States was a net exporter of mercury in 1999 and 2000, exporting 119 tons and 75 metric tons more than it imported in those years respectively, even though mercury is no longer mined in this country.[30] Mercury exports are due to declining domestic demand from increasing pressures on the manufacturing of mercury products, coupled with increased recycling of mercury from used products and other wastes and the availability of mercury from closing or converting mercury cell chlor-alkali plants.

Discharges to Water

Mercury discharges to water in Maine, other than via deposition, originate from wastewater treatment plants and historical contamination at specific sites such as HoltraChem. This later category cannot be completely quantified statewide at the present time; however, it is estimated that at least 12 pounds of mercury annually are discharged to the Penobscot River from untreated ground water at the HoltraChem facility, thereby necessitating site remediation to address these discharges. In 2000, another 1.2 pounds of mercury was discharged to the Penobscot River from surface water flowing through the site. There may also be releases to water statewide due to erosion of soils that have received historic air deposition of mercury and mercury spills, but there is insufficient information to quantify the nature and extent of this source. However, we do know that in 2001 0.12 pounds of mercury was prevented from entering the Penobscot River through erosion control measures at the Holtrachem facility.

Waste Water Treatment Plants

Before 1998, treatment plant effluent was analyzed by a method that was unable to detect any mercury in the effluent or the discharge waters. In the fall of 1998, the department began sampling the effluent of municipal and industrial wastewater treatment plants using a new analytical method that has a very low detection limit. This new test method allows accurate determination of how much mercury is in the effluent, and the department now requires regulated facilities to use it.

The new mercury data was collected from municipal and industrial wastewater treatment plants around the state. Analysis of that data indicates that 160 facilities discharged about 10.2 pounds of

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[29] Abascal-Garrido, F., Lucotte, M., Montgomery, S., Pilgrim, W., Porcella, D., Round, M., Santos-Burgoa, C., and Uriarte, M.I.I. "Meeting the Challenges of Continental Pollutant Pathways: MERCURY Case Study." *Final Report to the Secretariat of the CEC.*

[30] Reese, R.G. Jr., 2000, "Mercury", in Minerals Yearbook 2000. US Geological Survey.

mercury in that year. Unfortunately, because of the change in testing technique, historical comparisons can not be made at this time.

As a means to reduce the amount of mercury discharged to the waters of the state, these facilities have been required to develop their own pollution prevention plans to identify sources of mercury and work to eliminate or reduce these sources.

In addition, in the interest of identifying possible future courses of action, the Department also analyzed the effluent data to identify any differences in mercury discharge among the types of treatment facilities. Table 2 shows the results of this analysis.

Table 2.

Average Effluent Limits for Mercury by Wastewater Treatment Facility Type (1998 data)

Treatment facility type	Number of facilities	Average of all effluent limits
		Parts Per Trillion (ng/L)
All facilities	157	24.4
Municipal activated sludge treatment	74	18.3
Municipal lagoon treatment	26	13.3
Municipal fixed media treatment	10	24.9
Municipal sand filter treatment	11	13.5
Municipal primary only treatment	9	114.6
Industrial biological treatment	17	17.2
Industrial physical or chemical treatment	10	41.8

Mercury to Land

DEP estimates 42 pounds of mercury are contained in sludge and composted sludge applied to the land annually in Maine. This quantity largely reflects the use and disposal of mercury products in wastewaters destined for public/private wastewater treatment plants. The mercury is captured by the treatment plants prior to discharge to surface waters, and is collected in the sludge that must be managed. Typical wastewater treatment sludges contain mercury in concentration of 1.12 ppm.

Municipal solid waste is either incinerated (60%) or placed directly in landfills (40%). On an annual basis, the ash of the incinerated portion of municipal solid waste is estimated to contain 3,364 pounds of mercury. This ash is disposed of in licensed, secure landfills with engineering controls

designed to protect ground water, surface water and air quality. The other 40% of municipal solid waste directly landfilled also includes products containing mercury, but the total amount of mercury has not been quantified.

IV. Activity and Progress Since 1997 and Recommended Future Actions

This section follows the format of Section IV(C) of the 1997 Mercury in Maine Report to allow the reader to assess, four years later, progress in carrying out the mercury reduction strategies set forth in that report. The ten mercury reduction strategies from the 1997 Report are listed below. Following each strategy, the "Proposed Actions" from the 1997 Report are restated, the "Actions Taken" since 1997 are identified, and "Future Actions" are proposed. The Future Actions are the Department's recommendations to further reduce mercury in Maine's environment.

Strategy 1: Reduce air emissions discharges from Maine's largest mercury sources

Large Municipal Waste Combustors (MWCs)

Proposed Actions (1997 Report):
Complete rule-making for large municipal waste combustors (MWCs).

Actions Taken (1998 - 2001):
When the 1997 LWRC Mercury in Maine Report was written, HoltraChem was the largest source of mercury air emissions in Maine, followed by the municipal waste combustors. While federal regulations were anticipated to reduce municipal waste combustor emissions, federal air toxic rules would not have controlled HoltraChem emissions in the near term. As a consequence, DEP submitted a bill to the Legislature to require all sources emit no more than 100 pounds of mercury annually, after January 1, 2000, and no more than 50 pounds annually after January 1, 2004. This bill, signed by Governor King in April 1998, essentially impacted three facilities: HoltraChem and the two municipal waste combustors using mass burn technology (Regional Waste Systems of Portland (RWS) and Mid-Maine Waste Action Corporation of Auburn (MMWAC)).

Federal regulations for the large municipal waste combustors were established in early 1998, and facilities were required to be in compliance by December 19, 2000. Maine Energy Recovery in Biddeford (MERC) and Penobscot Energy Recovery Company (PERC) already met the standards, but RWS had to install controls. Stack tests done in autumn 2000 to demonstrate compliance with the state rules show a 92% reduction in mercury emissions at RWS. MMVAC and HoltraChem are discussed immediately below.

Future Actions (2002 and beyond):
The state will continue its efforts to reduce emissions from municipal waste incinerators through source reduction and source separation initiatives that target mercury-added products.

Small Municipal Waste Combustors

Proposed Actions (1997 Report):
DEP will initiate a rule-making process to develop a state standard for small MWCs.

Actions Taken (1998 - 2001):
The Mid-Maine Waste Action Corporation (MMWAC) incinerator in Auburn is the only one of Maine's four, municipal waste combustors that is not large enough to require compliance with the new federal limits on mercury emissions. However, MWAC is subject to the state statute that limits mercury air emissions to 100 pounds as of January 1, 2000 and 50 pounds by January 1, 2004. DEP issued a license amendment to require compliance with the state statute and with the federal regulations that apply to large combustors. Stack tests done in autumn 2000 show that MMWAC has achieved a 96% reduction in mercury emissions.

Future Actions (2002 and beyond):
The state will continue its efforts to reduce emissions from municipal waste incinerators through source reduction and source separation initiatives that target mercury-added products.

HoltraChem

Proposed Actions (1997 Report):
DEP should pursue reductions in allowable emissions through permit modification or legislation.

Actions Taken (1998 - 2001):
The Department submitted legislation, enacted as PL 1997, c. 722 that would have limited air emissions from HoltraChem to 100 pounds per year beginning January 1, 2000. However, HoltraChem ceased production operations in September 2000, and is decommissioning the facility. Consequently, no action regarding permit modification was necessary.

Future Actions (2002 and beyond):
The DEP will oversee cleanup of mercury contamination on the HoltraChem site and in the Penobscot River adjacent to the site. During remediation and closure activities, air monitoring will be conducted to ensure that mercury air emissions are within acceptable limits.

Medical Waste Incinerators
Proposed Actions (1997 Report):
Work with medical waste incinerators to reduce incineration of mercury-containing products.

Actions Taken (1998 - 2001):

Most medical waste incinerators have ceased incinerating waste on-site. Two remaining rural incinerators in Calais and Fort Kent will cease operations by September 15, 2002.

Future Actions (2002 and beyond):

The Department will continue its partnership with Maine's hospitals to achieve the virtual elimination of mercury from the hospital waste stream through use of mercury-free products and source separation of remaining mercury-containing items (see discussion under Strategy 3).

Industrial and Utility Boilers

Proposed Actions (1997 Report):

DEP will investigate whether any incentives could be provided to coal-fired industrial and utility boiler operators to switch to alternative fuels. (See discussion below on sector-specific mercury pollution prevention partnerships.)

Actions Taken (1998-2001):

High oil prices in the recent past have made coal more attractive as a fuel, and two pulp mills are using it (SAPPI-Westbrook and Mead). Dragon Cement in Thomaston also uses coal. Mercury testing will be required for Dragon as part of their new air emissions license.

Most other industrial and utility boilers do not use coal, but emit mercury incidentally when combusting biomass and oil. Mercury is present in trace amounts in these fuels. Future strategies to deal with these sources could include switching to cleaner fuels and energy conservation.

Future Actions (2002 and beyond):

Maine statute requires, as of January 1, 2004, that no facility emit more than 50 pounds of mercury annually. Federal air toxics requirements (e.g. MACT) will require Dragon Cement to perform stack testing for mercury. DEP will use this data to determine compliance with state statute. DEP will also require stack testing for Mead and SAPPI-Westbrook to ascertain compliance. Based on test results, DEP will evaluate further options for control.

Strategy 2: Reduce and eliminate mercury discharges to state waters.

HoltraChem

Proposed Actions (1997 Report):

Through permit modification or change of law, HoltraChem's authority to discharge mercury to Maine waters will end.

Actions Taken (1998 - 2001):

In 1998, Maine law was changed to reduce the maximum allowable discharge of mercury from a wastewater treatment facility to less than 1 pound per year after January 1, 2002 and less than 45 grams (0.1 pound) per year after January 1, 2004.[31] . The HoltraChem wastewater treatment plant was substantially upgraded during 2001 to allow for onsite clean-up of a portion of the mercury contaminated ground water. The total amount of mercury discharged through the licensed outfall during 2001 was 0.13066 pounds.

Future Actions (2002 and beyond):

The mercury discharge limit for HoltraChem's wastewater discharge license in 2002 will be 0.1 pounds per year.

Unpermitted Discharges

Proposed Actions (1997 Report):

DEP will give priority to identifying unpermitted mercury in wastewater effluent for testing and elimination through the effluent toxics wet testing program.

Actions Taken (1998 - 2001):

The Legislature and Maine DEP have taken a number of steps to identify sources of mercury and then eliminate or reduce the use of the products containing mercury.

Legislation passed in 1998[32] in response to the 1997 Mercury in Maine Report required the DEP to investigate and report on the following:

1) Facilities in non-compliance with 38 MRSA 420 (requires facilities discharging mercury to waters of the state to make reasonable progress in implementing pollution prevention measures);
2) Results of effluent testing using more refined test protocols;
3) Evaluation of sources of mercury to certain facilities;
4) Status of new USEPA method 1631; and
5) Levels of natural concentrations of mercury in receiving waters.

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[31] See PL 1997, c. 722, §2, enacting 38 MRSA §420(1)(A-1), and PL 1999, c. 500, §§1 and 2, which repealed section 38 MRSA §420(1)(A-1) and enacted 38 MRSA §420(1-A)(C) in its place.

In response to the above legislation, the Department conducted an extensive field sampling of 91 municipal and industrial wastewater treatment facilities across the state. A total of 122 influent and effluent samples were collected and analyzed. All of this sampling work was performed utilizing the new USEPA 1631 method of analysis, which the Department obtained interim approval to use from the USEPA. This sampling combined with another sampling event conducted by Department staff, enabled us to understand more about the current levels of mercury in our waters and how much mercury was discharged from each of the facilities sampled. All of this information was submitted to the legislature on February 1, 1999 in a report titled, Mercury in Wastewater: Discharges to the Waters of the State 1999.

Legislation passed in 1999[33], required that the DEP:

1) Establish interim discharge limits for mercury for each wastewater treatment facility, including rules which explain how the limits are created and enforced;
2) Develop model pollution prevention plans for all facilities involved with the new interim discharge limits; and
3) Develop a new statewide criteria for mercury.

During 1999, the Department conducted another extensive field sampling event to collect more mercury effluent information on the wastewater treatment facilities across the state. This time, 198 samples were collected from 93 facilities. This event gave the Department a better understanding of the discharges taking place across the state, and combined with some sampling done by the facility staff, the Department was able to establish interim limits for all affected facilities.

Department staff and a group of 10 stakeholders developed municipal and industrial model pollution prevention plans. These plans were distributed to the facilities throughout the state to utilize as a guide to develop their own customized pollution prevention plan. Prior to the distribution of the model pollution prevention plans, the DEP surveyed the wastewater treatment facilities to determine how many of the plants may have begun doing pollution prevention on their own. DEP staff was in the process of developing the regulations that would create and manage the interim limits for all of the facilities. All of this information was summarized and submitted to the legislature on January 14, 2000 in a report titled, Status of Mercury from Wastewater Facilities in Maine.

Throughout calendar year 2000, DEP continued to assist in the development and implementation of the municipal and industrial pollution prevention plans. In some cases, tests revealed violations of a facility's interim limit, and follow-up testing and investigation was required. A significant amount of additional data

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[32]See PL 1997, c. 722, §6.
[33] See PL 1999, c.500, §§3-6.

was accumulated by the operators at the various wastewater treatment facilities and was summarized in a report to the Legislature on January 15, 2001 titled, Status of Mercury Discharged from Wastewater Treatment Facilities in Maine.

In 2001, the Maine Legislature enacted new ambient water quality criteria for protection of human health based on a fish tissue residue criteria, and criteria for protection of aquatic life based on mercury concentration in the water. However, the ambient level of mercury in Maine rivers and lakes often exceeds the new water quality criteria. The Department recognizes that the effluent from many facilities contains lower concentrations of mercury than the current ambient levels, but may nonetheless exceed the new ambient criteria. Therefore, the new law allows the Department to establish interim mercury discharge limits for each facility (which may be higher than ambient concentrations) and requires reasonable progress in implementing pollution prevention plans for all discharges. These plans will require dischargers to take actions to decrease mercury concentrations in effluent. These actions are aimed at the state's continuing goal of reducing mercury discharges over time. Achievement of this goal will be determined by monitoring discharges to measure the success of these efforts. The Department is also directed to establish a mercury water quality standard for protection of wildlife.

Future Actions (2002 and beyond):
The Department will continue to monitor the effluent testing conducted by wastewater treatment facilities to ensure compliance with mercury discharge limits. In addition, the Department will continue to provide support to the wastewater treatment facilities to maintain their pollution prevention plans. Source reduction and source separation initiatives targeting mercury products will also contribute to discharge reductions.

Strategy 3: Divert Mercury from the solid waste stream.

Mercury-containing lamps

Proposed Actions (1997 Report):
DEP will give high priority to ensuring compliance with rules regarding disposal of mercury-containing lamps. DEP will utilize education and assistance first to ensure that there is knowledge of existing regulations and disposal options. Enforcement will be utilized as needed.

Actions Taken (1998 - 2001):

- In 1998 and 1999, the DEP distributed and explained its *Mercury-Containing Lamp Policy* at regional workshops for small quantity hazardous waste generators and during on-site visits with other hazardous waste generators.

- In 1999, the SPO contracted with the Androscoggin Valley Council of Governments (AVCoG) to expand their successful annual HHW program to include mercury-added products, such as fluorescent lamps. AVCoG staff worked with a number of communities in establishing consolidation points for these products and arranged for the collection of the lamps as needed. This pilot project has provided information that has been helpful in designing a statewide initiative.
- In May 2000, Governor King signed legislation establishing a ban on disposal of all mercury-added lamps in municipal solid waste. The ban applies to lamps generated in commercial activity beginning July 15, 2002. It does not apply to waste lamps from households until January 1, 2005 in order to give municipalities time to develop collection facilities. The bill also requires vendors who sell large volumes of mercury-added lamps to provide written notice to the purchaser regarding the mercury content. Guidance on compliance with the latter requirement has been posted on the DEP website.
- In December 2000, the BEP revised its hazardous waste management rules to establish a new regulatory category called "universal waste," a term that includes mercury-added lamps. The universal waste standards for lamps are derived from the DEP's 1996 *Mercury-Containing Lamp Policy* and, like the lamp policy, are expected to increase recycling rates by tailoring the regulatory requirements.
- In March 2001, the State Planning Office announced a grants program to assist municipalities and regional entities with managing mercury added products and other universal wastes. About $300,000 was allocated from the Maine Solid Waste Management Fund for this purpose. Grants were awarded for 50 storage sheds serving about 66% of the state population, and six "one-time" household hazardous waste collections. As of December 31, 2001, 23 recipients have received their storage shed or completed construction of the universal waste storage facility.
- In August 2001, the DEP published and began distributing the *Universal Waste Handbook* to promote proper handling, storage and recycling of spent fluorescent lamps, thermostats and other universal hazardous wastes.
- From September to December 2001, the DEP held 14 training sessions for municipalities that plan to collect spent fluorescent lamps and other mercury-added products at their solid waste transfer stations. At many of these sessions, SPO was present to provide information on its grants program for mercury product storage facilities.
- In October 2001, SPO released a Request for Proposals for statewide collection of mercury-added products and other universal wastes from municipal facilities. The impetus for this action is to assist communities and regions in controlling expenses by securing a single vendor who would be able to take advantage of economies of scale to provide pickup and recycling services to all areas of the state for a fixed, affordable price.

- From September through November 2001, the DEP held 15 sessions to inform businesses regarding the handling of universal waste, to increase their awareness of mercury's impact on the environment and to discuss the requirements in recent legislation covering mercury products. These sessions were held throughout the state from Sanford to Caribou.

- In December 2001, a one-page summary of the universal waste standards with a spill plan on the reverse side was developed for small universal waste generators.

- In December 2001, a universal waste brochure was mailed to all businesses in the state through a taxation annual mailing. This awareness level brochure was mailed to approximately 58,000 businesses.

- In December 2001, a mailing was sent to the 432 tanning salons on the proper disposal of their used fluorescent lamps. This was sent along with an annual mailing from the Division of Health Engineering, Radiation Control Program of the Department of Human Services.

Future Actions (2002 and beyond):

- A bond is proposed by the State Planning Office for the 2002 legislative session that includes funds for completing deployment of storage sheds statewide.
- Continue education and outreach activities to apprise the regulated community of lamp recycling requirements;
- Continue to provide training and technical assistance on lamp recycling to the regulated community and municipalities; and
- Continue to work with SPO and municipalities in developing collection facilities for spent lamps.

Other mercury-containing products

Proposed Actions (1997 Report):

To the extent practicable, DEP will utilize the 1996 Mercury Containing Lamp Policy as a framework for the development of similar policies governing the recycling and disposal of other mercury-containing wastes: e.g., thermostats, switches, mercury-containing laboratory preparations.

Actions Taken (1998 - 2001):

- The revisions to Maine's hazardous waste rules adopted by the BEP in December 2000 include thermostats in a new regulatory category called "universal waste" and establish management standards that allow thermostat manufacturers to operate a thermostat recycling program in Maine. Under this program, used mercury thermostats may be returned to the Thermostat Recycling Corporation, a company formed by thermostat manufacturers.
- In December 2001, the DEP began rule revision proceedings to include other mercury-added products, such as switches and thermometers, in the definition of universal waste. The proposed rule revisions include management standards similar to those that apply to mercury lamps and thermostats.

Future Actions (2002 and beyond):
Complete rulemaking proceedings to establish standards for managing other mercury-added products as universal waste to facilitate the segregation of these products from the solid waste stream.

Sector-specific mercury pollution prevention partnerships

Proposed Actions (1997 Report):
DEP will seek funding for outreach efforts with appropriate trade associations for specific mercury-using audiences, targeting those determined to be the highest contributors of mercury to Maine's waste stream. Those to be considered include: medical waste generators, including hospitals/labs, dentists and veterinarians; lighting and electrical contractors; heating/ventilator/AC contractors; and other mercury using businesses.

Actions Taken (1998 - 2001):
The DEP has undertaken mercury reduction initiatives with the sectors enumerated below. The Legislature allocated funds for a staff position to conduct outreach efforts from existing fees paid to the Solid Waste Management Fund. DEP has also utilized EPA grant funds for this purpose.[34]

1. Hospitals and laboratories

Actions Taken (1998 - 2001):

- In January 1999, the DEP held workshops for biomedical waste generators at which information was provided on identification and proper handling of mercury-added products.
- In April 1999, the DEP published an information sheet for health care providers titled "Mercury Management in the Health Care Environment."

[34] See PL 1999, c. 779, § 8.

- In September and October 2000, the DEP held workshops on laboratory safety at which information was presented on identification and proper handling of mercury-added products.
- In February 2001, the DEP signed a pollution prevention agreement with the Maine Hospital Association (MHA) and the Natural Resources Council of Maine. The agreement calls for signatories to work toward virtual elimination of mercury from hospital settings. To facilitate this effort, the DEP and MHA supported enactment of a new law requiring manufacturers who sell products to hospitals to disclose the mercury content of the products upon hospital request [see PL 2001, c. 373, § 3].

2. Dentists

Actions Taken (1998 - 2001):

- In April 2000, the DEP published and began distributing "The Environmental Guide for Dentistry." The guide includes best management practices for using mercury amalgam.
- In September 2000, the DEP convened a stakeholder group to develop a pollution prevention plan for mercury from dental procedures. Maine law requires the plan to be developed by July 15, 2002 [see 38 MRSA §1667 as enacted under PL 1999, c. 779, §2].

3. Dairy farmers

Actions Taken (1998 - 2001):

- In August of 2000, the DEP and the State Veterinarian initiated a program to identify, collect and recycle mercury manometers used to measure vacuum in milking machines on dairy farms. The manometer will be replaced with an electronic, non-mercury gauge at no cost to the farmer. About 25 mercury manometers have been identified for collection and recycling through this program. Each manometer contains about 12 ounces of mercury. Information on the program is posted on the DEP website.

4. Heating, ventilation and air conditioning contractors

- In August 2000 the DEP contacted heating, ventilation and air conditioning contractors to encourage them to participate in the TRC recycling program operated by manufactures of mercury thermostats. The DEP also issued press releases in September and December 2000 to encourage participation in the TRC program. Information on the TRC program, including a list of participating wholesalers, is published on the DEP website.
- In the latter half of 2001, the Department and the Mercury Product Advisory Committee worked with TRC to improve participation in their recycling program. The Advisory Committee is also preparing a letter for distribution to retailers asking that they provide information to HVAC contractors and other thermostat customers about the hazards of mercury, recycling options, and non-mercury alternatives.

5. Automobile manufacturers and recyclers

- In September 2000, the DEP convened a stakeholder group to develop a source reduction and separation plan for mercury components in motor vehicles. The plan, which was submitted to the Maine Legislature in January 2002[35], calls for aggressive action to remove mercury switches from vehicles before they are crushed for recycling at end of life.

  Mercury switches were used in convenience lights under automobile hood and trunk lids and in antilock braking systems. There are an estimated 850,000 mercury switches in Maine cars today. At 0.8 grams of mercury per switch, this amounts to about 1,500 pounds of mercury. Most of this mercury will be emitted to the environment unless the switches are removed before the vehicles are crushed for recycling. The mercury is released when the crushed vehicles are subsequently shredded and smelted to produce recycled steel.

  To help ensure that mercury switches in Maine cars do not contribute to global mercury pollution, the DEP has developed a source reduction and separation plan that calls for the Maine Legislature to:

  - Ban the sale of new automobiles with mercury-added switches;
  - Prohibit the crushing of automobiles that contain a mercury-added switch;
  - Require car dealers and automakers to remove many mercury light switches from vehicles still on the road so that the entire burden of the removal program does not fall on junkyard operators, dismantlers and others engaged in handling vehicles at end-of-life; and
  - Require automakers to help pay for recycling the mercury switches removed from automobiles.

  The plan is intended to maximize the switch capture rate by providing multiple opportunities for removal. Further, it ensures program costs are fairly shared by those responsible for removal and by the automakers.

Future Actions (2002 and beyond):

- **Hospitals.** Continue working with the Maine Hospital Association (MHA) to identify and reduce the use of mercury-containing products in hospitals. Support MHA's mercury reduction efforts

[35] See 38 MRSA §1665 as enacted by PL 1999, c. 779, §2.

which include workshops, training sessions and dissemination of information on its web site, as recently expanded with funding from the DEP and SPO.

- **Dentists.** With the assistance of dentists and other stakeholders, complete the pollution prevention plan called for under 38 MRSA §1667 and mail a copy to each dentist in Maine.
- **Lamps and thermostats.** Continue to hold training seminars on proper handling of waste mercury-added lamps and thermostats. Work with municipalities to enhance and refine the collection infrastructure for lamps, thermostats and other mercury-added products. Negotiate a contract for recycling of mercury-added products collected by municipalities. Work with TRC and the Mercury Products Advisory Committee to promote participation by wholesalers and contractors in the TRC thermostat recycling program.
- **Automobiles.** Work with automobile manufacturers, dealers, junkyards, dismantlers and recyclers to ensure that mercury switches are removed from motor vehicles before they are crushed for recycling. Disseminate information to the public on mercury-added components in vehicles and encourage early removal of mercury-added convenience light switches by car owners and used car dealers, before vehicles reach the end-of-life.
- **Schools.** Work with schools to clean out elemental mercury compounds, mercury-containing scientific instruments, and potentially other mercury-added products.

Mercury-containing battery disposal

Proposed Actions (1997 Report):

DEP and SPO will collaborate to determine the level of compliance with the existing law requiring the collection of mercuric oxide and rechargeable batteries in the state.

- DEP and SPO will work with battery manufacturers to determine the extent to which other battery types sold in the state contain mercury and to determine if other types of batteries should be diverted from the solid waste stream.
- DEP and SPO will seek the cooperation of the Maine Municipal Association to develop a "user friendly" battery collection system that builds on existing municipal recycling programs, while taking into account the special hazards posed by these wastes. Funding will be sought to conduct a pilot program for a collection system to recycle batteries in at least one community for broader application in the state.
- As appropriate following completion of an inventory of mercury sources in Maine, action will be taken to ensure that government agencies are disposing of batteries in compliance with the law.

Actions Taken (1998 - 2001):

In 1984 and 1985, the battery industry accounted for about 55% of the total U.S. consumption of mercury. By 1994, however, the industry had eliminated mercury from most battery formulations. Today, mercury is used in only two types of batteries—large mercuric oxide batteries used in specialized settings such as hospitals, and small button batteries like those used in hearing aids and watches. Based on information filed by the National Electrical Manufacturers Association, button batteries sold in Maine in 2000 contained a total of about 18 pounds of mercury. Mercury is not used in formulation of rechargeable batteries.

1998

- The DEP confirmed that Alexander Technologies, Inc., the only U.S. manufacturer of mercuric oxide batteries, has established a battery collection system as required under Maine law at 38 MRSA § 2165. Attendees of a workshop on biomedical waste were informed of the statutory requirement to use this collection system for disposal of mercuric oxide batteries, which are used in some hospitals as a back-up power source for emergency medical equipment.
- The DEP arranged a collection program following the ice storm in January 1998 to capture any mercury-containing batteries that may have been used during the prolonged power outages associated with the storm. The collection program was a one-time, limited duration event targeting towns that incinerate their solid waste. Ongoing collection of non-rechargeable batteries was determined to be unwarranted because, except for button cells, mercury is not used in formulation of mass-marketed batteries made after 1994. The ice storm is presumed to have "flushed out" any batteries made before that date.

2000

- The DEP published and began distributing an information sheet on Consumer Battery Management.

2001

- The DEP had button cell batteries from several toys and novelty items analyzed for mercury content, and found that those made in foreign countries exceed the 25 milligram limit under state and federal law [see 38 MRSA §2165(6)(D)]. The results have been reported to the USEPA for possible enforcement action.

Future Actions (2002 and beyond):

The DEP and Mercury Products Advisory Committee should monitor and assess information filed by button battery manufacturers under Maine's new mercury product notification law, 38 MRSA §1661-A, to determine if manufacturers are meeting the 25 milligram limit and if the amount of mercury in button cell batteries warrants a targeted collection program. The DEP and the Advisory Committee should gather

available information on button battery recycling by others in determining if such programs should be piloted or implemented in Maine.

Mercury in products

Proposed Actions (1997 Report):
DEP and SPO will explore with the Legislature the legal viability and overall effectiveness of a state ban on non-essential mercury-containing products.

Actions Taken (1998 - 2001):

- In its January 1999 report to the Legislature titled *Labeling and Collection of Mercury-Added Products*, the Land and Water Resources Council explored the effectiveness and legality of a statutory ban on the sale of mercury-added products. The discussion, which is drawn largely from a memorandum prepared by staff in the Department of Attorney General, identifies several principles of constitutional law that might be implicated by a ban and sets forth broad guidelines to consider in drafting legislation to pass constitutional muster.
- Effective September 21, 2001, the Maine Legislature banned the sale of mercury fever thermometers and mercury manometers used to measure vacuum in milking machines, and the sale of mercury and mercury compounds for use in schools.[36] These bans have not been challenged on Constitutional grounds.

Future Actions (2002 and beyond):

The Legislature will be considering LD 2004 during the 2002 session, which would authorize DEP to administer a program to phase out the use of mercury in products over an eight-year period where alternatives are available. If enacted, DEP will implement this law in conjunction with other New England states as contemplated by the NEWMOA model legislation.

Mercury in packaging

Proposed Actions (1997 Report):
DEP will continue to implement federal and state laws that set limits on the mercury content in packaging.

Actions Taken (1998 - 2001):

[36] See 38 MRSA §1661-C, as enacted by PL 2001, c. 373, §3.

The DEP remains a member of the Toxics in Packaging Clearinghouse formed to promote regulatory consistency among the states. DEP Office of Innovation and Assistance staff represent the Department in clearinghouse discussions and has served on a national work group organized to examine ways to eliminate toxics in packaging.

Future Actions (2002 and beyond):
Continue to participate in the Toxics in Packaging Clearinghouse, and consider updating legislation to make Maine law consistent with changes made by Clearinghouse member states' changes when such changes would serve the intent of Maine's law.

Strategy 4: Complete a Maine inventory and risk ranking.

Local emissions monitoring

Proposed Actions (1997 Report):
Emissions sampling to verify national emissions factors against Maine sources will be conducted at sources likely to be significant based on emission factors.

Actions Taken (1998 - 2001):
Mercury testing occurred at all four MWCs to ensure compliance with new regulations. Dragon Cement also conducted testing in 1998.

Future Actions (2002 and beyond):
Testing will be required for mercury emissions at each facility that burns coal in Maine, and periodic compliance testing will continue to be required at MWCs.

Waste characterization

Proposed Actions (1997 Report):
DEP and SPO will use models from other New England states to identify sectors of Maine commerce where mercury use is highest. As resources allow, DEP and SPO will undertake a study of the mercury levels in Maine solid waste.

Actions Taken (1998 - 2001):

- In a January 1999 report to the Legislature titled *Labeling and Collection of Mercury-Added Products*, the Land and Water Resources Council identified five specific products—thermostats, thermometers, fluorescent lamps, convenience light tilt switches in auto hood and trunk lids, chest

freezers, and button batteries—that appear to account for the bulk of mercury in the Maine solid waste stream. However, the report also noted that dozens of other mercury-added products are sold in the state and that efforts to put numbers to mercury amounts in products are hampered by the lack of hard data.

- Legislation enacted in May 2000 requires manufacturers to identify mercury-added products by affixing a label to them.[37] In January 2001, the BEP adopted rules establishing labeling standards.[38]
- Legislation enacted in June 2001 requires manufacturer notification prior to sale of mercury-added products in Maine. The notification must include the following information:
  - A brief description of the product;
  - The purpose for which the mercury is used in the product;
  - The amount of mercury in each unit of the product; and
  - The total amount of mercury in all units of the product sold in the United States during the most recent calendar year for which sales are available.

Future Actions (2002 and beyond):

DEP recently participated in the formation of the Interstate Mercury Reduction and Education Clearinghouse (IMERC) in conjunction with other New England states under the auspices of NEWMOA. IMERC will be the principal point of contact for submittal of mercury notification information in the region. IMERC will collect the data and organize it into a publicly accessible database. Initial operations of the database should begin by April 2002, and information will be updated as received on a continuing basis thereafter.

"Clean State" mercury inventory

Proposed Actions (1997 Report):

As resources allow, DEP will work with other state agencies under the "Clean State" initiative[39], to complete a comprehensive inventory of mercury use, including recycling and disposal practices. Depending upon the findings from this effort, DEP may recommend additional pollution prevention activities aimed at state agencies.

Actions Taken (1998 - 2001):

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[37] See 38 MRSA §1662, sub-§1, as enacted by PL 1999, c.779, sec. 2.
[38] See DEP rules, Chapter 870, effective March 4, 2001.

Maine law governing the Clean Government program requires state agencies to seek continuous improvement in environmental performance through, in part, procurement of environmentally friendly commodities, including technically comparable, cost effective and reasonably available alternatives to products that may release mercury to the environment. The DEP is working with the Department of Administrative and Financial Services to develop procurement policies that implement this requirement. The DEP and the Department of Administration also have begun a program to remove mercury convenience light switches from surplus state vehicles before they are auctioned so that the mercury is not released when the vehicles are recycled at end of life.

Future Actions (2002 and beyond):

- Conduct a mercury thermometer collection program for participation by all state employees.
- Continue removal of convenience light switches and eventually transfer responsibility for removal from surplus state vehicles.
- Identify opportunities in procurement and other Clean Government mechanisms to reduce state purchase of mercury-added products and ensure proper management of mercury-added products.

- **Residential wood combustion**

Proposed Actions (1997 Report):

Research into mercury from residential wood combustion of Maine tree species will be done at the University of Maine in Orono. DEP will pursue both possibilities for regional and national collaboration and additional funding to supplement UMO's research efforts.

Actions Taken (1998 - 2001):

UMO completed their analysis, however results were inconclusive. DEP pursued and obtained additional funds for research. This funding was diverted to other mercury research (Mercury Deposition Network).

Future Actions (2002 and beyond):

Additional action will not take place due to lack of funding.

Risk Ranking

Proposed Actions (1997 Report):

DEP and SPO will develop a risk ranking of significant mercury sources, based upon both levels released to the environment and the human/wildlife implications of exposure pathways.

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[39] The CLEAN STATE Initiative was an informal program begun in 1997. Participation by state agencies was voluntary. In 2001, legislation establishing the Clean Government program was

Actions Taken (1998 - 2001):

A risk ranking has not been formally done. The risk ranking as originally conceived is not workable, as it relies on data from other geopolitical entities that is not obtainable.

Future Actions (2002 and beyond):

Continue to monitor mercury contributions from various sources, and work with the NESCAUM, EPA, and the NEGC/ECP Mercury Task Force to enhance the Mercury Air Deposition Monitoring Network. The Department also intends to update the mercury air emissions inventory in concert with regional efforts of the NEGC/ECP.

The Department will continue to monitor the effluent data collected by these wastewater facilities and assist them with implementation of their pollution prevention plans.

Economic effects

Proposed Actions (1997 Report):

As resources allow, DEP and SPO will undertake an analysis of the economic effects associated with mercury in Maine's environment. This study will examine such issues as the economic impacts of the fish consumption advisories, and the implications of continued ecological effects due to mercury contamination.

Actions Taken (1998 - 2001):

Due to lack of available resources no economic impact analyses were conducted.

Future Actions (2002 and beyond):

There are no plans at this time to conduct economic analyses of the fish consumption advisories or the ecological effects of mercury.

Strategy 5: Expand fish sampling.

Expanded sampling plan

Proposed Actions (1997 Report):

Under the guidance of the SWAT monitoring program, DEP will design an expanded sampling plan to yield: a) indicator species and b) priority lakes/areas for lake-specific fish consumption advisories.

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passed (see 38 MRSA §343-H).

Actions Taken (1998 - 2001):

In 1998 and 1999, as part of the Surface Water Ambient Toxics (SWAT) program, DEP collected multiple species from 11 lakes to determine a mercury indicator species of fish for the other species of fish in lakes and ponds. The results documented that the most contaminated species varied among the lakes and ponds sampled. Consequently, in consultation with the Maine Bureau of Health, DEP decided upon a different strategy to be able to predict risk from human consumption of fish. The SWAT program now focuses on getting adequate data for all species. In 2000, the focus was on lake trout, and DEP asked DIFW to supply lake trout caught in performance of their own work. In 2001, DEP expanded the sampling program and asked DIFW to supply any salmonid caught in performance of their own work. As sufficient additional data become available, the results will be provided to the Bureau of Health for periodically updating the health advisories.

Future Actions (2002 and beyond):

DEP will continue to seek additional fish samples from DIFW in performance of their regular work to gather more mercury data for each species.

Use of volunteers

Proposed Actions (1997 Report):

The use of volunteers to assist in sampling and extend state resources will be explored.

Actions Taken (1998 - 2001):

In 2001, DEP employed a 50% cost share arrangement with the Lakes Environmental Association to test fish from 10 to 12 lakes in the Bridgton area.

Future Actions (2002 and beyond):

DEP will continue to cost share with organizations that have the resources to complete sample collection for a number of lakes and ponds of interest that are lacking data.

Strategy 6: Continue remediation activities at mercury contaminated sites. DEP will evaluate any sites known or suspected to be contaminated with mercury for priority remedial action.

Contaminated sites

Proposed Actions (1997 Report):

DEP will push for prompt remedial action at HoltraChem and any other site in the state where soil or sediment contamination warrants.

Actions Taken (1998 - 2001):

DEP worked to curb mercury emissions from the HoltraChem site in Orrington, and to clean up the mercury contamination from past spills and practices at the site. During 2001, the wastewater treatment plant at HoltraChem was upgraded to begin treating a portion of the site's groundwater. This treatment is removing mercury down to 65 ppt. The Site Investigation Report is currently undergoing review by the DEP. The proposed remedial protection standards (clean up standards) are expected to be distributed for public comment during 2002. Following this phase, a remedial design plan will be proposed. It is expected that clean up of the site will begin in earnest during 2002/2003. HoltraChem ceased production in 2000 and the facility is being decommissioned, requiring DEP to address closure and site maintenance issues as well. Mallinckrodt has become the primary responsible party now that HoltraChem is undergoing dissolution and will eventually cease to exist as a corporate entity.

The Department initiated an investigation at Mead Corporation in Rumford into possible mercury releases from its old chlor-alkali plant. The investigation results are expected by the Department in Spring 2002.

Future Actions (2002 and beyond):

It is expected that remediation of the HoltraChem site will involve the capture and treatment of groundwater, sediment removal from the Southern Cove within the Penobscot River, and the removal of many of the mercury contaminated structures on the site.

Regarding the Mead site in Rumford, the Department will review the results of the Mead investigation and require remediation if appropriate.

Contaminated sediments

Proposed Actions (1997 Report):

DEP will work with EPA, other states, the University of Maine, responsible parties and others to identify successful methods for remediation of contaminated sediments in lakes, rivers and marine settings.

Actions Taken (1998 - 2001):

In 1999, DEP applied for, but was not granted, external research funding for a joint project with the University of New Hampshire to use the Holtrachem site as a field laboratory for new remediation methods.

Future Actions (2002 and beyond):

The remediation of mercury "hot spots" at the HoltraChem site is likely to involve traditional methods (dredging). The Department will consider and evaluate the potential use of emerging technologies where appropriate at the site.

Strategy 7. Develop regional and national strategies to further reduce mercury emissions and mercury-containing products.

Regional/national collaboration

Proposed Actions (1997 Report):
Governor King will host a workshop of environmental officials from New England and Canada in February 1998 to develop a regional strategy for mercury controls. The Governor is expected to charge the participants to examine several possible components of that strategy.

Actions Taken (1998 - 2001):
In June 1998, the Conference of New England Governors and Eastern Canadian Premiers (NEGC/ECP) adopted the Mercury Action Plan (MAP) to reduce emissions within the region's control or influence. The 1998 MAP established an ultimate goal of "virtual elimination" of anthropogenic releases into the environment, and an interim goal of at least 50% emissions reductions by the end of 2003. The MAP also contained a variety of recommendations aimed at reducing or eliminating non-essential uses of mercury in products, and segregating the remaining products for collection and recycling to the maximum extent feasible.

It appears that the 50% emissions reduction objective will be met in the New England states, principally through either improved controls or the closure of waste incinerators (solid and medical), and as a result of the closure of New England's sole mercury cell chlor-alkali facility (HoltraChem). In light of this success in meeting the 2003 emissions reduction objective, the New England Governors at their September 2000 meeting sought the development of a new target for 2010. In August 2001, the NEGC/ECP Mercury Task Force proposed and NEGC/ECP adopted a 75% or greater emissions reduction (from the 1998 baseline) by 2010. This objective will be evaluated in 2005 so that new data on emissions control options and other factors can be taken into account at that time.

At this juncture, the NEGC/ECP Mercury Task Force anticipates meeting the 2010 goal through substantial reductions of emissions from coal-fired boilers at utilities and large industrial sources; sewage sludge incinerators; and area sources; along with continued reductions at medical and municipal waste incinerators. Area sources constitute an array of sources involving the use and subsequent management of mercury products. Reducing area source emissions and achieving further reductions from waste

incinerators will require the continuation and enhancement of initiatives aimed at eliminating or reducing mercury in products, and recycling those that remain. To this end and in furtherance of the NEGC/ECP Mercury Action Plan, the New England Waste Management Officials Association (NEWMOA) drafted model legislation to guide the New England states in developing a consistent approach to regulation of mercury-added products.

The Maine Department of Environmental Protection remains an active participant on the New England Governor's and Eastern Canadian Premier's Mercury Task Force now entering its fourth year of implementation of the Mercury Action Plan, and in the IMERC established by NEWMOA.

Future Actions (2002 and beyond): Continue to participate in implementation of the New England Governor's and Eastern Canadian Premier's Mercury Action Plan, and in the IMERC established by NEWMOA.

Federal legislation

Proposed Actions (1997 Report):
The Land and Water Resources Council is evaluating MERCURI, the federal bill cosponsored by Maine Congressman Tom Allen, with an eye toward identifying elements which will support Maine's efforts. The Council will work with Maine's Congressional delegation to refine the bill and gain passage of legislation which will benefit Maine and national interests.

Actions Taken (1998 - 2001):
Congressman Allen's bill died in committee. However, Maine is participating in a Senate Public Works and the Environment stakeholders session on the development of a multi-pollutant bill that includes mercury. The DEP has also worked with the Maine Congressional delegation on federal legislation to provide for safe storage of the mercury from closure of the HoltraChem plant. Legislation introduced in June 2001 [the Mercury Storage and Safe Disposal Act of 2001] would have allowed the US Department of Defense to store the mercury until the USEPA identifies a long-term strategy to deal with excess supplies; however, the Department of Defense (DOD) opposed the bill. Attempts to attach the key portions of the bill to the FFY 2002 DOD authorization bill failed.

Future Actions (2002 and beyond):
Maine DEP will continue to be actively involved in federal legislative activities related to mercury emissions and surplus mercury management/retirement. In addition, DEP will continue working through multi-state organizations such as New England Waste Management Officials Association (NEWMOA),

Environmental Council of the States (ECOS), New England Governor's Conference (NEGC), and the National Governor's Association (NGA) in the federal arena. (See discussion immediately below.)

Sale of mercury stockpiles

Proposed Actions (1997 Report):

The U.S. Department of Defense is considering the sale of significant stockpiles of mercury. State officials have expressed Maine's position that this volume of mercury should not be reintroduced to the market to be used in products that will ultimately enter the waste stream. DEP and other state agencies, in collaboration with other states should continue to communicate this position to federal officials.

Actions Taken (1998 - 2001):

DEP has been an active participant in a variety of state organizations that have taken positions on mercury through joint resolutions. For example, DEP helped draft ECOS Resolutions 01-1 and 01-3, passed in February 2001, that called on the federal government to develop a plan to manage the long-term storage of mercury, develop recommendations for the safe retirement of excess mercury, and exercise leadership in international forums to work toward substantial global reductions in mercury production, uses, and releases.

In June 2001, DEP assisted in the drafting of ECOS comments on DOD's Notice of Intent to Prepare a Draft Programmatic Environment Impact Statement for the Long Term Management of the National Defense Stockpile Inventory of Excess Mercury. These ECOS comments stressed the need for DOD to consider expanding the current inventory of 10,000,000 pounds of storage, rather than reducing it, to accommodate the need to store large quantities of mercury from the private sector when they become available.

Future Actions (2002 and beyond):

DEP will continue its advocacy for a federal and international mercury policy and program which reduces the global supply and demand for mercury, including the management/retirement of excess mercury. In the short-term, DEP is a Steering Committee member planning for a Mercury Retirement Conference to be held in Boston in spring 2002. The conference will bring together national (and to a limited extent) international public and private sector officials interested in this issue to explore the technical and policy issues related to reducing global mercury supply and demand. Funding for the event is through a USEPA grant obtained by NEWMOA. Other activities foreseen at the present time include continued involvement in DOD's Environmental Impact Statement process regarding the disposition of the 10,000,000 pounds in the federal inventory.

Mercury-free products

Proposed Actions (1997 Report): DEP should push for national legislation or rules to limit the unnecessary use of mercury in products such as sneakers, toys and other consumer goods.

Actions Taken (1998 - 2001):
The DEP joined with representatives from other New England states to develop model legislation that, among other things, calls for an immediate ban on some mercury-added products and for a gradual phase out of all other mercury-added products to the extent practical. The model act was issued by the NEWMOA in April 2000. Several of its provisions already have been enacted by or introduced to state legislatures in New England and elsewhere. Drawing from the model, the Maine Legislature has enacted bans on mercury fever thermometers and mercury dairy manometers, but has not yet enacted the phase out provisions.

Future Actions (2002 and beyond):
The Legislature will be considering LD 2004 during the 2002 session, which would authorize DEP to administer a program to phase out the use of mercury in products over an eight-year period where alternatives are available. If enacted, DEP will implement this law in conjunction with other New England states as contemplated by the NEWMOA model legislation.

Strategy 8: Urge federal agencies to adopt a single health-based dose response standard for mercury contamination in fish.

Federal Consensus

Proposed Actions (1997 Report):
State officials should call on the Vice President to convene all relevant federal agencies to adopt a single does response threshold.

Actions Taken (1998 - 2001):
The year 2000 report from the National Academy of Science (NAS) on Toxicological Effects of methylmercury has advanced the goal of consistent estimates of a tolerable daily intake of methylmercury used by state and federal agencies. The NAS specific recommendations on data sets and methodology for computing a tolerable daily intake (referred to as a "reference dose") provided strong support for a limit of around 0.1 microgram of methylmercury per kilogram of body weight per day. In response, the USEPA has already modified their primary toxicological database. Many states have modified their fish consumption advisories to make use of this reference dose as well. The U.S. Food and Drug

Administration has made their consumption advisories on commercial fish more restrictive, presumably at least in part as a consequence of the NAS report, and resulting in more consistency with states that had issued advice on commercial fish. However, some inconsistency between federal agencies and state agencies remains. U.S. Food and Drug Administration (FDA) has yet to revise their fish tissue tolerance level for methylmercury (still at 1 ppm). The U.S. Agency for Toxic Substances and Disease Registry (ATSDR) still supports a minimal risk level for methylmercury of 0.3 microgram per kilogram per day (as compared to the reference dose of 0.1 ug/kg/day supported by USEPA). Some states (including Maine) issue two-tiered advisories using the 0.1 ug/kg/day as the basis for advisories for the sensitive population (fetus, infants, and young children) and 0.3 ug/kg/day for all others. Other states rely solely on the 0.1 ug/kg/day, and still others retain use of the FDA action level.

Future Actions (2002 and beyond):

The State of Maine Bureau of Health is involved in attempting to set up a multi-state collaborative review of the appropriateness of the two-tiered fish consumption advisory. The Bureau of Health is seeking USEPA funding support to evaluate studies on cardiovascular, immune system, and age-related effects associated with adult or life-time exposures. At issue is whether the current scientific literature supports the assumption that the developing fetus is more susceptible to methylmercury injury than are adults for endpoints other than neurodevelopmental effects.

Strategy 9: Focus biological research on the effects of mercury on the health of loons, fish, and other wildlife with elevated mercury levels.

Proposed Actions (1997 Report):

Research funded by the Surface Water Ambient Toxics program and other collaborative efforts will include projects aimed at documenting any reproductive or other effects that may be associated with elevated mercury levels. In addition, the state will begin to seek ways to document improvements in fish and wildlife effects following reduction of mercury loading.

Action taken (1998 – 2001):

In 1997 and 1998, DEP supported BioDiversity Research Institute (BRI), a non-profit research oriented institute in Freeport Maine, through a grant proposal to the Maine Outdoor Heritage Fund to research the effects of mercury on the state's loons. Results indicated that 21-40% of Maine's loons had egg blood or feather mercury levels exceeding safe limits predicted from laboratory studies. Consequently, in 1999 and 2000, under the SWAT program DEP funded BRI to conduct follow-up studies to determine if loons were experiencing actual effects. The results documented a 37% reduction in the number of fledged young loons, from the 30% of the adults that had high levels of mercury, indicating a reduction of about

10% in the population. Population modeling predicts that with this level of impact, Maine's loon population is not sustainable.

In 2000, prompted by reports of diminished populations of mink and otter in parts of Maine, working with DIFW and BRI, DEP initiated studies of mercury contamination in mink and otter obtained from trappers. Results showed that animals from the Flagstaff Lake area, St John River, and some other areas of Maine had significantly higher levels than other areas. Concentrations of mercury in fur of 30% and 62% of mink and otter, respectively, exceeded safe levels estimated from laboratory studies, but sample sizes are small and more data are needed. In consultation with DIFW and the University of Maine, studies of mercury contamination in black terns and sharptailed sparrows also began. Concentrations of mercury in eggs of both species also exceeded estimated safe levels. Studies of both mammals and sharptailed sparrows continued in 2001.

In 2001, the Maine Legislature established a new ambient mercury criterion for fish tissue residue of 0.2 ppm for the protection of human consumers. The new statute also requires DEP to develop a mercury wildlife criterion (WC) for the protection of wildlife. DEP intends to follow EPA's framework for a wildlife criterion, but focus on more relevant species and develop a Maine specific reference dose and bioaccumulation factors. Consequently, in the 2001 SWAT program, DEP has expanded studies with loons, mink, otter, and sharptailed sparrows. Development of a wildlife criterion is expected to require at least 2 to 3 years.

Future Actions (2002 and beyond):

Studies of loons, mink and otter may continue in 2002 and perhaps beyond depending on the findings from the 2001 studies. As required by the Legislature, the Department will develop a mercury wildlife criterion to protect wildlife.

Strategy 10: Assess and implement strategies to communicate fish consumption advisories to key populations segments.

Proposed Actions (1997 Report):

The Bureau of Health will continue to work with the federal government, other states and interested parties on this issue. Efforts will be made to develop a risk communication strategy, which informs people of both the health benefits of fish consumption and the risks associated with concentrations of toxics in fish. Specific strategies will be developed to reach the populations most at risk for mercury-related health effects, women of child-bearing age, children and other sensitive individuals.

Actions Taken (1998 - 2001):

The Bureau of Health developed a new "easy to read" brochure with safe eating guidelines for both recreationally caught fish as well as fish purchased commercially. The brochure was developed using focus group methodology to ensure it is able to effectively communicate fish consumption advisories regardless of low literacy levels. Copies of the brochure were mailed to all matches between the State of Maine fishing license and birth certificate registries (i.e., to identify nearly all Maine households having someone with a fishing license and a child born in Maine under age 8). In an effort to reach pregnant women and women planning to become pregnant, the brochures have been distributed through medical offices of all Maine physicians involved in obstetrics, and offices of nurse midwifes. Brochures have also been distributed through the Bureau's Women, Infant, Child (WIC) nutritional program that provides nutritional assistance to more than 40% of pregnant women in Maine. In conjunction with the State of Wisconsin Division of Public Health, the Bureau of Health surveyed a random sample of Maine women of childbearing age on their fish consumption behavior, knowledge of advisories, and mercury exposure. Surveys were performed both in advance of development of the Bureau's new fish brochure and soon after the brochure began to be distributed.

Future Actions (2002 and beyond):

The Bureau of Health will continue its efforts at educating pregnant women and women who may get pregnant about safe eating guidelines for fish by distributing brochures through health care providers and by direct targeted mailings. The Bureau of Health is additionally planning to expand core efforts through the development of a poster for offices of health care providers and possibly other locations. The purpose of the poster is to help people learn to identify which fish are low in mercury, and therefore preferred. The poster is also intended to help increase awareness of the brochure.

Maine and Wisconsin have recently jointly applied to the USEPA for funding to support formal evaluation of the effectiveness of these new risk communication efforts.

V. 2002 Reporting Requirements

The Maine Legislature, in PL 1999,c. 779,§6, required the DEP to submit a report by January 15, 2002 on the status of mercury releases into the Environment. The report must include the following:

- An inventory of mercury releases into the environment and the sources of the releases, including natural sources:
- A summary of regional efforts to reduce mercury releases;
- An assessment of the feasibility of reducing mercury pollution from crematoriums; and
- An assessment of the economic impact of the ban on disposal of low-mercury lamps, including infrastructure development, training and education.

The required inventory of mercury releases and sources is provided in Section III of this report in a discussion titled "Mercury in Maine's Environment". The other reporting requirements are addressed below:

Regional Efforts to Reduce Mercury Releases

In June 1998, the Conference of New England Governors and Eastern Canadian Premiers (NEGC/ECP) adopted the Mercury Action Plan (MAP) to reduce emissions within the region's control or influence. The 1998 MAP established an ultimate goal of "virtual elimination" of anthropogenic releases into the environment, and an interim goal of at least 50% emissions reductions by the end 2003. The MAP also contained a variety of recommendations aimed at reducing or eliminating non-essential uses of mercury in products, and segregating the remaining products for collection and recycling to the maximum extent feasible.

The 50% emissions reduction objective will be met in the New England states, principally through either improved controls or the closure of waste incinerators (solid and medical), and as a result of the closure of New England's sole mercury cell chlor-alkali facility (HoltraChem). In light of this success in meeting the 2003 emissions reduction objective, the New England Governors at their September 2000 meeting sought the development of a new target for 2010. In August 2001, the NEGC/ECP Mercury Task Force proposed and NEGC/ECP adopted a 75% or greater emissions reduction (from the 1998 baseline) by 2010. This objective will be evaluated in 2005 so that new data on emissions, control options and other factors can be taken into account at that time.

At this juncture, the NEGC/ECP Mercury Task Force anticipates meeting the 2010 goal through substantial reductions of emissions from coal-fired boilers at utilities and large industrial sources, sewage sludge incinerators, and area sources; along with continued reductions at medical and municipal waters incinerators. Area sources constitute an array of sources involving the use and subsequent management of mercury products.

Reducing area source emissions and achieving further reductions from waste incinerators will require the continuation and enhancement of initiatives aimed at eliminating or reducing mercury in products, and recycling those that remain. To this end and in furtherance of the NEGC/ECP Mercury Action Plan, the Northeast Waste Management Officials Association drafted model legislation to guide the New England states in developing a consistent approach to regulation of mercury-added products.

Mercury Pollution from Crematories

Cremation of human bodies with mercury amalgam tooth fillings is a potential source of mercury air emissions. A survey of available literature, as reported in the *Northeast States and Eastern Canadian Provinces Mercury Study* (February 1998), suggests an average emission factor of 2.9 grams per cremation, with a range from 0.8 to 5.6 grams.[52] In its *Mercury Study Report to Congress* (1999), the USEPA cited studies in three European countries (Germany, Switzerland and the United Kingdom) suggesting an emission factor of one gram of mercury per cremation.

Emission testing performed on operating crematories by EPA in 1999 and reported subsequent to publication of the 1999 *Mercury Study Report to Congress* suggest even lower mercury emission rates. Extrapolation of this test data yields a mercury emission rate of 2.7×10^{-6} pound of mercury per pound of body weight combusted. Thus, a body weight of 165 pounds would yield 0.2 grams of mercury.

In 2000, about 5416 bodies were cremated in the five licensed crematories[53] in Maine. A mercury emissions factor of 0.2 grams per body yields annual total mercury emissions of about 2.4 pounds from in-state cremation. An emissions factor of 1 gram per body yields total in-state mercury emissions of about 12 pounds.

Crematories in Maine are subject to a particulate emission standard and a visible emission standard. Air emission licenses for these facilities also may impose combustion temperature and retention time requirements. No specific emission limit for mercury currently is imposed on crematories and no such limit is currently under consideration. The department has instead focused its efforts on source reduction with the dental community. Mercury emissions from cremation are expected to decline in the future as a result of the declining use of mercury containing dental amalgam.

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[52] NESCAUM et al., *Northeast States and Eastern Canadian Provinces Mercury Study*, February 1998, page V-23.

[53] Gracelawn Crematory in Auburn; Mount Hope Crematory in Bangor; Northern Maine Crematory in Presque Isle; Brooklawn Crematory in Portland; and Laurel Hill Crematory in Saco.

Assessment of Ban on Disposal of Mercury-added Lamps

1. Use of mercury in lamps

All fluorescent lamps contain mercury. The mercury is added during manufacture and is essential to the operation of this energy efficient lighting. Over the last decade, lamp manufacturers have reduced mercury content, but it has not yet proven feasible under current technology to eliminate the mercury altogether. Without mercury, the lamp would not produce visible light.

High intensity discharge (HID) lamps like those used for street lighting and flood lights also contain mercury. The National Electrical Manufacturers Association (NEMA) reports that fluorescent and HID lamps sold in the U.S. by its member manufacturers in calendar year 2000 collectively contained 22,516 pounds of mercury.

Fluorescent lamps are made in numerous sizes and shapes for both general illumination and specialty applications like photocopying and automobile instrument panels. Perhaps most familiar are the linear fluorescent tubes widely used for illumination in schools, offices and warehouses. NEMA reports that linear fluorescent lamps contain 15.1 milligrams (mg) of mercury on average. The exact amount of mercury varies depending on manufacturer, model, length and diameter.

Linear fluorescent tubes are made in lengths from 6 inches to 10 feet and vary in diameter. The most common size is the 4-foot T8 or T12 tube, in which the "T" stands for tubular and the number refers to diameter in eighths of an inch. Thus, a T8 lamp is one inch in diameter; a T12 is 1½ inches in diameter. NEMA estimates that about 2 million 4-foot fluorescent tubes are sold in Maine each year.

2. Regulation of Lamp Disposal

Under current state law, all mercury-added lamps except those generated by households must be recycled if they qualify as hazardous waste. Some fluorescent lamp models, however, do not qualify as hazardous waste when analyzed for mercury using the USEPA Toxicity Characteristic Leaching Procedure (TCLP). These non-hazardous lamps legally may be placed in the municipal solid waste stream for disposal under current Maine law, with the result that the mercury is released to the environment when the bulb is broken during collection, or when it is landfilled or incinerated.

This situation will change on July 15, 2002, the effective date of a new law that prohibits placing mercury-added products in the trash regardless of whether they are hazardous under the TCLP. The Legislature did not exempt TCLP-compliant lamps from this prohibition for several reasons, including the potential confusion resulting from a recycling requirement that applies to some but not all fluorescent lamps even though they all contain mercury. Further, the Legislature was not persuaded that the TCLP test was a good way to differentiate lamps based on mercury content.

In December 2000, the DEP arranged for laboratory analyses to determine if there are significant differences in mercury content between lamps that are TCLP compliant and those that are not. A

statistically-valid sample of 4-foot fluorescent lamps for each of three U.S. manufacturers-Philips Lighting Company, Osram Sylvania and General Electric- were analyzed by Veritech Laboratories, Inc. of Fairfield, New Jersey and the results were validated by Kestrel Environmental Technologies, Inc. of Freeport, Maine.

The results of these analyses, reported in Appendix B, suggest there is no basis to exempt TCLP-compliant lamps from the statutory ban on disposal. Of the lamps studied, TCLP-compliant lamps contain slightly less mercury on average than non-compliant lamps, but the difference is not significant. TCLP-compliant lamps sometimes contain more mercury than lamps that are hazardous under the TCLP.

3. Lamp collection and recycling infrastructure

Commercial lamp recycling services now are available throughout the state as the number of private sector lamp recyclers has grown rapidly to meet the increasing demand. There are about 58,000 non-household generators of waste lamps in Maine, assuming most businesses use fluorescent lighting. The DEP web page lists about a dozen companies that will transport spent lamps for recycling. These companies have a statewide reach although most are based in southern and central Maine.

Municipal capability to collect and store lamps for recycling also is being expanded rapidly. As directed under 38 MRSA §1669, the DEP and the State Planning Office (SPO) have taken steps to help municipalities develop collection programs for mercury-added products including lamps. The DEP revised its Hazardous Waste Management Rules to establish management standards designed to facilitate and encourage municipalities to separate and collect mercury-added lamps and other "universal wastes" at municipal solid waste facilities. And the SPO has begun making grants to municipalities for sheds to collect and store fluorescent lamps and other mercury-added products for recycling.

The SPO grant program was funded from surplus revenues in the Solid Waste Management Fund. About $300,000 has been allocated from the fund to construct storage sheds, modify existing structures or support one-time collection events. Fifty-five grants have been awarded to date; forty-nine for storage sheds and six for one-time collection events. The sheds, once in place, will serve 223 municipalities representing 66% of the State population.

The sheds will be used to collect lamps, mercury thermometers, rechargeable batteries, and mercury containing thermostats. Twenty-four of the sheds serving about 48% of the population will be large enough to also allow for collection of computers and TVs. The timetable for placement of all sheds is by the end of 2002, but over half should be operating by the end of 2001. To help with operating costs, SPO also is seeking to enter into a group service contract with a recycling company. The contract would provide a statewide price for pickup and recycling of lamps and other universal wastes regardless of location. Any municipality would be able to obtain services at the contract price.

The areas of the state where collection sheds have not yet been funded include Washington and

Hancock Counties, the Greenville area, northern Aroostook County, parts of western Maine, and many towns in Penobscot County. The development of lamp collection infrastructure in these areas may depend on the availability of additional state grant money. The Governor has approved $1.5 million bond request for municipal recycling, to be considered during the Second Session of the 120th Maine Legislature. The bond includes funding for completion of shed deployment statewide.

4. Training and Education

The DEP has initiated an aggressive training and education program to aid development of municipal collection infrastructure and inform the public about collection and recycling options for fluorescent lamps and other universal waste (UW).

In September and October 2001, the DEP held 16 half-day training sessions for municipal solid waste personnel to educate them on how to best manage lamps and other UW. 210 people attended the training, many of whom represent municipalities that are receiving an infrastructure development grant from SPO. DEP staff will continue to offer this training upon request.

The DEP has developed and distributed educational brochures on fluorescent lamps and other UW. Over 40,000 copies of a general brochure on mercury and mercury products were mailed to Maine towns for distribution to the public. A separate brochure on municipal responsibilities under the UW rules was mailed to every municipal office. Another brochure informing businesses about the disposal ban and the obligation to recycle fluorescent lamps was sent to every business on the mailing list of the Maine Revenue Service.

The DEP in cooperation with electric utility companies has developed an insert for inclusion with consumer electricity bills. The insert encourages consumers to recycle fluorescent lamps and other mercury-added products. Central Maine Power included the insert in its September 2001 bills to residential and business customers. Maine's other electric utilities will do so soon.

The DEP has conducted UW training and education activities for the business community, including creation of a UW Handbook for generators and 20 training sessions attended by 609 business representatives. Many of those attendees have in turn have educated and trained others at their workplace.

The DEP will continue its UW education and outreach activities in 2002 and beyond. Planned activities include: refinement and distribution of informational brochures; additional training sessions for schools, municipalities and businesses, and improvements to the mercury page on the DEP web site. The web site already includes the following information:

- A fact sheet on fluorescent and other mercury containing lamps;
- A copy of the Universal Waste rules applicable to fluorescent lamps ;
- Contact information for companies that recycle lamps; and

- An electronic submittal form to receive educational materials and be placed on the mailing list for UW training seminars[40].

Economic Impact of Ban on Disposal of TCLP-Compliant Lamps

The ban on disposal of TCLP-compliant lamps means that those lamps may no longer be placed in the trash and must be recycled. The recycling cost will be the same as for a 4-foot non-compliant tubes because lamps recyclers base their pricing on lamp length. For example, Conservation Lighting, Inc., a lamp business based in Westbrook, charges 48¢ to transport and recycle a 4-foot fluorescent tube plus a $20 pickup fee per location. Wesco Distribution, Inc. of Bangor charges 40¢ per 4-foot tube with a $15 to $30 pickup charge depending on location. Businesses that generate large quantities of lamps may pay less due to volume discounts. Superior Special Services, the nation's largest lamp recycler, charges 32¢ per 4-lamp if the generator's total billing exceeds $750. Some generators may be able to negotiate even lower fees.

Information published by the U.S. Environmental Protection Agency under its Green Lights Program suggests that lamp recycling costs represent less than one percent of the life cycle cost of fluorescent lighting.[41] This recycling cost is not a significant disincentive to the use of energy efficient fluorescent lighting because the alternative–incandescent lighting--uses three to four times more energy according to the National Electrical Manufacturers Association. Fluorescent lighting is far more cost-effective even when recycling costs are included.[42]

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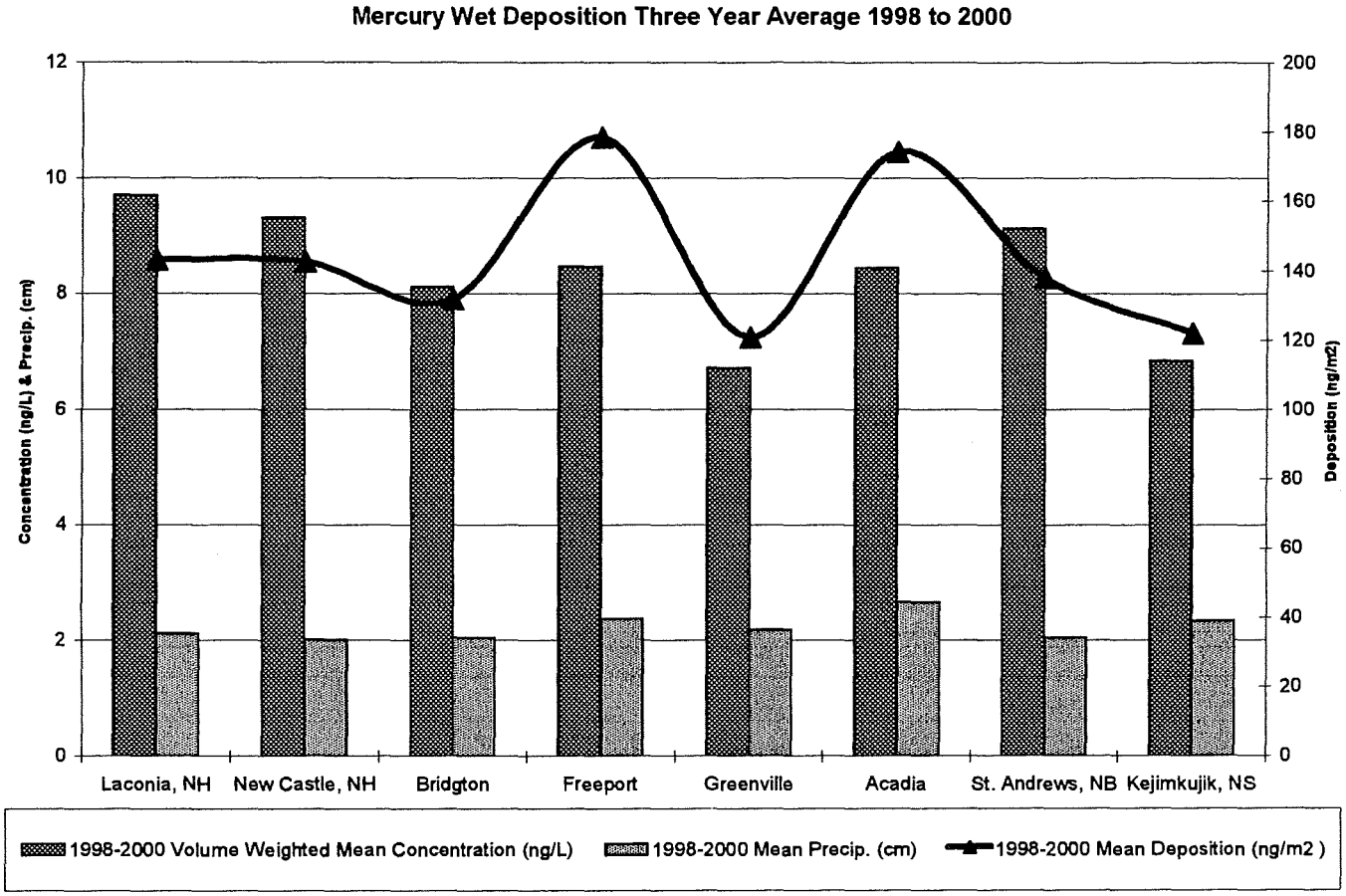
[40] Educational reference materials have been mailed to over 300 people in response to requests submitted via the web site

[41] Office of Solid Waste, U.S. Environmental Protection Agency, *Mercury Emissions from the Disposal of Fluorescent Lamps: Final Report*, June 30, 1997.

[42] National Electrical Manufacturers Association, *Fluorescent Lamps and the Environment*, November 1996.

APPENDIX A

MERCURY WET DEPOSITION 3-YEAR AVERAGE 1998 TO 2000


Mercury Wet Deposition Three Year Average 1998 to 2000
Concentration (ng/L) & Precip. (cm)
Deposition (ng/m2)
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160
180
200
Laconia, NH
New Castle, NH
Bridgton
Freeport
Greenville
Acadia
St. Andrews, NB
Kejimkujik, NS
1998-2000 Volume Weighted Mean Concentration (ng/L)
1998-2000 Mean Precip. (cm)
1998-2000 Mean Deposition (ng/m2)

APPENDIX B

MERCURY CONCENTRATION IN FLUORESCENT LAMPS

Maine Fluorescent Lamp Study
Final Report

Executive Summary:

In the year 2000, the Maine Legislature enacted a disposal ban on all mercury-added lamps following extensive debate focused on whether or not the ban should apply to lamps that pass the Toxicity Characteristic Leaching Procedure [TCLP]. The focus of this study was to determine total mercury content of certain common fluorescent lamps and whether or not lamps that are represented by manufacturers as TCLP-compliant[43] contain sufficiently lower amounts of mercury to warrant an exclusion from the enacted solid waste disposal ban. New and used lamps from ten popular lamp models were collected and tested for total mercury and TCLP mercury by specialized testing procedures. Results indicate that lamps that are represented as TCLP-compliant have total mercury results similar to their non-compliant counterparts. These results suggest that the disposal ban on all mercury-added lamps is appropriate.

Introduction:

In its 1997 annual report, Maine's Land & Water Resources Council recommended action to reduce mercury emissions by diverting mercury-added products from the solid waste stream. The Council subsequently prepared a report that identified specific mercury-added products and recommended a ban on their disposal in solid waste.

The Maine Legislature enacted the recommended disposal ban prospectively following extensive debate on whether or not the ban should apply to all fluorescent and other mercury-added lamps. Debate focused on whether or not the ban should apply to lamps that pass the TCLP. Under current state hazardous waste law, TCLP-compliant lamps can be placed in the solid waste stream; while non-compliant lamps, except those from households, must be recycled or sent to a hazardous waste disposal facility. This will change on July 15, 2002 when the new disposal ban takes effect for all mercury-added lamps except those generated by households. The ban is extended to households on January 1, 2005. The Department of Environmental Protection [ME DEP] is required to provide an assessment of the economic and environmental impacts of the ban as applied to TCLP-compliant lamps by January, 2002.

This study is part of the ME DEP required assessment of environmental impacts of the ban. Analyses conducted under this study sought to provide data bearing on whether Maine should retain the full ban. The results were used to compare the mercury content of lamps represented as TCLP-compliant to lamps that are not represented as TCLP-compliant. "TCLP-compliant" means a lamp that is determined to be non-hazardous using the Toxicity Characteristic Leaching Procedure [TCLP]. In addition, the analyses were expected to yield accurate and reliable data bearing on the relevance and efficacy of the TCLP for measuring the environmental impacts of lamp disposal.

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[43] Through out this paper, the designations "pass", "TCLP-pass", or "TCLP-compliant" refer to manufacturer representations of their products.

Study design was documented in the Fluorescent Lamp Study Quality Assurance Project Plan [QAPP], Revision 4, 3/20/2001 which was reviewed by stakeholders and approved by the Environmental Protection Agency-New England Region [EPA-NE].

Sampling:

Four foot fluorescent lamps from four different production batches for each of 10 lamp models were purchased, labeled, packed and shipped to the analytical laboratory according to the standard operating procedure [SOP] P1, which is included in appendix B of the Fluorescent Lamp Study QAPP. Sampling for this study was limited to lamps produced on or after January 1, 2000 in response to the National Electrical Manufacturers Association comment: *Lamps should all be of the same "vintage" i.e. manufactured in year 2000. With mercury reduction being such an active and ongoing issue, if the DEP purchases lamps from a variety of prior years, the results will be meaningless.*[44]
Used fluorescent lamps for the lamp models targeted in this study were provided by Northeast Lamp Recycling. Of the ten lamp models targeted, eight were available from Northeast Lamp Recycling; however, many of the used lamps available were produced prior to January 2000 which limits their usability for this study. "Used lamps" are defined as lamps disposed at the lamp recycling facility and thus were considered be representative of lamps that have entered the solid waste stream. All lamps were shipped to the laboratory in special boxes provided by the Portland Office of the US Postal Service. A sampling audit was conducted during sampling/ packaging/ shipping activities and results of the audit are included in Attachment 1 of this report. ME DEP provided the analytical laboratory with a list of samples to be analyzed for the first round of testing. Additional samples were submitted for analysis based on statistical analysis of the validated results from the initial round according to procedures discussed in section 20 of the Fluorescent Lamp Study QAPP. Please refer to the **All** worksheet included in the Excel file [Lamp Results.xls] for a complete list of samples submitted for analysis.

Analysis:

To provide more representative sampling and avoid sub-sampling inconsistency, fluorescent lamps were analyzed on a "whole lamp" basis for TCLP mercury and total mercury according to laboratory standard operating procedures [SOP] included in Appendix D of the Fluorescent Lamp Study QAPP. TCLP and total mercury digestion methods are based on the Science Applications International Corporation study [Analytical Results of Mercury in Fluorescent Lamps, 1992]. TCLP protocols for sample preparation provided by National Electrical Manufacturers' Association [NEMA LL 1] were also incorporated into the TCLP SOP. All samples were analyzed by Hampton-Clark, Inc./ Veritech Laboratories in Fairfield, NJ. Prior to analysis of lamps, Performance Evaluation [PE] samples were analyzed and evaluated to assess laboratory capability. The TCLP PE indicated that the laboratory was proficient for this analysis. The total mercury PE indicated that the laboratory was experiencing some problem with the analytical protocol. The calibration protocol was revised as a result of the PE and a new PE sample was analyzed successfully on 7/18/01. In addition, enough of the PE sample was sent to

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[44] In a 1992 study, EPA reported average total mercury levels in 4-foot lamps (25 lamps tested) as 33 mg/lamp for used lamps, and 29 mg/lamp for new lamps. EPA 1992, Management of Used Fluorescent Lamps: A Preliminary Risk Assessment, Table 1-3, pp 6-7

the laboratory to be analyzed as an independent standard reference material [SRM] with each batch of total mercury samples. For a full report of the PE and the associated revision in calibration protocol, see Attachment 2 of this report. SRM results for each analytical batch are included on the **SRM** worksheet in the attached Excel file [Lamp Results.xls] and are summarized in the **Data Usability** section of this report.

Data Validation:

Data validation was completed by Kestrel Environmental Technologies, Inc. of Freeport, ME. A full tier III validation procedure according to Region 1, EPA-NE Functional Guidelines for Data Validation was performed. Full data validation reports are included in Attachment 3 of this report. A summary of these reports is given below.

Based upon the available information, all mercury results are reported without qualification for all sample delivery groups [SDG] with the exception of TCLP SDG 4. Results for TCLP SDG 4 were qualified with a "J" [estimated] because matrix spike recoveries were outside [low] Region 1, EPA-NE Functional Guidelines for Data Validation criteria indicating that sample results may be biased low. However, matrix spike recoveries were within QAPP measurement performance criteria [MPC] for these samples and were therefore deemed usable for purposes of this study. Of the fourteen used lamps analyzed in TCLP SDG 4, two were for lamp model GE 13803, four for Sylvania 24596, four for Sylvania 21824, and four for Sylvania 24594. Only four samples in SDG 4 had results below the TCLP limit of 0.2 mg/L, and those were all Sylvania 24596, which are classified as TCLP-compliant by manufacturer testing.

Sample Results:

TCLP results generally confirmed manufacturer designations for TCLP-compliant [Pass] versus non TCLP-compliant [Fail] lamps; however TCLP results for new lamps are expected to be significantly lower than results for lamps at the end of life.[45] Used lamps for two lamp models [GE 26668 & Sylvania 21999] were not available for testing, and lamps from several other models were produced before January 2000 as noted in the result summary table *TCLP Mercury Results for Used Lamps*. Used lamps produced after January 1, 2000 appear to either have failed prematurely or have been recycled prior to lamp failure since the average life expectancy of these lamps is 20,000 hours. New lamps for one lamp model [GE 15949] in the "T8-Fail" classification did pass TCLP, however used lamps for the same model failed the TCLP. Full results are included on the **TCLP-New** and **TCLP-Used** worksheets in the attached Excel file [Lamp Results.xls]. Summaries of results are included in the following tables.

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[45] Lamps are dosed with elemental mercury when manufactured, and new, un-used lamps would be expected to exclusively contain this form or mercury. When lamps are burned, some portion of the elemental mercury initially present is converted to mercury salts (amounts and type depend on lamp design, including type of phosphor used, and hours burned before discarded), including oxides, which are more soluble in weak acids and acetate than elemental mercury. See Hildenbrand, et al., 2000, Interactions of thin oxide films with a low-pressure mercury discharge, Thin Solid Films 371 (2000) 295-302; and CRC Handbook of Chemistry and Physics, 82nd Edition, 2001

TCLP Mercury Results for New Lamps

MFG	Lamp Model	Class[1]	Average TCLP mg/L[2]	# samples required[3]	# samples analyzed	# Lamps from Y2K[4]
GE	13803	T12 Fail	0.264	6	8	8
Sylvania	24594	T12 Fail	0.395	1	4	4
GE	23010	T12 Pass	0.16	1	4	4
Philips	24470-7	T12 Pass	0.089	1	4	4
Sylvania	24596	T12 Pass	0.16	1	4	4
GE	15949	T8 Fail	0.147	4	4	4
Sylvania	21824	T8 Fail	0.413	1	4	4
GE	26668	T8 Pass	0.065	1	4	4
Philips	27248-4	T8 Pass	0.091	1	4	4
Sylvania	21999	T8 Pass	0.16	2	4	4

1 **Class** = Lamp size [T8 vs T12] and whether or not the manufacturer represents this lamp model as TCLP compliant.
2 The TCLP regulatory limit is 0.200 mg/L. Results above 0.200 mg/L fail TCLP.
3 **# samples required** = number of samples required to provide a representative sample, and result from calculations according to EPA SW-846 Chapter 9 Table 9-1 formulas for standard TCLP hazardous waste determination.
4 **# Lamps from Y2K** represents the number of lamps manufactured in January 2000 or more recently, and was determined by comparing date codes printed on lamps to date code information supplied by the three manufacturers.

TCLP Mercury Results for Used Lamps

MFG	Lamp Model	Class[1]	Average TCLP mg/L[2]	# samples required[3]	# Lamps analyzed	# Lamps from Y2K[4]
GE	13803	T12 Fail	0.363	4	4	1
Sylvania	24594	T12 Fail	0.563	1	4	0
GE	23010	T12 Pass	0.133	2	4	4
Philips	24470-7	T12 Pass	0.095	1	4	4
Sylvania	24596	T12 Pass	0.089	1	4	4
GE	15949	T8 Fail	0.548	2	4	0
Sylvania	21824	T8 Fail	0.703	5	4	0
GE	26668	T8 Pass	Not Available	NA	0	0
Philips	27248-4	T8 Pass	0.092	1	4	4
Sylvania	21999	T8 Pass	Not Available	NA	0	0

1 **Class** = Lamp size [T8 vs T12] and whether or not the manufacturer represents this lamp model as TCLP compliant.
2 The TCLP regulatory limit is 0.200 mg/L. Results above 0.200 mg/L fail TCLP.
3 **# samples required** = number of samples required to provide a representative sample, and result from calculations according to EPA SW-846 Chapter 9 Table 9-1 formulas for standard TCLP hazardous waste determination.
4 **# Lamps from Y2K** represents the number of lamps manufactured in January 2000 or more recently, and was determined by comparing date codes printed on lamps to date code information supplied by the three manufacturers.

Total mercury average results for new lamp models were based on twenty samples [per model] submitted for analysis. Several models contained less than twenty results due to a laboratory error, which invalidates SDG-1 [see **Data Usability**]. Full results are included on the **THg New** worksheet in the attached Excel file [Lamp Results.xls]. Summaries of results are included in the following tables.

Total Mercury Results for New Lamps Sorted by Lamp Model

MFG	Class[1]	Lamp Model	Average mg/Kg[2]	Average mg/Lamp	Lower CI[3] mg/ Lamp	Upper CI[4] mg/ Lamp	% Error[5]	# Lamps analyzed
GE	T12 Fail	13803	12.1	3.42	2.43	4.41	29.0	19
GE	T12 Pass	23010	13.7	3.89	3.07	4.71	21.2	20
GE	T8 Fail	15949	20.4	3.78	3.05	4.50	19.2	20
GE	T8 Pass	26668	12.6	2.35	1.76	2.94	25.0	20
Philips	T12 Pass	24470-7	8.7	2.33	1.93	2.72	16.9	17
Philips	T8 Pass	27248-4	12.1	2.31	1.98	2.63	14.0	16
Sylvania	T12 Fail	24594	12.4	3.44	2.34	4.54	31.9	20
Sylvania	T12 Pass	24596	11.4	3.19	2.62	3.75	17.7	16
Sylvania	T8 Fail	21824	36.4	6.00	4.49	7.50	25.1	16
Sylvania	T8 Pass	21999	21.1	3.68	2.91	4.46	21.0	16

1 **Class** = Lamp size [T8 vs T12] and whether or not the manufacturer represents this lamp model as TCLP compliant.
2 **Average mg/Kg** = This is a calculated PPM value based on results and lamp mass.
3 **Lower CI** = Lower Confidence Interval, determined according to EPA SW-846 Chapter 9 Table 9-1 formulas using double sided 95th percentile t-scores.
4 **Upper CI** = Upper Confidence Interval, determined according to EPA SW-846 Chapter 9 Table 9-1 formulas using double sided 95th percentile t-scores.
5 **% Error** = Error of the mean at the 95th percentile, determined according to EPA SW-846 Chapter 9 Table 9-1 formulas using double sided 95th percentile t-scores.

Another view of this data showing the comparison of TCLP-compliant [Pass] total mercury averages compared to their non-compliant [Fail] counterparts is presented and reviewed in the **Discussion** section of this report.

In the following table results are summarized by grouping all three lamp manufacturers together according to lamp size and TCLP status [Class]. These results are also reviewed in the **Discussion** section of this report.

Total Mercury Results For New Lamps Sorted by Lamp Class

Class[1]	Average mg/Kg[2]	Average mg/Lamp	Lower CI mg/Lamp[3]	Upper CI mg/Lamp[4]	% Error[5]	# Lamps analyzed
T12 Fail	12.3	3.43	2.72	4.14	20.7	39
T12 Pass	11.4	3.18	2.78	3.57	12.5	53
T8 Fail	27.5	4.76	3.94	5.59	17.4	36
T8 Pass	15.0	2.75	2.38	3.11	13.2	52

1 **Class** = Lamp size [T8 vs T12] and whether or not the manufacturer represents this lamp model as TCLP compliant.
2 **Average mg/Kg** = This is a calculated PPM value based on results and lamp mass.
3 **Lower CI** = Lower Confidence Interval, determined from formulas based on SW-846 Chapter 9 Table 9-1 using double sided 95th percentile t-scores.
4 **Upper CI** = Upper Confidence Interval, determined from formulas based on SW-846 Chapter 9 Table 9-1 using double sided 95th percentile t-scores.
5 **% Error** = Error of the mean at the 95th percentile, determined from formulas based on SW-846 Chapter 9 Table 9-1 using double sided 95th percentile t-scores.

The number of total mercury tests performed on used lamps is limited due to the lack of availability of newer models at the recycling facility (presumably most lamps manufactured after 1/1/2000 are still in service). Results were based on two to five samples for each of the eight

available lamp models. Many of the used lamps were manufactured prior to January 2000. Lamps manufactured in years prior to January 2000 were produced with a variety of mercury dosing concentrations. Because only a limited number of samples were analyzed and many of these were from different production years, it is not appropriate to compare average results as done above for the new lamps. Full results for the twenty-six samples analyzed, including production dates, are recorded on the **THg Used** worksheet in the Excel file [Lamp Results.xls].

Data Usability:

All validated data were evaluated and reconciled with project quality objectives according to procedures in the Fluorescent Lamp Study QAPP, section 20.

TCLP testing was conducted in order to confirm manufacturers' TCLP rating for the lamps evaluated in this study. Results for new lamp TCLP testing meet the requirements of the QAPP. In each case enough samples were analyzed to characterize the lamps as either TCLP-compliant [Pass] or non-compliant [Fail]. However, since TCLP results increase as lamps age, it is important to also run TCLP on lamps at the end of life. Since industry has lowered mercury dosing of lamps in recent years, our study focussed on newer lamp models, and spent lamps were not commonly available.

Results for total mercury analyses do not meet the QAPP requirement that the mean be determined with an accuracy of ± 10% at the 95th percentile. Initial calculations indicated that more than 20 samples of each model would need to be tested to meet this objective. In some cases several hundred samples would need to be analyzed to meet the objective. The alternative objective is to calculate the error of the mean at the 95th percentile for the lamps analyzed. This calculation is included in the above result summaries for new lamps. In addition, variability in the SRM sample was calculated to give some indication whether the analytical method is too variable to meet the QAPP requirement or whether results reflect the true variability in mercury dosing of lamps. SRM results for SDG 2 through SDG 12 [a total of 22 samples] were averaged and error of the mean at the 95th percentile determined. The true value for the SRM is 3.0 mg per sample, which is in the same concentration range of the lamps analyzed. The resulting statistics for the SRM are presented below:

SRM Statistics:	Result:
Average [mg/sample]	3.03
Lower CI [mg/sample]	2.94
Upper CI [mg/sample]	3.11
Error of the mean	2.85 %

These results indicate that the method variability for the SRM is well within the project requirement. The SRM matrix is water, which is not subject to the same digestion challenges as lamp samples; however, it does demonstrate that any error contributions from the determinative portion of the analysis and error associated with dilution procedures are low. Additional testing would be required to determine whether the digestion method for whole lamp analysis significantly contributed to the variability of the results.

It is also possible that the amount of mercury recovered from lamps is less than 100% recovery because of matrix problems. Because each lamp was totally consumed in the testing process it was not possible to assess matrix problems with the customary matrix spike. Quality Control information obtained from Philips Lighting for T8 lamp model 27248-4 from the four production dates for lamps included in this study are tabled below:

Production Date	Philips weight average[1] [mg/Lamp]	Study Average [mg/Lamp]	Percent Recovery[2]
September 2000	3.52	2.50	71.0
November 2000	3.52	2.20	62.5
December 2000	3.51	2.58	73.5
January 2001	3.53	1.95	55.2
total	3.52	2.31	65.6

1. Philips weight average = The average weight of mercury used to dose Philips lamp model 27248-4 based on a sampling of 6 to 8 mercury dosing capsules for each production batch.
2. Percent Recovery = Study Average/Philips weight average X 100%, and assumes that the Philips weight average is the correct lamp mercury dose.

These results indicate that the recovery of mercury from lamps in the total mercury test may be only 65.6% of the total lamp mercury content. Although percent recovery of total mercury is likely to be biased low, it is generally assumed that all lamps will be affected more or less equally, and that comparisons among lamp manufacturers and lamp classes are valid.

To answer the question as to what extent the analytical digestion method used in this study contributes to bias and variation in analytical results a follow-up study will be done. In the follow-up study 20 undosed lamps will be spiked with known amounts of mercury in the laboratory. The 20 spiked lamps, along with 2 undosed lamps [matrix blanks] will be digested and analyzed at the same laboratory according to the same standard operating procedures [SOP] followed in the original study. The resulting average % recovery, confidence intervals, and error of the mean will be compared to the SRM and lamp results from the original study.

A review of validated data for total mercury revealed that results from SDG 1 gave generally higher results than other total mercury sample delivery groups. Results from SDG 1 are compared to results from subsequent SDG in the following table:

MFG	Class[1]	Lamp Model	SDG 1 Average mg/Lamp	Subsequent SDG Average mg/Lamp
Philips	T12 Pass	24470-7	4.50	2.33
Philips	T8 Pass	27248-4	6.33	2.31
Sylvania	T12 Pass	24596	6.85	3.19
Sylvania	T8 Fail	21824	15.2	6.00
Sylvania	T8 Pass	21999	12.0	3.68

1 **Class** = Lamp size [T8 vs T12] and whether or not the manufacturer represents this lamp model as TCLP compliant.

When lamps of the same model were compared across sample delivery groups it appeared that something had changed in the analytical realm. The laboratory was contacted, and it was discovered that the reagent blank water that was used when making dilutions had been changed after SDG 1. For SDG 1 de-ionized water was used for dilutions. In subsequent SDG reagent

blank water for dilutions contained acid at the same concentration as the samples. The standard operating procedure for dilutions is to use reagent blank water containing acid at the same concentration as the samples. For this reason results from SDG 1 were removed from data summaries included in this report. An analysis of this problem by Veritech Laboratory is included in the Lamp Study records.

Discussion:

In this study TCLP testing was performed to confirm manufacturer representations of TCLP status for lamps evaluated in this study. Total mercury results for these lamps were then evaluated to determine whether the TCLP test is useful to determine environmental impacts from lamps based on their total mercury content. It should be noted that the TCLP was intended to be a measure of the leachability of mercury from a waste, not an indicator of total mercury content or of total environmental impact. It will only be a measure of potential ground water contamination and water transport of mercury contamination. Since environmental impacts of mercury may include other pathways, for example mercury vapor in landfill gas, the total mercury content of lamps may be a better indicator of environmental impact. However, there has been a perception that new TCLP-compliant lamps pass TCLP chiefly because the mercury content of these lamps has been significantly reduced.

When the average results for new lamps sorted by manufacturer and size are compared [Total Mercury Results Comparison Chart 1], the following observations apply. TCLP-compliant T8 lamps from GE and Sylvania appear to have lower total mercury content than their non-compliant counterparts. However, total mercury results for TCLP-compliant T12 lamps from GE and Sylvania do not appear to differ significantly from their non-compliant counterparts. Results for Philips were not compared because non-compliant models were not available.

Total Mercury Results Comparison Chart 1:

Lamp Size	Mfg	TCLP Compliant model [mg/Lamp][1]	Non-compliant model [mg/Lamp][2]
T8	GE	2.35	3.78
T8	Sylvania	3.68	6.00
T12	GE	3.89	3.42
T12	Sylvania	3.19	3.44

1. TCLP Compliant model means that the lamp manufacturer represents these as lamps that pass TCLP limits for mercury.
2. Non-compliant model indicates that the manufacturer does not represent these as lamps that pass TCLP limits for mercury.

When lamp results are sorted and averaged by lamp size [Total Mercury Results Comparison Chart 2] TCLP compliant T8 lamps appear to contain less mercury than their non-compliant counterparts. However, T12 lamps do not appear to differ significantly based on TCLP compliance.

Total Mercury Results Comparison Chart 2:

Lamp Size	TCLP Compliant model [mg/Lamp][1]	Non-compliant model [mg/Lamp][2]
T8	2.75	4.76
T12	3.18	3.43

1. TCLP Compliant model means that the lamp manufacturer represents these as lamps that pass TCLP limits for mercury.
2. Non-compliant model indicates that the manufacturer does not represent these as lamps that pass TCLP limits for mercury.

These results suggest that the TCLP test is not always effective in differentiating lamps based on their total mercury content. In other words, TCLP-compliant lamps may not have lower total mercury content than non-compliant lamps.

Twenty-six used lamps, representing eight of the ten target lamp models, were analyzed for total mercury in this study. However, results for used lamps were not combined with results for new lamps because fifteen of the twenty-six used lamps tested were manufactured prior to January, 2000 and would not be comparable in mercury dosing to the new lamps analyzed. Also, the analytical method for total mercury did not include a digestion capable of recovering mercury that may become imbedded in the glass during normal lamp use, a phenomenon that has been reported by lamp manufacturers. Results from the used lamps are documented on the **THg Used** worksheet of the Excel file [Lamp Results.xls] and were useful in a limited evaluation of how mercury content of lamps has been reduced since 1994.

Conclusions:

Based on the results of a statistically valid number of new lamps, the TCLP status of the ten lamp models was verified; however, sufficient numbers of used lamps were unavailable to confirm TCLP status.[46]

Based on the results of 180 new lamps and 26 used lamps tested for total mercury, two conclusions can be drawn. The TCLP is not a reliable test to differentiate lamps with higher total mercury content from those with lower total mercury content. It appears that lamps that are represented as TCLP-compliant do not have significantly lower mercury content from non-compliant lamps. Also, from a review of limited data on used lamps, recently manufactured lamps appear to contain less total mercury than their counterparts produced in earlier years.

The question as to what extent the analytical digestion method used in this study contributes to bias and variability in analytical results will be determined in a follow-up study.

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[46] Under RCRA regulations, waste generators are responsible for determining whether their wastes are hazardous (40 CFR 262.11). Since the form of mercury in lamps changes as lamps are burned, and since discarded lamps are typically used, not new lamps, data from TCLP testing of new lamps cannot be reliably used to determine the waste status of used, discarded lamps.