Mercury

On the Road to Zero

Recommended Strategies to Eliminate Mercury Releases from Human Activities in Oregon by 2020

Produced By

Oregon Environmental Council
& The Mercury Solution Team

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Disclaimer

A statement of support for the contents of this report by a member of the Oregon Mercury Solution Team does not necessarily mean the member supports every statement or recommendation contained in the report. Rather, a statement of support indicates support for the goals of the Solution Team.

Many thanks to all the members of the Solution Team for their participation. The authors would also like to thank Susan Hammer for her great work as facilitator. Also, many thanks to Scott Hemple for his valuable research.

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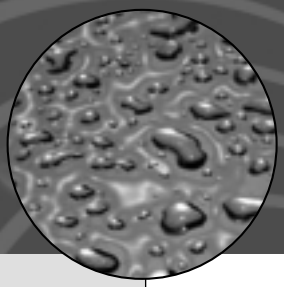


Executive Summary

Background

Mercury is a naturally occurring element that has many industrial and commercial uses. However, mercury is also a "persistent bioaccumulative toxin" or PBT. It is highly toxic, persists for years in the environment without breaking down, and can accumulate to higher concentrations as it moves up the food chain. Mercury is a neurotoxin that can slow fetal and child development and cause irreversible deficits in brain function. People are exposed to mercury primarily through fish consumption. Mercury accumulates in fish, and is the number one reason for fish consumption advisories nationwide, as well as in Oregon.

Reduction Efforts

In the last several years, a widespread scientific and policy consensus has formed around the need to address public health and ecological threats posed by mercury pollution. Mercury has been targeted by the U.S. EPA, Environment Canada, the International Joint Commission for Environmental Cooperation, and many state and provincial governments for being one of the most critical pollutants for elimination or reduction. However, the U.S. has not fully implemented a comprehensive national strategy to significantly reduce the amount of mercury released to the environment.

In September 1999, Oregon Governor John Kitzhaber signed an Executive Order that requires the Oregon Department of Environmental Quality (DEQ) to lead a statewide effort to eliminate the release of persistent, bioaccumulative and toxic pollutants (PBTs) into the environment by the year 2020. In an effort to demonstrate the feasibility of achieving zero discharge of these pollutants, the Oregon Environmental Council (OEC) focused on the reduction of one key PBT – mercury.

In the spirit of cooperation and constructive problem–solving, OEC convened a broad group of stakeholders to form the Oregon Mercury Solution Team. The Team's goal was to develop strategies to eliminate the release of mercury from human activities in Oregon by the year 2020, and to reduce overall mercury exposure to the extent feasible.

Oregon's Mercury Sources

Mercury in Oregon comes from a number of sources, both from within and from outside the borders of the state. Within the state, mercury is released from both anthropogenic (human–made) sources and from natural sources. Natural releases come from deposits of ore, called cinnabar, particularly in conjunction with geothermal and volcanic activity. Mercury enters the

environment through the solid waste stream, through releases to waterways, by emissions to air and through certain soil amendments applied to land.

Human–made sources of mercury are numerous. It is released from abandoned mercury and gold mines throughout the state. It is an incidental by–product of several types of industrial processes, such as power plants that burn coal, cement kilns, steel mills, crematories and solid waste incinerators. It is also used in a number of common consumer products, such as thermometers, switches in cars, fluorescent lights, thermostats, blood pressure cuffs, relay and tilt switches, and dental amalgam. All of these uses of mercury, while providing useful goods and services, can contribute to the overall load of mercury in our environment.

"The total amount of mercury released from human sources in Oregon is estimated to range from 3,600 to 10,600 pounds per year."

For this report, OEC conducted an inventory of mercury sources, and for the first time in Oregon, estimated the quantities of mercury from most sources. In order to develop these estimates, we used the best information available at the time of publication. It is hoped that more information to better characterize mercury releases in Oregon will be developed in the future. The total amount of mercury released from human sources in Oregon is estimated to range from 3,600 to 10,600 pounds per year*. The large range in this estimate is due to uncertainty and variability associated with certain sources of mercury, such as abandoned mines, steel mills, dental offices and crematories.

A significant amount of mercury enters Oregon's waterways from abandoned mines – roughly between 680 and 6,700 pounds per year. We estimate that mercury from abandoned mines represents between 15% and 65% of the total amount of mercury from human sources. An estimated 2,000 pounds of mercury enters Oregon's solid waste stream each year just from mercury–added products. And another 800–1,850 pounds is released into the air each year from industrial point sources.

"We estimate that mercury from abandoned mines represents between 15% and 65% of the total amount of mercury from human sources."

Oregon Mercury Solution Team

The mission of the Mercury Solution Team was to develop a comprehensive strategy to eliminate the release of mercury from human activities in Oregon by the year 2020, and to reduce overall mercury exposure to the extent feasible. Some mercury releases can be addressed quickly, while others may take several years. In order to keep moving toward the goal of zero discharge, the Mercury Solution Team set the following interim goals:

- By 2006, reduce mercury releases by 50% from 2001 levels.
- By 2011, reduce mercury releases by 75% from 2001 levels.
- By 2020, achieve 100% reduction.

When Governor Kitzhaber signed Executive Order (EO) 99–13, he set the standard for eliminating the discharge of persistent, bioaccumulative

**This estimate includes all mercury in the waste stream.*

and toxic (PBT) chemicals in Oregon. The EO says the DEQ must develop a strategy to eliminate the discharge of all PBTs by the year 2020. The Mercury Solution Team's mission is consistent with this standard of mercury elimination. Nonetheless, the concept of "zero discharge" of mercury is not as simple as it might seem. Since mercury occurs naturally in geologic deposits such as coal, limestone, and fossil fuels, it is not currently technologically or economically feasible to completely eliminate all discharges of mercury. Furthermore, with our current scientific tools, it is not evenpossible to measure "zero."

Therefore, the Team recognizes that there are significant technological and economic limitations to achieving and measuring zero discharge. The Team also recognizes that it is not possible to eliminate mercury from our environment entirely, particularly because of its persistent nature. In fact, others have used the term "virtual elimination" instead of zero discharge. Instead of getting bogged down in semantics, the Team agreed that eliminating the discharge of mercury should continue to be our goal, and to focus on practical steps we can take that will have a measurable effect on the levels of mercury discharged in Oregon, both in the short and long term. When we use the term "eliminate" in this document, we do so with a full recognition of the technological and economic limitations involved.

The Mercury Solution Team categorized sources of mercury in Oregon into four major classes:

1. **Mercury–Added Products,** which are products that intentionally use mercury for its unique properties.
2. **Point Sources,** which are industrial and munipical sources that hold a permit from DEQ, or are otherwise clearly defined and relatively small in number.
3. **Non–Point Sources,** which are sources of mercury that are wide spread and are not products or point–sources.
4. **Abandoned mines,** which belong in their own category, largely due to the different strategies that are needed to deal with this source of mercury.

Within each major category, the Team recommends several general strategies. However, not all general strategies apply in every case, so specific strategies were also developed for individual sources. In general, the Team agreed that strategies to eliminate mercury should be guided by the following principles:

- ✶ Create an even playing field,
- ✶ Adopt shared responsibility,
- ✶ Ensure that recommended strategies avoid unintended consequences,
- ✶ Start with the least expensive approaches, and
- ✶ Use financial incentives to encourage faster and more aggressive mercury reduction activities.

Reduction Strategies for Mercury–Added Products

The following 10 general strategies are recommended to reduce mercury releases from Mercury–Added Products:

1. Expand and Support Mercury Recovery Programs.
2. Implement a Concerted Education and Outreach Effort.
3. Prohibit the Sale of Certain Mercury–Added Products.
4. Require Consumer Notification/Labeling.
5. Promote Product Stewardship.
6. Government Lead by Example.
7. Prohibit Disposal of Mercury–Added Products.
8. Ensure Statewide Tracking of Mercury–Added Products.
9. Fund Research into Alternatives.
10. Investigate Financing Mechanisms That Use Economic Incentives and/or Disincentives.

Reduction Strategies for Point Sources

The following five general strategies are recommended to reduce mercury releases from Point Sources:

1. Require Mercury Point Sources to Develop and Submit a Mercury Reduction Plan.
2. Study a Mercury Emissions Fee.
3. Study the Feasibility of Setting Up a Cap and Trade System.
4. Provide Financial Incentives to Encourage Action.
5. Use Existing Regulations to Reduce Mercury Releases.

Reduction Strategies for Non–Point Sources

The following seven general strategies are recommended to reduce mercury releases from Non–Point Sources:

1. Implement a Concerted Education and Outreach Program.
2. Expand and Support Recovery Programs.
3. Encourage Alternatives and Promote Pollution Prevention.
4. Create an Inventory of Mercury from these Sources.
5. Require Facilities to Develop Reduction Plans.
6. Investigate Economic Incentives and/or Disincentives.
7. Use Existing Regulations to Reduce Mercury Releases.

Reduction Strategies for Abandoned Mines

The following four strategies are recommended to reduce mercury releases from abandoned mines:

1. Implement an extensive sampling program.
2. Develop and prioritize a list of abandoned mines for cleanup.
3. Clean up abandoned mines, in cooperation with responsible parties.
4. Require monitoring of mercury emissions at any active mine.

Conclusion

Mercury is a serious environmental toxin, and more effort must be spent on reduction and elimination of mercury releases to our environment. This report includes a long list of strategies that the Team recommends be implemented in Oregon. However, not all of these strategies can or should be implemented immediately. Therefore, the Team has identified the following top five priorities that should be the focus of our efforts as we begin:

- Clean up abandoned mercury mines across the state, which are estimated to be a major, uncontrolled source of mercury to Oregon's waters.
- Continue to phase out products with mercury, promote alternatives wherever possible, and ensure full implementation of the Oregon Mercury Reduction Act of 2001.
- Fill gaps in regulations and permits, to ensure the state is adequately monitoring and controlling industrial facilities that discharge mercury.
- Reduce mercury in the waste stream via greater investments in consumer education and outreach and recovery programs.
- Increase the use of Best Management Practices throughout Oregon businesses to reduce non-point mercury pollution.

OEC and the Oregon Mercury Solution Team hope that the collaborative approach we used becomes a model for addressing other pollution problems. We also hope that by implementing the strategies outlined in this report, we will make significant progress toward eliminating the discharge of mercury from anthropogenic sources in Oregon by 2020. Before reaching that goal however much work needs to be done. We are only at the beginning of the process.

CHAPTER 1

Introduction

Mercury is a naturally occurring element that has been used historically in a wide variety of industrial and commercial applications. However, mercury is also a "persistent bioaccumulative toxin" or PBT. It is highly toxic, persists for years in the environment without breaking down, and tends to accumulate to higher concentrations as it moves up the food chain. A neurotoxin, mercury slows fetal and child development, causes irreversible deficits in brain function, and is a particular risk for children exposed before birth through their mothers.

People are exposed to mercury primarily through their consumption of fish. Mercury accumulates in fish, and is the number one reason for fish consumption advisories nationwide. The Centers for Disease Control found that 1 in 10 women of childbearing age have levels of mercury high enough that a small increase in their exposure to mercury while pregnant could jeopardize the neurological development of their baby.

"Mercury is highly toxic, persists for years in the environment without breaking down, and tends to accumulate to higher concentrations as it moves up the food chain."

In September 1999, Governor John Kitzhaber signed an Executive Order that requires the Oregon Department of Environmental Quality (DEQ) to lead a statewide effort to eliminate the release of persistent, bioaccumulative and toxic pollutants (PBTs) into the environment by the year 2020. In an effort to demonstrate the feasibility of achieving zero discharge, the Oregon Environmental Council (OEC) focused on the reduction of one key PBT – mercury.

In the spirit of cooperation and constructive problem–solving, OEC convened a broad group of stakeholders to form the Oregon Mercury Solution Team. The Team's goal was to develop strategies to eliminate the release of mercury into Oregon's environment from human sources by the year 2020 and to reduce overall exposure to the extent feasible. This report reflects the recommendations of that Team.

This approach reflects a new and dramatically different approach for reducing toxic pollution, one that is unique because it:

- ***Recognizes the complexity of the issue.*** There are dozens of sources of mercury, from consumer products to abandoned mines. These strategies are comprehensive, focusing on the most effective places to reduce mercury pollution rather than singling out any one source.
- ***Brings people together.*** The active participation of a 16–member Mercury Solution Team has ensured that recommended strategies are effective and efficient, and that they have the broad support that will ensure they are effectively implemented.

- ***Crafts creative solutions.*** These strategies highlight dozens of creative, voluntary, incentive-based steps – as well as smart changes in state policy to reduce mercury pollution in Oregon. These carefully designed solutions will be far more effective than sweeping regulatory approaches.

The Oregon Environmental Council intends to evaluate the success of these strategies in one year, and is confident that there will be substantial progress over that relatively short time frame, demonstrating the effectiveness of a cooperative approach.

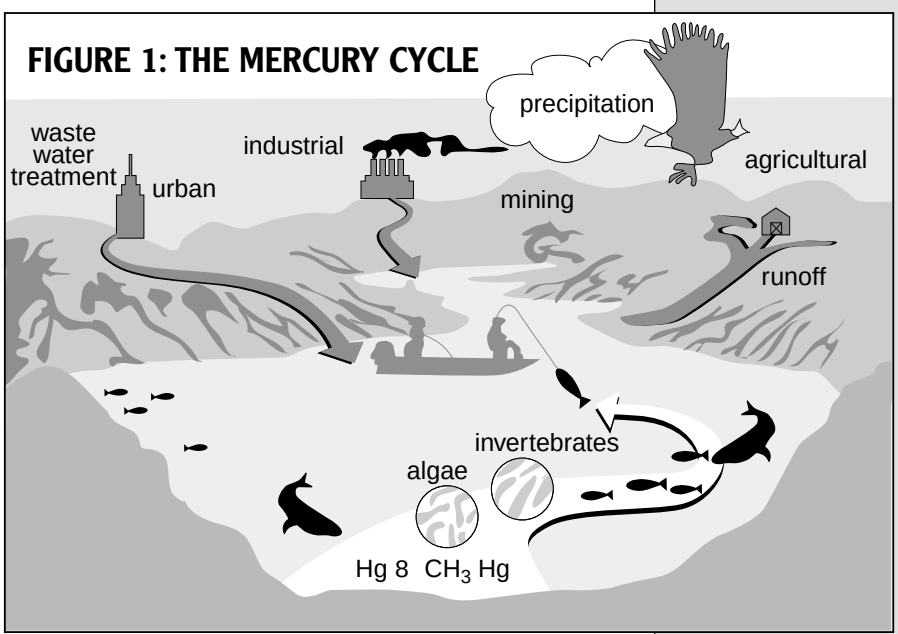
The Mercury Solution Team process has been successful in developing a broad range of creative strategies while increasing public awareness around this important issue. We hope this effort, and these strategies, will provide a model for other states, and the nation, as they grapple with ways to eliminate mercury pollution and address other persistent toxins. We invite your support and participation in its implementation.

CHAPTER 2

Background

Mercury as an Environmental and Health Issue

Mercury is a naturally occurring element, a metal that is liquid at room temperature. Mercury is produced by mining the ore, called cinnabar, and then heating it and condensing the vapors. For centuries mercury has been valued for its unique properties and has been utilized in many modern processes. It is used to measure temperature and pressure, it conducts electricity, acts as a biocide, and functions as an industrial catalyst. In the past it was used extensively in the mining of gold during the "Gold Rush" era, and in some parts of world it is still used for this purpose.



Mercury can be released into the environment naturally from volcanic formations, geothermal activities, and marine environments or it can be released into the environment from anthropogenic (human-made) sources. (see Figure 1) Human activity has increased the amount of mercury circulating globally. Recent studies suggest that human activity contributes 50–70 percent of the mercury in the environment globally (USEPA, 1997).

How Mercury Behaves in the Environment

Mercury is among a group of pollutants called persistent bioaccumulative toxins or PBTs. These types of toxins are particularly dangerous in the environment because they build up in plants and animals or "bioaccumulate." Once in the environment, PBTs are particularly tenacious. They "persist" in the environment, meaning that they do not break down and go away. Because it is an element, mercury cannot be destroyed, it cannot be combusted, and it does not degrade.

Once mercury enters the environment, it circulates in and out of the atmosphere until it ends up in the bottoms of lakes and oceans. Depending on its form, mercury may travel long distances before it falls to earth with precipitation or dust, and can remain airborne for up to a year or more (USEPA & Environment Canada, 1999). Mercury eventually falls to the ground with rain or snow, and then migrates to lakes and streams.

When mercury enters a lake or river, it can enter the food chain, or it can be released back to the atmosphere by volatilization. Mercury also has a long retention time in soil and sediment, and therefore may continue to be released from soil deposits to surface water and the atmosphere for long periods of time, possibly hundreds of years. Many scientists currently think that higher acidity and dissolved organic carbon levels increase the mobility of mercury in the environment, making it more likely to enter the food chain. Many of the details of the aquatic mercury cycle are still unknown, however, and remain areas of active research (USGS, 1995).

Mercury can be converted by bacteria to the more toxic methylmercury. Plants and fish easily absorb this form of mercury. Larger fish eat smaller fish and in doing so, accumulate higher levels of methylmercury. Fish at the top of the food chain, therefore, often contain very high levels of mercury (See Figure 2).

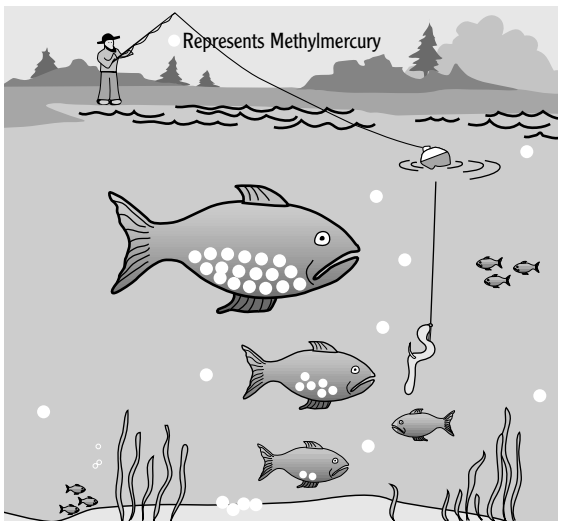


FIGURE 2: MERCURY BIOACCUMULATION UP THE FOOD CHAIN

Human Exposure to Mercury

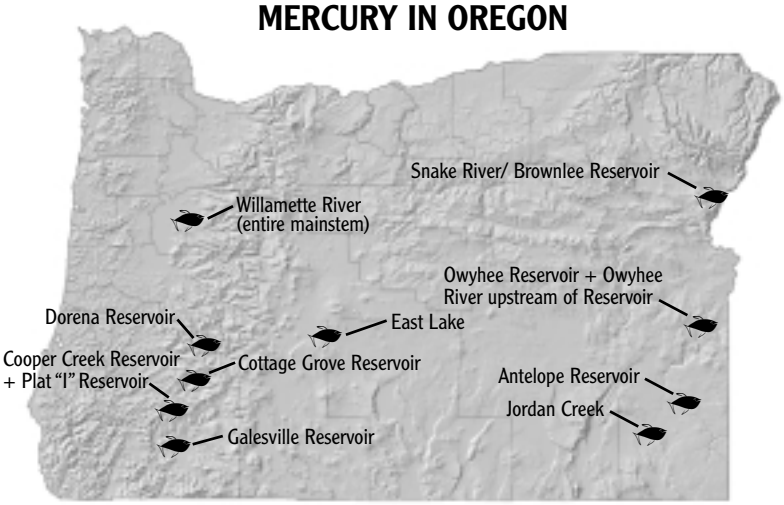
Human exposure to mercury occurs most frequently through consumption of mercury-contaminated fish. Mercury is tightly bound to proteins in all fish tissue. In older and larger fish, mercury becomes very concentrated and it can reach a level that is millions of times higher than the level in the surrounding water. Because mercury is tightly bound to muscle tissue, there is no method of cooking or preparation that will remove or reduce mercury once it is in fish (U.S.FDA, 1995).

Forty-one states have issued fish consumption advisories due to mercury contamination (U.S. EPA, 2001a). In Oregon, the State Health Division has issued fish consumption advisories for 11 water bodies due to mercury (OHD, 2001), including the entire mainstem of the Willamette River (See Figure 3).

Mercury is toxic even in small amounts.Because it increases in concentration as it moves up the food chain, just one gram of mercury (the amount in just one or two thermometers) can contaminate a 20-acre lake so the fish are unsafe to eat.

The Food and Drug Administration, which regulates commercially–sold fish, currently recommends that pregnant and nursing women, women of childbearing are who may become pregnant, and young children avoid eating any shark, swordfish, tilefish and king mackerel because of high levels of methylmercury (FDA, 2001).

FIGURE 3: FISH ADVISORIES DUE TO MERCURY IN OREGON



Risk calculations are based on average rates of fish consumption for the general American public. Because of varying fish consumption rates, risks associated with methylmercury in fish vary among individuals and populations. Members of many Native American Tribes, for example, eat diets based on fish and have exposure rates substantially higher than the general public and consequently have substantially higher risk of health consequences.

Other human exposures can also come from inhaling mercury vapors from broken fluorescent lamps, for example, or from close proximity to spilled or leaking mercury from devices such as gas regulators or thermometers. There have been cases of mercury exposures from accidental swallowing, but these cases are rare. Most people are exposed to mercury via their consumption of fish.

Human Health and Mercury

Mercury is highly toxic. It is a potent neurotoxin, meaning that it interferes with the way nerve cells function. Mercury poisoning causes a decreased ability to see, hear, talk, and walk. It can cause personality changes, depression, irritability, nervousness, and the inability to concentrate. It can also cause damage to the brain, kidneys, and lungs. At higher levels, it can even cause death.

The toxic effects of mercury have been known for centuries. During the 1800's, people employed in the felt hat industry were exposed to high levels of mercury. As a result, they developed mercury poisoning and hence the phrase "mad as a hatter" was coined. Since then, workplace regulations have been implemented which protect employees from mercury poisoning and mercury has been phased out of some industrial processes.

Nonetheless, mercury exposure remains a serious problem in the U.S. and elsewhere, particularly for pregnant women and children (National Research Council, 2000; American Academy of Pediatrics, 2001). Fetuses

and young children suffer the greatest risk because their nervous systems are still developing. They are four or five times more sensitive to mercury than adults. The Centers for Disease Control recently reported that one in ten women of childbearing age in the U.S. are at risk of having newborns with decreased neurological performance due to mercury exposure (CDC, 2001). Unborn children can be seriously affected even though the mercury causes no symptoms in their mothers.

Mercury poisoning in children can be subtle, often resulting in delayed walking, impaired language skills, memory, and attention span. Effects in children are often latent in infancy and manifest only later in childhood, although the damage can occur before birth or in infancy. Mercury exposure could be the cause of decreased school performance, particularly in populations of children whose mothers eat large amounts of fish (National Research Council, 2000).

Fish–eating wildlife can also suffer from mercury poisoning. In wildlife, mercury poisoning results in lowered reproduction, weight loss and death. Mercury poisoning has been documented in the endangered Florida panther and wood stork, as well as populations of loons, eagles, and fur–bearing mammals such as mink and otters (U.S. EPA, 1997).

Mercury Reduction Efforts Across the U.S.

In the last several years, a widespread scientific and policy consensus has formed around the need to address public health and ecological threats posed by mercury pollution. Mercury has been targeted by the U.S. EPA, Environment Canada, the International Joint Commission for Environmental Cooperation, and many state and provincial governments for being one of the most critical pollutants for elimination or reduction.

Mercury Regulation and Reduction at the Federal Level

Mercury is subject to a complex mix of regulations and laws at both the state and federal levels. At the federal level, existing regulations do not apply uniformly to all sources of mercury releases (U.S. EPA and Environment Canada, 1999). In addition, several states have passed their own laws and regulations relating to mercury (Environmental Council of States, 2001).

In 1997, the U.S. EPA completed a major study of the sources of mercury emissions, the health and environmental implications of those emissions and the availability and cost of control technologies. This eight volume *Mercury Study Report to Congress,* forms the basis of much of EPA's work on mercury regulation and control (U.S. EPA, 1997). Nonetheless, the U.S. has not fully implemented a comprehensive national strategy to significantly reduce the amount of mercury released to the environment.

Clean Air Act

Under the Clean Air Act, mercury and mercury compounds are considered hazardous air pollutants or HAPs. EPA regulates only major sources of HAPs, which are defined as those that release 10 tons per year of any one HAP or 25 tons per year of total HAPs. Since most mercury sources discharge significantly less than 10 tons per year, they are typically not regulated under the Clean Air Act. However, the EPA has identified mercury as one of the toxic air pollutants of greatest concern for public health due to its effects on the nervous system.

Clean Water Act

Under section 303(d) of the Clean Water Act, states must list all waterways where water quality standards are not being met. For each waterbody that fails to meet standards, the state must prepare a Total Maximum Daily Load (TMDL) to achieve the standard. In Oregon, there are eight waterbodies that fail to meet Clean Water Standards for mercury, including most of the Willamette River (DEQ, 2001a). As a result, DEQ is currently going through the process of establishing a mercury TMDL for the Willamette River, which is due to be complete in late 2003.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) regulates the disposal of solid and hazardous wastes. Under RCRA, EPA developed regulations that require that wastes containing more than 0.2 milligrams of mercury per liter of waste extract be managed as hazardous waste. A recent federal regulation, known as the Universal Waste Rule, prohibits the land disposal of some items, such as fluorescent lamps and thermostats, and encourages that they be recycled. The Oregon DEQ has adopted these policies and provides compliance assistance to Oregon businesses.

EPA's PBT Strategy

The U.S. EPA has developed and is beginning to implement a multi-media strategy for PBT's, including mercury. This strategy reinforces and builds on existing EPA commitments related to priority PBTs, such as the 1997 Canada-U.S. Binational Toxics Strategy (BNS), the North American Agreement on Environmental Cooperation, and EPA's Clean Water Action Plan. EPA is focusing on reducing risks from and exposures to priority PBT pollutants through increased coordination and funding among national and regional programs. The agency has developed "Action Plans" for several PBT's,including mercury (seehttp://www.epa.gov/pbt/epaaction.htm for these Action Plans).

EXAMPLES OF FEDERAL STANDARDS RELATED TO MERCURY

- The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part per million (1ppm) in seafood for human consumption.
- Under the Clean Water Act , the U.S. Environmental Protection Agency (EPA) has set a criteria of 0.3 ppm in fish tissue.
- The EPA has set a limit of 2 parts per billion (2 ppb) in drinking water.
- The Occupational Safety and Health Administration (OSHA) has set a limit of 0.1 milligrams of mercury per cubic meter of workplace air, and half that amount for exposures over an 8 hour period.

EXAMPLES OF STATE AND LOCAL GOVERNMENT EFFORTS TO REDUCE MERCURY POLLUTION

Many states and local governments have implemented a variety of mercury reduction programs. Below is a list of some of these efforts. In addition to these programs, many states have passed legislation to address mercury. For more information about these laws, see the Environmental Council of States report, 2001; NEWMOA's web page (www.newmoa.org); and the Mercury Policy project website at www.mercurypolicy.org.

Federal, State or Local Government Agency	Program	Website for more information…
National Institutes of Health	Campaign for a Mercury Free NIH	www.nih.gov/od/ors/ds/nomercury/
New England Waste Management Officials Association	Mercury Program	www.newmoa.org/prevention/mercury
U.S. EPA, Region 5 and Environment Canada	Binational Mercury Toxics Strategy	www.epa.gov/Region5/air/mercury/mercury.html
Vermont	Mercury Education and Reduction Campaign	www.anr.state.vt.us/dec/ead/mercury/merc.htm
Maine	Mercury Information	www.state.me.us/dep/mercury.htm
Minnesota	Reducing Mercury in the Environment	www.moea.state.mn.us/berc/mercury.cfm and www.pca.state.mn.us/air/mercury.html
New Hampshire	New Hampshire Mercury Reduction Strategy	www.des.state.nh.us/nhppp/taskforce.htm
Connecticut	Information About Mercury	www.dep.state.ct.us/wst/mercury/mercury.htm
Indiana	Mercury Information and Programs	www.IN.gov/idem/mercury/
Massachusetts	Mercury Awareness Outreach Campaign	www.state.ma.us/dep/pao/files/mercury1.htm
Michigan	Mercury Awareness for Michigan Citizens	www.deq.state.mi.us
City of Palo Alto	Mercury Pollution Prevention Program	www.city.palo–alto.ca.us/cleanbay/mercury.html
Western Lake Superior Sanitary District	Blueprint for Mercury Elimination	www.wlssd.duluth.mn.us/Blueprint%20for%20mercury/HG1.HTM

Mercury Reduction Efforts in the Great Lakes Region

In April 1997, the United States and Canada signed the Binational Toxics Strategy. This strategy establishes a collaborative process to achieve virtual elimination of persistent toxic substances resulting from human activity, particularly those that bioaccumulate in the Great Lakes basin. The Binational Toxics Strategy set an interim goal of 50 percent reduction by 2006 in the deliberate use of mercury nationwide and a 50 percent reduction by 2006 in the release of mercury from sources resulting from human activity.

The Binational Toxics Strategy has prompted important voluntary commitments by industry groups such as the Chlorine Institute, American Hospital Association and three Indiana steel mills. In the last few years, many states and local governments in the region have also begun implementing mercury reduction strategies.

Also in the Great Lakes, the EPA has banned the use of "mixing zones" – areas of the Lakes where discharges of toxic chemicals are allowed to mix with receiving waters and dilute. This new regulation, finalized in November 2000, prohibits new discharges of PBTs, including mercury, into mixing zones in the Great Lakes Basin and will phase out the use of existing mixing zones for PBTs over 10 years. EPA expects this regulation to reduce mercury discharges from point sources by 90%. The states of Indiana, Illinois, Michigan, Minnesota, and Wisconsin had already eliminated mixing zones for PBTs in the Great Lakes Basin prior to this regulation (EPA, 2000).

Mercury Reduction Efforts by New England States

In the Northeast, officials have recognized that mercury is pervasive in freshwater fish at levels that pose serious health risks to people and some species of wildlife. The conference of New England Governors and Canadian Premieres concluded that aggressive and concerted actions were needed to reduce potential health risks attributable to mercury (Confe-rence of New England Governors and Easter Canadian Premiers, 1998). In 1998, they adopted a plan that calls for the implementation of stringent regulations limiting man-made mercury emissions to the environment. The objective of the plan is to reduce mercury emissions by implementing actions that are expected to reduce mercury emissions by at least 50 percent by the year 2003. In response to this call for action, several New England states passed legislation to reduce mercury emissions (Environmental Council of States, 2001).

Oregon's Mercury Reduction Efforts

In September 1999, Oregon's Governor John Kitzhaber signed an Executive Order requiring the DEQ to lead a state-wide effort to eliminate the release of PBTs into the environment by the year 2020 – including mercury. As yet, a statewide effort to address mercury or any other PBT has not been implemented, although DEQ is developing a plan. The 2001 Legislature passed a bill, which was signed into law in August, 2001, to reduce mercury in the environment by eliminating its use in certain products (see Sidebar on HB 3007).

Mercury has also been the focus of various local pollution reduction efforts. For example, the City of Portland and the Oregon Dental Association (ODA) recently developed a best management practices program for ODA members to reduce the amount of mercury coming from dental offices. Also, a number of local governments have established collection programs for mercury-containing wastes. For example, Marion, Douglas and Tillamook Counties have sponsored mercury thermometer collection events as part of their household hazardous waste programs.

IS ZERO MORE THAN A CONCEPT?

When Governor Kitzhaber signed Executive Order (EO) 99–13, he set the standard for eliminating the discharge of persistent, bioaccumulative and toxic (PBT) chemicals in Oregon. The EO directs DEQ to develop a strategy to eliminate the discharge of all PBTs by the year 2020. The Mercury Solution Team's mission is consistent with this standard of mercury elimination. Nonetheless, the concept of "zero discharge" of mercury is not as simple as it might seem. Since mercury occurs naturally in geologic deposits such as coal, limestone, and fossil fuels, it is not currently technologically or economically feasible to completely eliminate all discharges of mercury. Furthermore, with our current scientific tools, it is not even possible to measure "zero."

Therefore, the Team recognizes that there are significant technological and economic limitations of achieving and measuring zero discharge. The Team also recognizes that it is not possible to eliminate mercury from our environment entirely, particularly because of its persistent nature. In fact, others have used the term "virtual elimination" instead of zero discharge. Instead of getting bogged down in semantics, the Team agreed that eliminating the discharge of mercury should continue to be our goal, and to focus on practical steps we can take that will have a measurable effect on the levels of mercury discharged in Oregon, both in the short and long term. When we use the term " eliminate" in this document, we do so with a full recognition of the technological and economic limitations involved.

In the fall of 2001, OEC, the Northwest Automotive Trades Association, DEQ, Metro and the Port of Portland teamed up to develop a pilot program to replace mercury automotive switches. The goal of the project is to replace 10,000 switches under the hood and/or trunks of cars, while increasing public awareness of the dangers of mercury.

Oregon's Mercury Solution Team

In September 2000, OEC convened the Mercury Solution Team. The goal was to demonstrate the feasibility of achieving zero discharge of PBTs by focusing on the reduction of one key PBT – mercury. Representatives of organizations with an interest in the issues related to mercury elimination were recruited to develop a comprehensive, long–term strategy for eliminating the discharge of mercury in Oregon.

The Mercury Solution Team set the following goal for themselves:

> ***To develop a comprehensive strategy for eliminating the release of mercury from human activities in Oregon by the year 2020, and for reducing overall mercury exposure to the extent feasible.***

The Mercury Solution Team explored a range of creative strategies to promote source reduction and pollution prevention. Short–term steps that could be implemented within one year, as well as steps to be taken over the longer term were discussed. In addition to strategies for mercury reduction, the Team looked at reduction targets and tools for measuring progress. Members also committed to promoting the implementation of the strategies and advocating for mercury reduction policies through public presentations, advocacy to business and government leaders and any other appropriate means.

Wherever possible, the Mercury Solution Team encouraged those members who were directly involved with the mercury source to lead in the development of the recommended strategy for that source. In order to ensure that all perspectives where considered, the Team solicited input from sources without a representative on the Mercury Solution Team whenever possible.

OEC and the Mercury Solution Team made some early progress in mercury reduction with the passage of HB 3007. OEC, in consultation with the Solution Team, crafted legislation to reduce mercury in Oregon by phasing out certain products for which alternatives are readily available, including thermometers, thermostats, novelty products and automotive light switches. This legislation passed with overwhelming support and was signed into law by Governor Kitzhaber in August 2001. It made Oregon the first state in the nation to specifically prohibit the installation of mercury thermostats. While making great strides in the right direction, there are still many mercury sources that HB 3007 does not address.

THE OREGON MERCURY REDUCTION ACT OF 2001 (HB 3007)

HB 3007, passed by the 2001 Oregon Legislature, phases out the use of mercury in certain common consumer products for which there are readily available alternatives. The unnecessary use of mercury in these products threatens the health of all Oregonians, especially children. HB 3007 will reduce mercury pollution by mandating the following:

Thermostats

- Requires thermostat manufacturers to take responsibility to recover the mercury from used thermostats.
- Requires heating and cooling contractors to ensure the proper disposal of mercury–containing thermostats.
- Phases out the installation of new mercury thermostats in five years. Digital thermostats are now widely used and are more energy efficient.
- Requires mercury–containing thermostats to be labeled accordingly.

Thermometers

- Prohibits the sale of mercury fever thermometers as of July 1, 2002.

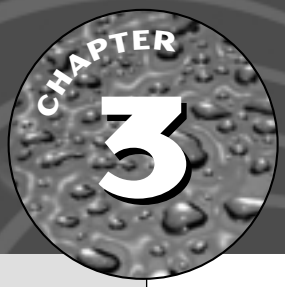
Novelty Products

- Prohibits the sale of novelty products containing mercury, such as children's toys and games, as of January 1, 2002.

Automotive Switches

- Requires anyone crushing a car to remove the light switch under the hood and trunk if it contains mercury and manage the mercury properly.
- Requires DEQ to provide technical assistance to car crushers.
- Prohibits the sale of new vehicles with mercury light switches as of January 1, 2006.

In addition, SB 594 was signed into law in 2001, which requires the State Board of Education to adopt rules that will eliminate the use and purchase of elemental mercury, mercury compounds and mercury–added instructional materials by public elementary and secondary schools.



Mercury in Oregon's Environment

Mercury in Oregon comes from a number of sources, both human-made and naturally-occuring. Naturally-occuring mercury is released from natural deposits of cinnabar particularly in conjunction with geothermal and volcanic activity. Small amounts of mercury can also be released during forest fires. Some mercury in Oregon is also transported here from elsewhere in the U.S. or overseas. For example, as much as 50% of the air deposition of mercury in Oregon may come from Asia (Shick, 2000).

Oregon can do very little about naturally-occuring mercury or mercury from out-of-state sources. Nonetheless, it is important to recognize that these sources may be substantial. National and international strategies will be needed, and it is important to acknowledge that there will always be some background level of mercury in the environment.

Human-made sources of mercury in Oregon are numerous. Abandoned mercury and gold mines are a significant source of mercury in Oregon. It is an incidental by-product of several types of industrial processes, such as power plants that burn coal, cement kilns, steel mills, and solid waste incinerators. Mercury is also used in a number of common products, such as thermometers, switches in cars, fluorescent lights, thermostats, relay and tilt switches. Mercury can also be found in hospitals, laboratories, and dental offices. All of these uses of mercury, while providing useful goods and services, can contribute to the overall load of mercury in our environment.

To evaluate the success of the strategies recommended in this report, the Team recognized the need to estimate the amount of mercury being released to Oregon's air, water and land from as many sources as possible. No estimates of total mercury releases in Oregon, however, had ever been made. Therefore, OEC conducted an inventory of mercury sources, and for the first time in Oregon, estimated the quantities of mercury from most sources. In order to develop these estimates, we used the best information we could find, but it was necessary to make a number of assumptions (*see Appendix II for details*). It is hoped that more information to better characterize mercury releases in Oregon will be developed in the future.

Mercury in the Solid Waste Stream

In the United States, manufacturers use about 500–600 metric tons of mercury annually as part of their manufacturing processes or to create products that rely on mercury's diverse properties (U.S. EPA and Environment Canada, 1999). Mercury can enter the solid waste stream when products are taken out of service.

Based on data from EPA, Oregon DEQ and other sources, an estimated 2,000 pounds of mercury enters Oregon's solid waste stream each year just from mercury-added products. This represents about roughly 50% of the anthropogenic mercury sources in Oregon (assuming that abandoned mines contribute roughly 1,000 pounds per year, which closer to the lower end of our estimate).

Once a mercury product enters the waste stream, the potential exists for mercury to reach the environment. If the product is broken and the mercury is exposed to air at room temperature, the mercury begins to volatize and move into the atmosphere. If mercury escapes from its vessel, such as when a thermometer breaks, it is also extremely hard to retrieve. It tends to break up into very small pieces that scatter and eventually volatilize or find their way to water.

SOURCES OF MERCURY IN OREGON'S SOLID WASTE STREAM

Source	Estimated Pounds of Mercury/Year
Automotive light switches	260
Batteries	620
Blood pressure cuffs	40
Computers	270
Fluorescent lamps	210
Thermometers	370
Thermostats	220
Manometers	10
TOTAL	**2,000**

Note: Relays and tilt switches and certain novelty products may also include mercury, but their yearly contribution to the waste stream could not be quantified.

Mercury Discharged to Water

A significant amount of the mercury in river systems such as the Willamette River originates from abandoned mercury and gold mines, scattered across Oregon, although no monitoring or analysis has been done to determine how much mercury is being released from these mines. Data to estimate how much mercury originates from these sources are scarce. For this report, OEC staff developed an estimated range of the amount of mercury discharged from abandoned mercury mines in Oregon (*see Appendix I for details*).

SOURCES OF MERCURY TO WATER IN OREGON

Source	Estimated Pounds of Mercury/Year
Abandoned Mercury Mines	680 – 6,700*
Wastewater Treatment Plants	10 – 15**
Total	**690 – 6,715**

*This range is a very ROUGH estimate based on a number of assumptions (*see Appendix I for details*).

** Based on assumption that about 95% of the mercury coming from wastewater treatment plants ends up in the biosolids (biosolids account for about 230 pounds of mercury each year).

Residual levels of mercury are also passed into our river systems by wastewater treatment plants. Mercury is not generated by the wastewater treatment process; instead it enters the wastewater treatment system from households and from commercial and industrial facilities (such as hospitals, laboratories and dental offices, as well as from human waste) that discharge to the wastewater collection system. Mercury in human waste comes from consumption of fish, leaching from dental fillings, and low levels of mercury in some food products. Many household and some personal hygiene products also contain low levels of mercury.

Mercury discharged to the air, either locally or from distant sources, can also contribute to the total amount of mercury in water through deposition. Natural processes also contribute mercury to water, such as geothermal and volcanic activity and mercury that is released from naturally-occurring cinnabar. However, these have not been quantified.

Mercury Discharged to Air

Because it is a naturally occurring element, mercury is present as a trace metal in many raw materials such as ore and fuel. When these types of raw materials are heated, mercury can be released to the air. Industries in Oregon that release mercury in this manner include a coal-fired power plant, cement plants, and commercial or industrial boilers.

Mercury releases to air also occur as an industrial by-product when material contaminated with mercury is heated in the industrial process. Industries in this category include steel mills, crematories and municipal solid waste (MSW) incinerators.

Mercury Applied to Land

Sometimes mercury is applied unintentionally to land when it is a contaminant in soil amendments such as biosolids or fertilizers. Biosolids are the solid phase generated during the wastewater treatment process. Biosolids contain beneficial soil nutrients, and the Oregon DEQ encourages

its use for agricultural production. Fertilizers and other soil amendments are sometimes contaminated by mercury and other heavy metals when they are made from industrial by-products. When these products are used, mercury is then unintentionally applied to land.

In Oregon, about 60,000 tons of biosolids are land-applied each year (DEQ, 2001b). The average concentration of mercury in biosolids is estimated to be 0.00389 lbs/ton (based on concentrations reported by City of Portland and Clean Water Services in Washington County). This equates to about 230 pounds of mercury applied to land each year via biosolids.

The amount of mercury in fertilizers applied to land in Oregon is currently unknown. However, a 2001 Oregon law requires fertilizer companies to test waste-derived fertilizers for mercury and other heavy metals and provide that information to the Oregon Department of Agriculture. This requirement will take affect beginning January 2003, and should provide better data for the future.

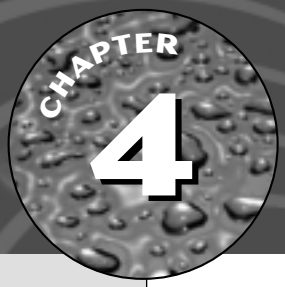
SOURCES OF MERCURY TO AIR IN OREGON

Source	Estimated Pounds of Mercury/ Year
Boilers	380
Cement kiln	110
Coal–fired power plant	165
Crematories	70*
MSW Incinerators	60
Steel mills	10 – 1,070**
Total	**800 – 1,850**

*This represents our best estimate, based on an average emissions factor of 2 grams/body. The range of potential mercury releases from crematories presented in Appendix II is 0.03 to 200 lbs per year.

** This wide range reflects the large uncertainty associated with mercury releases from steel mills. Based on data collected recently by three facilities in Ohio and NJ, the authors of "Toxics in Vehicles: Mercury" (Ecology Center, 2001) calculated an average emissions factor for steel mills with electric arc furnaces of 0.00069 lbs Hg/ton, and determined that the two steel mills in Oregon release about 838 lbs per year. However, the same report shows that in 1992, 19 mills reported a much lower average emissions factor of 0.000008 lbs Hg/ton in response to an EPA request for information. The authors note that it is not known if these tests were performed using EPA methods. To calculate the range shown here, we used the low emissions estimate from the 1992 data for the low end, and a high end emissions factor of 0.0014 as reported more recently by Marion Steel in Ohio.

EPA estimates that mercury emissions from motor vehicles in the U.S. total 0.19 tons/year (or 380 lbs/year). Based on this estimate, the amount of mercury from automobiles in Oregon would total only about 4 pounds a year (or 1.1% of 380). See http://www.epa.gov/ttn/chief/nti/index.html#nti



Recommended Strategies for Oregon

Statement of Goals

The mission of the Mercury Solution Team was to develop a comprehensive strategy to eliminate the release of mercury from human activities in Oregon by the year 2020, and to reduce overall mercury exposure to the extent feasible. Some mercury releases can be addressed quickly, while others may take several years. In order to keep moving toward the goal of zero mercury releases, the Mercury Solution Team set the following interim goals:

- By 2006, reduce mercury releases by 50% from 2001 levels.
- By 2011, reduce mercury releases by 75% from 2001 levels.
- By 2020, achieve 100% reduction.

These goals are similar to those established in other regions. For example, the New England Governors' Conference and Eastern Canadian Premiers adopted a Mercury Action Plan in 1998 that called for a 50% reduction goal by 2003. The Great Lakes Binational Toxics Strategy calls for a 50% reduction by 2006.

The Mercury Solution Team categorized sources of mercury into four general classes:

1. **Mercury–Added Products**, which are products that intentionally use mercury for its unique properties;
2. **Point Sources**, which are industrial and municipal sources that hold a permit from DEQ, or are otherwise clearly defined and relatively small in number;
3. **Non–point Sources**, which are sources of mercury that are wide spread and are not products or point sources.
4. **Abandoned Mines**, which belong in their own category, largely due to the different strategies that are needed to deal with this source of mercury.

Within each major class, the Team recommends several general strategies. Since not all general strategies can be applied to a specific source, specific strategies for each source are outlined in more detail in Chapter 5.

Guiding Principles

In general, the Team agreed that strategies to eliminate mercury should be guided by the following principles:

- ✶ Create an even playing field,
- ✶ Adopt shared responsibility,
- ✶ Ensure that recommended strategies avoid unintended consequences,
- ✶ Start with the least expensive approaches, and
- ✶ Use financial incentives to encourage faster and more aggressive mercury reduction activities.

The Team recognizes that mercury is pervasive in the environment from both natural and human-made sources. Given the known toxic effects of mercury, the prudent approach is to minimize exposure to humans. However, the Team recognizes that there are decisions that we will need to make as a society regarding what is a reasonable cost and the speed of our efforts to reduce exposure to mercury over time.

Reduction Strategies for Mercury–Added Products

A number of commonly used consumer and industrial products contain mercury, including thermometers, thermostats, switches, batteries, fluorescent bulbs, electronics and novelty products. These products intentionally use mercury due to its unique properties. After use, mercury in these products can be released into the environment during waste handling and disposal.

"An estimated 2,000 pounds of mercury enters Oregon's waste stream each year just from mercury – added products."

An estimated 2,000 pounds of mercury enters Oregon's waste stream each year just from mercury-added products. This represents about 50% of anthropogenic mercury sources in Oregon identified in this report (assuming that abandoned mines contribute roughly 1,000 lbs per year, which is closer to the lower end of our estimate).

A very small amount of mercury may be found as a contaminant in household products such as shampoos, soaps, drain cleaners, and even dyes used in food products. A study by the Association of Metropolitan Sewerage Agencies found that the mercury in these products accounts for less than 1% of the mercury concentration in domestic wastewater (AMSA, 2000). While this is a concern and should be addressed by manufacturers, the strategies in this report apply only to products where mercury has been intentionally added.

RECOVERY, RECYCLING AND LONG TERM STORAGE

In general, recycling is an environmentally beneficial approach to managing waste. With mercury, however, there is an obvious dilemma regarding how to best manage mercury waste. Recycling implies the continuing use of mercury, when the preferred goal is to replace the use of mercury whenever possible. In addition, as we replace mercury with other technologies, less mercury will be needed in commerce, and stockpiles of recovered mercury will accumulate. As these stockpiles grow, we need to develop systems to "retire" this mercury through stabilization, encapsulatation or other technologies so it cannot reach the environment. In this report, then, we generally refer to "recovery" rather than "recycling" as the preferred strategy for mercury products. "Retirement" of the recovered mercury is also encouraged.

One strategy favored by the Mercury Solution Team is a ban on mercury-added products that have a widely available, viable and economically competitive replacement. This strategy has already been applied to thermometers, thermostats, novelty product and automotive light switches in Oregon as a result of legislation authored by OEC, with advice from the Mercury Solution Team (see Sidebar on HB 3007).

Listed below are ten reduction strategies for eliminating the discharge of mercury from mercury-added products in Oregon by the year 2020. Not every strategy listed below will apply to every mercury-added product. For example, for mercury-added products where replacement technologies are widely available (e.g.: thermostats, thermometers), the Solution Team recommends phasing out the sale and use of the mercury-added products over the next five years or so. For products with no viable alternative to mercury (such as fluorescent light bulbs), the best short-term solution is to increase the recovery of those products to keep the mercury out of the waste stream. *For specific recommendations organized by product, see Chapter 5.*

1. Expand and Support Mercury Recovery Programs

Ensuring the proper disposal of mercury-added products is one of the keys to keeping mercury out of the waste stream. The Team recommends that state and local government agencies should dedicate more resources to ensuring the recovery of mercury-added products. The term "recovery" means diverting mercury from the waste stream, which may involve recycling in some cases.

One of the barriers to increased recovery is convenient access to a recycling or other recovery facility. For example, while a growing number of communities are developing permanent household hazardous waste facilities, only four communities in Oregon have facilities with ongoing household waste fluorescent lamp collection programs (these four are in the Portland area (where Metro just began collecting lamps in late summer of 2001), Marion County, Lane County and Jackson County). It is crucial that consumers and businesses across Oregon have access to convenient and reasonably priced mercury recovery facilities. Manufacturers of mercury-added products should also commit additional resources to ensure greater recovery.

The goal is to significantly increase recovery rates of mercury-added products to as close to 100% as possible by the year 2010 and to increase access to recycling facilities across the state.

2. Implement a Concerted Education and Outreach Effort

Providing consumers with better information may prevent some mercury pollution. Consumers and businesses need to be fully informed about mercury in the products they use and they need to understand the risks

associated with mercury, so they can make informed decisions about the use and disposal of mercury products.

Therefore, the Solution Team recommends that state and local governments implement a concerted education and outreach effort to alert the public to the dangers of mercury, increase recovery rates, and decrease the use of mercury overall. Education and outreach should be instituted for both consumers and businesses across the state. Businesses that use or sell mercury-added products should also be involved in these efforts.

3. Prohibit the Sale of Certain Mercury–Added Products

Products for which there are viable alternatives should be phased out of use. Several states and local governments have already passed laws to prohibit the sale of some products containing mercury (ECOS, 2001). In the 2001 legislative session, the Oregon Legislature passed HB 3007, which phases out the use of mercury in thermometers, thermostats, novelty products and automotive light switches. However, other mercury-added products with alternatives still exist, and as more mercury-free products become viable, legislative action may be necessary to phase out other mercury-added products.

4. Require Consumer Notification/Labeling

Labeling products or otherwise notifying consumers that the product they are purchasing contains mercury provides valuable information to consumers who want to handle or dispose of mercury products properly. Labeling and notification help enable consumers to make fully informed purchasing choices, especially when alternatives exist. Recycling and proper disposal cannot take place unless the mercury content of products is known and consumers have access to the necessary recovery facilities.

Labeling can also be useful for companies in their pollution prevention efforts. For example, labeling mercury-added products can help manufacturers to identify equipment containing mercury (Lake Michigan Forum, 2000). Absent such labels, manufacturers and other businesses have to obtain the model number and purchase order for each item and contact the vendor to determine if the item contains mercury.

The Mercury Solution Team recommends that all mercury-added products be labeled accordingly. Manufacturers should be required to certify with the state that they have developed a labeling plan for their mercury-added products.

5. Promote Product Stewardship

Product Stewardship is the concept that manufacturers, distributors, retailers and consumers share responsibility for the environmental impacts of their products, including their end-of-life management. This approach takes some of the burden off government agencies and public funds to develop programs and systems that provide for appropriate waste management.

There are several products that contain mercury whose producers can and should take a greater role in ensuring that waste mercury from their products is managed responsibly. For example, 26 state Attorneys General recently asked Ford Motor Company to replace light switches containing mercury during the 2001 recall of defective tires.

Manufacturers of mercury-added products should be responsible for the costs of collecting and managing their products to ensure that they do not enter the waste stream. State and local governments should pursue collaborative efforts and negotiated agreements to achieve this goal.

6. Government Lead by Example

State and local government agencies should play a leadership role in reducing mercury use and ensuring that all mercury-added products are recycled or otherwise managed to keep the mercury out of the environment. All state and local agencies must find ways to reduce their use of mercury and recycle all mercury-added products. All state and local government agencies should be recycling 100% of any mercury-added products they still use by 2010.

7. Prohibit Disposal of Mercury–Added Products

Several states have used disposal bans as a tool to encourage the recovery of mercury-added products. For example, state officials in Minnesota believe they have a 70% recycling rate for fluorescent light tubes due to the combination of a disposal ban and a well-funded outreach program (Zero Waste Alliance, 2001). Once the mechanisms are in place to ensure appropriate management and recycling of mercury-added waste in Oregon, the state should ban disposal of mercury-added products as solid waste. The state should also investigate equitable funding sources for programs to support appropriate waste management and recycling.

Responsibility for complying with a disposal ban could be placed either on the waste generator or on the solid waste disposal facility, or both. The Mercury Solution Team believes that the responsibility for compliance should lie with the waste generator or consumer, as it is not feasible for disposal facilities to effectively monitor the incoming waste stream for all products. Disposal facilities can assist by informing their users about the mercury products they should not throw away and setting up diversion programs with local government agencies.

8. Require Statewide Tracking of Mercury–Added Products

The state will be better equipped to focus its resources on the most significant sources of mercury if it has a record of products that contain mercury and the amount of mercury in each product. Therefore, all manufacturers of mercury-added products should be required to provide information about their mercury-added product to the state, including the amount of mercury in each unit of the product and the number of units of products offered for sale, use or distribution in Oregon.

9. Fund Research into Alternatives

For some uses of mercury, including some highly beneficial ones (e.g.: fluorescent light tubes), there are few currently viable alternatives (although lighting manufacturers are currently researching more ways to reduce mercury). Therefore, resources at the state and federal level, from consumers and from the business community, should be committed to develop and evaluate new technologies that provide viable and environmentally friendly alternatives to mercury use. Once alternative products are available, resources should be committed to promote the use of the new product and the phase out of the mercury-added product.

10. Investigate Financing Mechanisms That Use Economic Incentives and/or Disincentives

Economic incentives can be a powerful force for affecting behavior. Oregon should support efforts to realize the true cost of mercury use and improper disposal. There are many options to reflect the full environmetal life cycle costs of mercury, including:

- A bounty could be placed on collection of mercury-added products (i.e.: payment to individuals who turn in mercury-added products).
- A fee could be imposed on the sale of mercury-added products based on their mercury content.
- A fee could be imposed on the use or sale of elemental mercury.
- A surrogate, such as a flat increase in waste disposal fees could be imposed (although this would not be an incentive to reduce mercury waste).
- A deposit/refund system could increase the number of products returned for recycling or proper disposal.
- An "advance disposal fee" could cover the cost of proper disposal and be collected at the point of product sale.

These options, and potentially others, should be explored and studied further. Furthermore, since many of the recommended strategies require an investment of public funds, Oregon should establish a Mercury Reduction Fund with the revenues from any such funding mechanisms.

Reduction Strategies for Point Sources

Mercury is released into Oregon's environment from a number of "point sources" across the state, including commercial and industrial boilers, a cement kiln, municipal solid waste incinerators, crematories, a coal-fired power plant, and steel mills.

Regulations regarding mercury vary from industry to industry. For example, municipal solid waste incinerators were required to install pollution controls for mercury in the mid 1990's, while existing steel mills are not required to test for mercury in the air and water and do not have

mercury limits in their air and water discharge permits. Meanwhile, EPA is developing new rules for coal-fired power plants due to be promulgated by 2004 and then implemented by 2007.

Given this variability, the Solution Team recommends strategies that "even the playing field" across all mercury sources. However, there is concern about imposing costs on industrial facilities in Oregon that compete with similar facilities outside the state. For example, there is only one cement plant in Oregon, but the plant does not supply all of the cement used in Oregon. Significant amounts of cement are imported from other states, Canada, and the Pacific Rim countries. In addition, a significant amount of cement is sold outside of Oregon. Any program that significantly increases costs for the Oregon plant, while not affecting the cost of other producers, puts the Oregon plant at an economic disadvantage and could have the unintended consequences of encouraging the purchase of cement from sources that do not control mercury emissions. These economic problems must be carefully considered.

Listed below are five reduction strategies for eliminating the discharge of mercury from point sources in Oregon by the year 2020. *More detailed recommendations for each point source are outlined in Chapter 5.*

1. Require Mercury Point Sources to Develop and Submit a Plan

Each point source should submit a plan to DEQ by January 1, 2004 describing:

- The facility's current mercury emissions in all media, including air, water and solid waste;
- Plans for reduction efforts over the next five years, both voluntary and those required by current or pending regulations;
- Estimated future mercury emissions;
- How the facility plans to eliminate mercury emissions by 2020; and
- The estimated cost of planned measures to be taken over the next five years and for the total program.

This would apply to all point sources, industry and municipal, regardless of their current regulatory status. DEQ should develop criteria for evaluating these plans and require regular updates every five years.

These plans may include an off-set program. An off-set program allows facilities that release mercury to support mercury reduction efforts by contributing in other ways. For example, a company may opt to fund a program to recover and recycle fluorescent light bulbs, instead of installing expensive pollution control equipment in the short-term. DEQ should study off-set programs implemented elsewhere in the country and make recommendations on the feasibility of developing an off-set program in Oregon.

DEQ should request voluntary participation immediately. If voluntary compliance is not achieved quickly, DEQ should implement this requirement under its current regulatory authority. If new regulations or legal authority is required, DEQ should seek it as quickly as possible.

WISCONSIN REGULATION PROVIDES A MODEL FOR REDUCING MERCURY FROM POINT SOURCES
New Rules Use A Combination of Regulations, Industry–Generated Plans, Off–Set Programs and Cap and Trade System.

Wisconsin is poised to establish a set of regulations that would cut mercury emissions by 90% over the next 15 years. The program encourages industries that release mercury to trade credits with industries that use mercury in their industrial process. For example, power plants would be able to trade credits with chlor–alkali plants, which use mercury in the chlorine manufacturing process. Although the Wisconsin rule targets coal–fired power plants first, the rule is of most interest as a model for reducing mercury from all point sources of mercury. Among the provisions of the proposed rules:

- Mercury emissions would be reduced in stages over the next 15 years.
- Certain large industries would submit compliance plans to cut mercury emissions by 30% after five years, 50% after 10 years and 90% after 15 years.
- At the end of the first and second five–year phases, the state could adjust mercury reductions to make allowances for cost and technical feasibility.
- Certain large industries could satisfy 25% of their compliance goals by organizing comunity collection and disposal programs to remove mercury from other sources, such as thermometers and electrical switches.
- Other smaller sources that emit 10 pounds or more of mercury per year will be required to determine their average emissions, which will be used to set a cap.
- To provide for industrial expansion, the regulations will set caps for all sources, beyond which each pound of new emissions must be offset by a reduction of 1.5 pounds of airborne mercury.

2. Study a Mercury Emissions Fee

As a mechanism to further encourage mercury reduction, DEQ should study the feasibility of assessing a mercury emissions fee. This assessment should include consideration of:

- The appropriate level of a fee,
- How to avoid placing Oregon firms at a competitive disadvantage,
- The potential to increase out-of-state mercury emissions,
- Social equity and economic impacts.

The assessment should be completed by December 2004 so that any fee that might be recommended could begin by 2006. Point sources with DEQ-approved plans should be exempt from the fee.

A fee on mercury emissions provides an economic disincentive to emit mercury to the environment. It increases the cost of emitting mercury, and likewise, lowers the cost when mercury emissions are reduced. The revenue from such a fee should be dedicated to the Mercury Reduction Fund discussed previously to help cover the costs of other mercury reduction activities.

3. Study the Feasibility of Setting Up a Cap and Trade System

Under a cap and trade system, total allowable mercury releases would be capped at a specified level, and then that total reduced over time. Each source would be allocated a share of the total allowable releases, which it cannot exceed, but then these sources would be allowed to trade their shares. This sort of program allows industry flexibility in meeting emissions caps. Sources with lower reduction costs may chose to reduce their emissions below their allowable level and trade the "excess" reductions to sources with higher costs, who may find purchasing those shares cheaper than investing in capital equipment for a while.

Currently there is not enough information to determine if a cap and trade system for mercury in Oregon is feasible. Some believe that this type of system works most effectively when there is a large pool of trading partners. Also, the amount of mercury released by each needs to be measurable. It is possible that the pool of point sources within Oregon is too small and any cap and trade program may need to be regional or national in scope. As point sources submit reduction plans, and Oregon gathers more information, DEQ should study the feasibility of a cap and trade system.

4. Provide Financial Incentives to Encourage Action

Financial incentives, such as tax credits, should also be used to encourage companies to make investments that reduce or eliminate mercury emissions beyond that which is required by law. At a minimum, existing tax credits or grant/loan programs (e.g.; Pollution Control Tax Credit) should prioritize investments that reduce mercury pollution and other PBTs. Over the long run, new incentives may also be needed.

5. Use Existing Regulations to Reduce Mercury Releases

The Mercury Solution Team favors using existing regulation over new regulations. As DEQ develops its strategy for implementing the Governor's Executive Order for the elimination of PBTs, it should look for and use existing broad authorities that can be used more effectively. In reviewing permits, DEQ should look for missing sources of mercury emissions and add mercury reporting requirements and limits to permits where applicable and where DEQ has regulatory authority. These permits would then provide more accurate information about mercury discharges and ensure all significant sources are addressed.

Reduction Strategies for Non–Point Sources

There are a number of mercury sources in Oregon that are not mercury-added products or point sources. These sources include:

- ✶ dental offices
- ✶ laboratories
- ✶ health care facilities (including doctors' offices)
- ✶ waste-derived fertilizers
- ✶ biosolids from publicly-owned treatment works (POTWs)

Each of these sources uses mercury in very different and distinct ways. To be effective, strategies must be customized and applied individually to these sources. However, strategies for this category are intended to "even the playing field" as much as possible among all sources. The following general strategies are recommended.

1. Implement a Concerted Education and Outreach Program

A crucial element of any mercury reduction strategy is an education and outreach program that allows individuals, businesses and government agencies to make informed decisions. For example, the Woodburn wastewater treatment facility has instituted education and outreach programs to help prevent pollution and reduce the load of mercury and other toxins coming into their plant. People are more likely to divert mercury products and wastes from the garbage when they know there is mercury present and that they have recycling options. These types of outreach program should be enhanced and expanded across Oregon.

2. Expand and Support Recycling Programs

Access to recycling facilities is another important element to ensure that waste mercury is appropriately managed. This is especially true for dental offices, health care facilities and laboratories that may have waste mercury to manage. Therefore, the Team recommends that state and local governments help to ensure that mercury sources have reasonable and practical access to service contractors, local government programs and recycling facilities statewide.

3. Encourage Alternatives and Promote Pollution Prevention

The best way to reduce mercury pollution is to avoid using it altogether. Therefore, the Solution Team recommends approaches and management practices that rely on use of alternatives to mercury wherever possible. For example, several hospitals are changing purchasing policies to avoid buying mercury-added products such as thermometers and blood pressure cuffs.

4. Conduct an Inventory of Mercury from these Sources

There are still questions about the amount of mercury generated from some of these sources. Therefore, the Solution Team recommends that the state conduct an inventory of mercury from these sources, as well as identify any other sources of mercury that may not have been identified in this report.

5. Require Facilities to Develop Reduction Plans

Facilities that use mercury and/or mercury-added products should be required to develop plans to reduce and eventually eliminate their mercury use. These plans may be developed with the assistance of professional or trade organizations as appropriate. Where appropriate, DEQ may require submission of these plans as part of its existing regulatory processes.

6. Investigate Economic Incentives and/or Disincentives

Economic incentives provide a powerful pollution prevention tool. The Solution Team favors strategies that gradually incorporate the full environmental costs of mercury into its price, making it more expensive to use and/or improperly dispose of mercury while financially rewarding those who make decisions that prevent adding more mercury to the environment. The Team encourages careful scrutiny of this approach on a case-by-case basis, in part to avoid unintended consequences. Any revenues generated from any such programs should be devoted to the Mercury Reduction Fund discussed earlier.

7. Use Existing Regulations to Reduce Mercury Releases

The Solution Team recommends that DEQ and other state and local agencies should use existing regulatory authority to reduce mercury emissions. DEQ has broad authority in its air, water and waste permitting programs to prevent pollution. As DEQ develops its strategy for implementing the Governor's Executive Order, it should look for existing authorities that can be used more effectively before instituting new regulations.

Source-Specific Strategies for Mercury Elimination

CHAPTER 5

The following sections describe in more detail recommended strategies for mercury elimination from abandoned mines, mercury-added products, industrial processes, and non-point sources.

Strategies for Abandoned Mines

Mercury contamination related to mining activities can occur from two types of historic mining within Oregon –- mercury mines and gold mines. Oregon has had an active history in lode mine production for both mercury and gold as well as placer production of gold. Development of these mines occurred at the turn of the century and extended until the 1940's for the gold production and into the 1950's for the production of mercury.

Mercury production centered around two dominant belts, one located in southwestern Oregon and the other in central Oregon. Cinnabar, the main ore from which mercury is produced, contains 86% mercury (DOGAMI, 2001). This vermilion-red ore has been exploited since ancient times, initially as a pigment and later for its metal value.

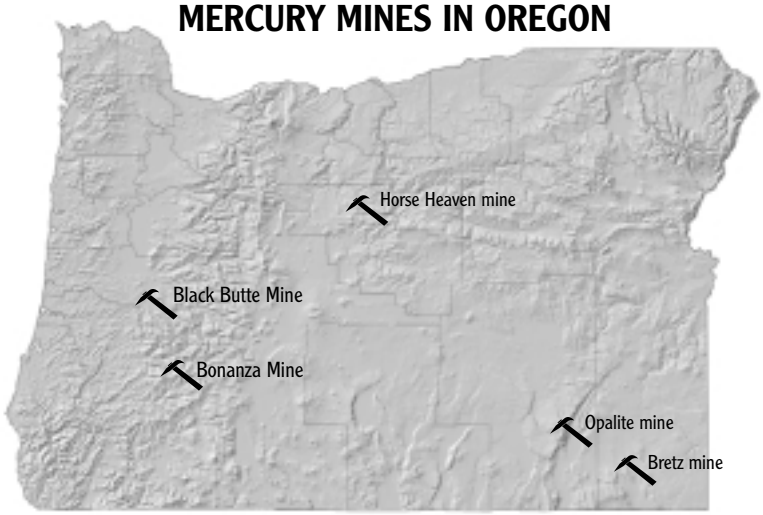
While there are roughly 135 mercury mines identified by the Oregon Department of Geology and Mineral Industries (DOGAMI), most were very small. Only 34 mines produced 10 or more flasks of mercury (Brooks, 1971). Five of these mines produced the vast majority of the mercury in Oregon. These five mines, listed below and identified on the map (See Figure 4, next page), accounted for about 94% of the total mercury production in Oregon (Brooks, 1971):

- ✶ Bonanza mine (Douglas County)
- ✶ Horse Heaven mine (Jefferson County)
- ✶ Black Butte mine (Lane County)
- ✶ Bretz mine (Malheur County)
- ✶ Opalite mine (Malheur County)

Two of these mines, Black Butte and Bonanza, account for about half of Oregon's historical mercury production (Park and Curtis, 1997; Brooks, 1971). Main sources of mercury to the environment are tailings piles (spent or used material), waste rock piles (not processed), and tailings that were placed in other areas (such as for building dams, etc).

Several studies show elevated levels of mercury in fish, water and sediments in areas impacted by abandoned mines (Park and Curtis, 1997; Hygelund, et. al., 2000). However, there have been no attempts to quantify

FIGURE 4: LOCATION OF THE FIVE LARGEST MERCURY MINES IN OREGON



These five mines produced 94% of the total mercury mined in Oregon

the amount of mercury being discharged from abandoned mines in Oregon.

For this report, we calculated that abandoned mercury mines in Oregon account for **roughly** 680 to 6,700 pounds per year (*see Appendix I for details*).

Historic gold mines are spread over a much wider geographic area than the mercury mines. Mining was scattered across the state with production centered in southwestern Oregon, the western Cascades, central Oregon and portions of eastern Oregon. Gold mines used mercury as an amalgam in the processing ores. The gold-bearing material was crushed and often treated with mercury to form gold amalgam. Due to inefficiencies and poor handling practices, large amounts of mercury often escaped into the environment. While not all gold mines employed this practice, a significant number of them used mercury as a final step in collecting small particles of gold. The result of this practice was to leave elevated mercury levels in both waste dumps and streams located near the processing sites. There is almost no way to estimate the quantity of mercury used at any given mine for this process so it is extremely difficult to calculate the amount of mercury produced by these sources.

The Oregon DEQ has begun to address the abandoned mercury mine problem. The DEQ's western regional office has selected 40 privately owned mines to be screened. Screening involves visiting sites, identifying waste piles, taking samples, looking for drainage, and testing air in the area for mercury. The purpose of screening is to decide which mines to focus on first. DEQ's goal is to get 20 screenings done by June 2002.

Abandoned Mines Strategies

- ✓ There has been little to no comprehensive sampling of mine waters and dumps by any of the federal or state agencies. In order to identify problem mine sites, an extensive and comprehensive sampling program should be instituted which focuses not just on total mercury content (which has typically been the practice), but on the various forms of mercury.
- ✓ State and federal agencies should work together to ensure that these abandoned mines are remediated as quickly as possible. Clean-up efforts should be prioritized.

- ✓ Responsible state agencies, such as DOGAMI and DEQ, should work cooperatively to produce a report for the Governor and the Legislature by December 2002 that includes:
  - their best estimate of mercury releases into Oregon's environment from abandoned mines, as well as from natural mineral deposits;
  - maps and prioritized lists of abandoned mines in Oregon; and
  - a workplan and estimated cost to sample, prioritize, and clean up all of these sites by 2020.
- ✓ Any active mine sites in Oregon should monitor for mercury emissions at their site.

Strategies For Mercury–Added Products

Batteries

Although batteries are a significant source of mercury – roughly 600 pounds a year – this problem has been largely addressed through federal and state laws that restrict the sale of mercury–added batteries. The National Electronic Manufacturers Association estimates that mercury levels in used alkaline batteries will be close to zero by 2006 or 2008. Therefore, the Solution Team did not develop recommendations for mercury–added batteries.

Thermometers

Mercury in thermometers is used to give a precise measurement of temperature. A fever thermometer contains about a half gram of mercury, while a laboratory thermometer contains about three grams of mercury. The mercury containing glass tube is fragile and susceptible to breakage. Thermometer breakage and disposal is estimated to contribute 370 pounds of mercury to Oregon's waste stream each year (*See Appendix II for details*).

Alternatives in the form of digital thermometers are commonly available and widely used. In fact, several major retailers including Albertsons, Rite–Aid, and K–Mart have already discontinued selling mercury fever thermometers. Several states and local governments have also banned the sale of mercury fever thermometers (examples include the cities of San Francisco, Duluth and Boston, and the states of Minnesota and New Hampshire).

Thermometer Strategies

- ✓ The state of Oregon should prohibit the sale of mercury fever thermometers. (This became law with the passage of HB 3007 in the 2001 legislative session.)
- ✓ The state and local governments should dedicate more resources to ensuring the collection and recycling of mercury thermometers.
- ✓ All hospitals and health care facilities and other businesses that use thermometers should replace existing mercury thermometers and ensure that used mercury thermometers are recovered.

Thermostats

The mercury in thermostats serves to connect two electrodes, completing an electrical circuit that triggers heating and air-conditioning units. Each thermostat contains two to three grams per ampoule, with some thermostats having more than one ampoule. Mercury from old thermostats can be released into the environment during demolition and deconstruction of buildings. Each year an estimated 220 pounds of mercury is released to Oregon's waste stream from the disposal of mercury thermostats (*see Appendix II for details*).

Alternatives to mercury thermostats in the form of electronic, digital thermostats are readily available and, in fact, are more energy efficient than mercury thermostats.

Thermostat Strategies

- ✓ Thermostats with mercury should be phased out of use (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ Thermostat manufacturers should be responsible for collecting used thermostats (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ Heating and cooling contractors should be encouraged to recycle used mercury thermostats. (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ Thermostats containing mercury should be labeled (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ Home repair centers should offer thermostat collection programs for their customers.
- ✓ Mercury thermostats should not be permitted in solid waste landfills.
- ✓ Local governments should accept used thermostats at their household hazardous waste facilities wherever possible.

THERMOSTAT MANUFACTURERS TAKE BACK OLD MERCURY THERMOSTATS

The Thermostat Recycling Corporation (TRC) is a private corporation established by thermostat manufacturers Honeywell, General Electric, and White–Rodgers. In 1998, the TRC began operating a recycling program for mercury–containing thermostats. Under this voluntary effort, heating and cooling contractors can drop off old mercury thermostats—no matter what the brand—at participating wholesalers. Wholesalers collect the thermostats in protective bins supplied by TRC. When the bins are full, wholesalers send them to the corporation's recycling center where the switches are removed and forwarded to a mercury recycler.

The TRC originally began operating this program in eight Midwestern states, and in 2000, expanded the program to 13 east coast states. In April 2001, TRC expanded the program again to include all 48 contiguous states. The TRC reports that they havehas collected over 99,000 thermostats and processed 913 pounds of mercury since it began operations in 1998 (see: http://www.nema.org/index_nema.cfm/664/).

Fluorescent Lamps

Mercury is an essential component in fluorescent lamps and high intensity discharge (HID) lamps used in streetlights and floodlights. Fluorescent lamps contain mercury in vapor form and in the phosphor coating on the lamp tube. The mercury vapor is energized to emit ultraviolet light. According to the lighting industry, 80% of fluorescent bulbs sold in the U.S. are used by large commercial and industrial facilities, with the remainder used in homes and small commercial establishments (Sustainable Conservation, 2000).

Fluorescent and HID lamps use significantly less energy than incandescent bulbs, thereby creating other environmental benefits. Many utilities and environmental groups are actively promoting a switch to compact fluorescent lighting. Currently there is not a substitute process to manufacture fluorescent lights without mercury. If handled improperly, fluorescent and HID lamps can be a source of mercury emissions during waste handling and disposal.

According to the National Electric Manufacturers Association (NEMA), when a lamp is broken, as is likely to occur during disposal, mercury in the vapor phase is immediately released to the air. Much of the remaining mercury slowly vaporizes as long as it is exposed to the air. Studies in other states have shown that mercury from broken lamps can hover in dumpsters for days, and concentrate in waste transfer stations and landfills (Lindberg, 1997, and Lindberg, et. al., 1999).

Despite manufacturing advances that have significantly reduced the mercury content in lamps over the last several years, disposal of fluorescent and HID lamps continues to be a significant source of mercury emissions in Oregon. About 6 million light tubes are sold each year in Oregon, and the DEQ estimates that only about 20% of the used tubes are recycled (compared to an estimated 70% in Minnesota, for example). This is confirmed by the National Association of Lighting and Mercury Recyclers, who report that lamp recycling rates are at about 20%. The disposal of fluorescent light tubes contributes about 210 pounds of mercury to the waste stream in Oregon (*see Appendix II for details*).

Fluorescent Lamp Strategies

- ✓ State and local governments should institute a concerted education and outreach effort to increase the recycling rate of fluorescent light tubes, while ensuring that commercial and non-commercial lamp users have easy access to recycling facilities.
- ✓ Sellers of mercury-added lamps in Oregon for use in an industrial, commercial or office building should be required to inform the purchasers in writing that the lamp contains mercury and that it should be recycled at the end of its life.
- ✓ All publicly-funded agencies should ensure that all fluorescent light tubes from their facilities are recycled.

FLUORESCENT LAMPS CAN REDUCE MERCURY POLLUTION

Fluorescent lamps present an interesting dilemma, illustrating the complexity of eliminating mercury pollution. Although these lights contain a small amount of mercury, their use can actually reduce net mercury pollution, by saving energy. Because a significant amount of Oregon's power comes from burning coal (which generates mercury) – both within and outside of Oregon's borders – saving energy also reduces mercury pollution – and this is greater than the mercury content of the lamps.

- ✓ Information about fluorescent tube recycling should be provided via existing energy efficiency programs which encourage the use of fluorescent lights.
- ✓ Once the above steps have been taken, DEQ should consider prohibiting the disposal of fluorescent lamps as solid waste.
- ✓ Lighting manufacturers should commit research dollars to finding environmentally-friendly replacements for mercury in energy efficient lighting and should share responsibility with state and local government agencies working to increase recycling.

Automotive Switches

A variety of switches in automobiles contain mercury. Currently, the predominant use of mercury switches in U.S. automobiles is for convenience lighting in trunks and hoods (Environmental Defense, 2001). One automotive light switch contains about 1 gram of mercury, and some cars have two switches. It is not known what percentage of cars currently in use have mercury light switches.

While the auto industry is reducing its reliance on mercury switches for lighting purposes, it is increasing their use in other applications. *The Toxics in Vehicles: Mercury* (Ecology Center, 2001) report found that in 1996, mercury light switches accounted for 87% of the use of mercury in automobiles (Ecology Center, 2001). Since that time, mercury use in convenience lighting has declined about 70%, while the use of mercury for anti-lock braking system (ABS) applications has increased by about 150%.

When taken out of service, about 90% of all automobiles are dismantled to remove reusable parts (Maine Land and Water Resources Council,1999). The hulk is then shredded and crushed for metal recovery. Mercury may be released to the environment when scrap autos are crushed and shredded or when the scrap steel is melted to produce new steel. In Oregon, auto switches from scrapped cars contribute an estimated 260 pounds of mercury to Oregon's waste stream each year *(see Appendix II for details)*.

Alternatives to mercury switches are available. In 1995, U.S. automakers pledged to phase-out the use of convenience lighting switches containing mercury. While some manufacturers have phased out the use of these switches, others have not, so progress toward achieving this pledge has been slow. According to data collected under Vermont's unique mercury labeling law, over 6 million mercury switches were used in model year 2000 vehicles.

Automotive Switch Strategies

- ✓ Prohibit the sale of new cars containing mercury in Oregon (HB 3007 prohibits the sale of new cars with mercury switches under the hood or trunk as of 2006).
- ✓ Require automakers to take responsibility for ensuring the collection and recycling of switches from existing cars.

- ✓ Support a voluntary program to replace mercury switches in cars in service.
- ✓ Government fleets should replace and recycle mercury switches and commit to purchasing cars without mercury switches.
- ✓ Require scrap yards to remove and recycle mercury switches prior to crushing (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ Provide technical assistance to scrap yards (HB 3007 requires DEQ is provide this assistance).
- ✓ Require labeling of all uses of mercury in cars.
- ✓ Upgrade environmental standards, and permit requirements for scrap yards and facilities that recycle crushed autos.

Electronics

Mercury-containing switches and relays are found in some electronic and electrical products, and printed circuit boards contain varying amounts of mercury (Minnesota Office of Environmental Assistance, 2001).

The average desktop computer is 0.0022% mercury (Silicon Valley Toxics Coalition, 2001). According to DEQ, Oregon consumers dispose of approximately 6,200 tons of computer equipment each year. This would equate to 270 pounds of mercury *(see Appendix II for details)*.

Electronics Strategies

- ✓ Electronics manufacturers should take responsibility for collection and recycling of used electronic equipment.
- ✓ Electronics manufacturers should find alternatives to mercury in their manufacturing process.
- ✓ The state and local governments should support efforts to recycle and reuse electronics.

Manometers

Manometers are used on dairy farms and in some other industries to measure pressure. Often these pressure gauges contain mercury. In milking machines, the pressure gauge is a glass or plastic tube with liquid mercury that moves up and down in response to vacuum changes in the milking system. Each dairy manometer contains about 12 ounces of mercury. Alternatives to mercury gauges are readily available.

There are 470 licensed milk producers in Oregon. We assume that 20% of these milk producers use manometers with mercury gauges (Minnesota Technical Assistance Program, 1995). Based on this assumption, the contribution to the waste stream from these sources could be as much as 10 pounds per year. Mercury in manometers can be released into the environment if broken during use or during waste handling and disposal.

Manometer Strategies

- ✓ Oregon should fund a trade–in program for mercury manometers on dairy farms.
- ✓ The state should prohibit the future use of mercury manometers on dairy farms provided that non–mercury alternatives do not place an unacceptable economic burden on that industry.
- ✓ The Oregon Department of Agriculture should conduct outreach and education to dairy farmers about the risks of mercury manometers and to encourage their replacement.

Novelty Products

Certain "novelty" products geared toward children, such as toys and games, contain mercury. These include maze games, children's jewelry and switches in toys or other amusement devices. One popular novelty product that contains mercury is a children's shoe that lights–up or flashes. The mercury in such products can enter the environment during use or disposal. Furthermore, if released during use, the mercury in these products creates needless threats to children.

There are no data available to allow an estimate of the amount of mercury that these products contribute to the environment in Oregon. The States of Minnesota and New Hampshire have banned the sale of toys or games that contain mercury and the sale of any clothing that contains a mercury switch. The ban on toys and games has been in place in Minnesota since 1992, and the ban on mercury switches in clothing has been in effect since 1994.

Novelty Product Strategies

- ✓ The State of Oregon should prohibit the sale of novelty products that contain mercury (This became law with the passage of HB 3007 in the 2001 legislative session).
- ✓ The State and local governments should ensure that consumers understand how to properly dispose of any novelty products they may have.

Relay and Tilt Switches

Because it is a liquid at normal temperatures and an excellent electrical conductor, mercury has been used in various electrical switches that operate by tilting to close an electrical circuit. Applications include convenience lighting in chest freezers, float switches commonly used in sump pumps, and bilge pumps to turn equipment on and off when water reaches a certain level. These switches and relays are also used in furnaces, heating and cooling equipment, and other equipment, and can be found in commercial, and industrial and residential settings.

Mercury from relays and switches can enter the environment unless recycled or otherwise properly disposed of. In Oregon, no data have been identified that would allow for an estimation of the amount of mercury contributed to the environment by these relays and switches.

Relay and Tilt Switch Strategies

- ✓ All new mercury-added switches and relays should be labeled.
- ✓ Oregon businesses that use such equipment should be encouraged to conduct an inventory of their facilities to locate all sources of mercury in their operation.
- ✓ Manufacturers and users should be responsible for the costs of collecting and managing their relays and switches so they do not enter the waste stream.
- ✓ After five years, the state should prohibit the sale of mercury-added switches or relays unless the manufacturers have established an effective take-back program.
- ✓ The state should require the removal of mercury-containing components from appliances prior to shredding.

Strategies For Point Sources

Coal–fired Power Plants

Mercury occurs naturally in coal at trace levels. When coal is burned as a fuel source in the production of electricity, mercury is released into the air and some mercury ends up in the plant fly ash. In Oregon, coal is used to generate electrical power only at one plant in Boardman. This plant uses a coal source that produces fuel with far lower levels of mercury than most coal, and also employs very modern pollution control equipment (PGE, 2001). From 1998–2000, the average annual mercury associated with combustion at Boardman has been 220 pounds per year. Using the Electrical Power Research Institute (EPRI) model, it is estimated that about 25% will be removed with ash by the plant's electrostatic precipitator (ESP). Thus, the best estimate for the average annual mercury releases are 165 pounds released to air and an estimated 55 pounds remaining in the ash (PGE, 2001).

The concentration of mercury in the ash is approximately 0.24 ppm (parts per million). About half of the ash is disposed of in a state-approved onsite landfill. The other half is sold for use as an additive for concrete that is then used as a lining for landfills (PGE, 2001).

Strategies to address mercury from coal-fired power plants in Oregon must be careful to avoid unintended consequences. For example, while coal combustion in Oregon is a relatively small source of mercury, many coal-fired power plants in other states produce electricity that is used in Oregon, and these plants often emit significantly more mercury than the Boardman plant. Furthermore, mercury pollution from plants in nearby states – or even from plants as far away as Asia – can reach Oregon and contaminate our lakes and rivers. It is important to recognize these complexities when considering strategies to reduce mercury emissions.

"EPA has announced its intention to develop rules that would address mercury emissions from coal-fired power plants by 2004. These rules are to go into effect in 2007 and may require coal-fired power plants to add pollution control equipment."

Currently, mercury emissions to air from coal-fired power plants are not regulated. However, EPA has announced its intention to develop rules that would address mercury emissions from coal-fired power plants by 2004. These rules are to go into effect in 2007 and may require coal-fired power plants to add pollution control equipment.

Coal–Fired Power Plant Strategies

- ✓ Utilities should come quickly into full compliance with all forth-coming Federal regulations pertaining to mercury emissions.
- ✓ Utilities should develop and submit to DEQ a mercury reduction plan.
- ✓ Utilities should continually ensure that ash from their facilities is managed appropriately and in a manner that prevents the release of mercury into the environment.
- ✓ Utilities should work with stakeholders and public officials to develop and support voluntary programs that offset mercury emissions.

Municipal Solid Waste (MSW) Incinerators

Mercury is released from incinerators only because mercury occurs in the solid waste stream. There are currently two municipal solid waste incinerators in Oregon. The largest facility is in Brooks in Marion County. The other facility, which is about 10 times smaller, operates in Coos Bay and is managed by Coos County. Both plants are regulated under Title V of the Clean Air Act, and are required to monitor for mercury emissions.

The Brooks incinerator is permitted to release up to 126 pounds of mercury per year. Actual stack tests in the year 2000 show that the facility releases less than 42 pounds per year. The Coos Bay facility is permitted to release 40 pounds per year. Actual reported emissions from 2000 show that they are releasing about 20 pounds per year. Mercury from these facilities comes solely from burning wastes containing mercury.

The ash generated from waste incineration also contains some mercury. Coos Bay disposes of their fly ash as hazardous waste. The Brooks facility mixes the two types of ash they generate – bottom ash and fly ash. As required by law, the ash is tested to determine if metals leach out at levels that exceed standards. Since it has never failed this test, the ash is sent to a lined ash monofill, (a type of landfill), in Woodburn. Marion County monitors this ash fill, including the leachate generated from it.

MSW Incinerator Strategies

- ✓ The incinerators should develop and submit to DEQ a mercury reduction plan.
- ✓ The incinerators should work with stakeholders and public officials to develop and support voluntary programs that offset mercury emissions.
- ✓ Incinerators should continually ensure that their ash is managed appropriately and in a manner that prevents the release of mercury into the environment.

- ✓ Due to limitations on air testing, the incinerators should test their ash for total mercury to determine progress of programs implemented to reduce mercury in the waste stream.
- ✓ The incinerators should support strategies that reduce and ultimately eliminate mercury from the solid waste stream *(see Reduction Strategies for Mercury-Added Products)*.

Cement Kilns

In the production of cement, limestone is used, which naturally contains mercury as a trace contaminant. Nationally, EPA estimates that production of Portland cement generates about 4.8 tons of mercury per year. Two cement facilities operate in Oregon, one in Portland that manufactures lime, the other in Durkee, which manufactures Portland cement.

At the Durkee cement plant, two mercury emission tests have been performed. Based on these tests, this facility releases about 109 pounds of mercury per year. Mercury emissions have not been estimated from any of the process equipment at the lime plant in Portland (Ash Grove Cement, 2001).

Cement Kilns Strategies

- ✓ Cement plants should develop and submit to DEQ a mercury reduction plan.
- ✓ DEQ should amend existing permits to include mercury limits and require periodic monitoring.
- ✓ Cement kilns should continually ensure that their cement kiln dust is managed appropriately and in a manner that prevents the release of mercury into the environment.
- ✓ Cement kilns should work with stakeholders and public officials to develop and support voluntary programs that offset mercury emissions.

Steel Mills

Steel mills generate mercury emissions only when scrap material they are processing is contaminated with mercury (e.g: scrapped cars or appliances with mercury switches). There are two steel mills in Oregon, one in McMinnville and the other in Portland. Both facilities operate under a Title V air permit. However, neither permit requires mercury testing or monitoring, nor includes limits for mercury.

A recent study by the Ecology Center, the University of Tennessee and others estimated that more than 800 pounds of mercury is released from the two Oregon steel mills combined each year (Ecology Center, 2001). However, this report relies on extrapolation from a small number of emissions tests conducted at facilities in other states. Actual emissions from Oregon steel mills could be an order of magnitude lower, or even slightly higher. Without testing, there is no way to produce a more accurate estimate.

Mercury is also found in the ash generated by these plants. Federal rules have allowed steel mills to recycle their ash into fertilizer which are then

applied on farmland without any monitoring or standards. Recently, EPA has proposed regulations to change the regulatory status of electric arc furnace dust, which will require all fertilizers to meet standards for metals and dioxin in the future (EPA, 2001b).

Steel Mill Strategies

- ✓ The steel mills should develop and submit to DEQ a mercury reduction plan.
- ✓ DEQ should amend existing permits to include mercury limits and require periodic monitoring.
- ✓ Steel mills should continually manage their ash appropriately and in a manner that prevents the mercury from entering the environment.
- ✓ The steel mills should work with stakeholders and public officials to support and develop programs to collect and recycle mercury-added products, to reduce input of mercury-contaminated wastes and to offset the facilities' emissions.
- ✓ Steel mills should institute an aggressive program to ensure that the scrap metal they accept is mercury-free, since the most successful strategy focuses on pollution prevention.

Commercial and Industrial Boilers

Boilers are widely used by almost all segments of U.S. industry to produce hot water and steam for a variety of purposes. They create steam by burning fuels such as natural gas, diesel oil, coal, waste products, and wood products. EPA estimates that commercial and industrial boilers release about 28 tons of mercury each year across the U.S. (U.S. EPA, 1997).

ESTIMATED MERCURY EMISSIONS FROM INDUSTRIAL AND COMMERCIAL BOILERS IN OREGON

Type of Boiler	Number of Boilers	Estimated Pounds of Mercury/Year
Permitted boilers (wood, coal and oil)	56	110
Permitted boilers (natural gas)	72	188
"Unpermitted" boilers	300	79
Total	**428**	**377**

All fuels, including wood and coal, emit some level of mercury when combusted. According to DEQ, a typical emissions rate is 0.00042 pounds of mercury/1000 gallons of distillate oil burned in a small industrial boiler, or 0.00026 pounds of mercury per million cubic feet of natural gas burned.

Oregon DEQ has calculated mercury emissions for these various types of commercial and industrial boilers. These estimates are based on the number of boilers in the state and 1996 EPA emissions factors associated with each fuel type. DEQ estimates that all boilers combined emit 377 pounds of mercury per year across the state (not including the Boardman plant, Ash Grove Cement and the MSW incinerators). However, none of these facilities have a mercury limit in their permit.

Of the 377 pounds total, about 110 pounds of mercury are emitted by all "permitted" facilities in the state that burn wood, coal or oil. About 103 pounds (or 90% of these "permitted" emissions) are from:

- one coal boiler at a sugar plant in eastern Oregon (43 pounds/yr),
- four Kraft paper mills that burn distillate oil (44 pounds/yr), and
- 40 or so wood boilers around the state (15.8 pounds/yr).

In addition, there are 72 facilities that burn natural gas, emitting a total of 188 pounds of mercury each year. Of these, eight facilities are responsible for 90% of the total (or 169 pounds/year).

Lastly, there are over 300 "un-permitted" boiler sources across the state that emit an estimated 79 pounds of mercury each year. Most of this comes from industrial natural gas boilers (23 pounds/year) and from the use of distillate oil boilers in industrial, commercial and residential settings (42 pounds/year).

Commercial and Industrial Boiler Strategies

- ✓ All boilers that would be expected to emit more than five pounds of mercury a year should be required to get a permit from DEQ, which should include a mercury limit and requirements for monitoring.
- ✓ These boilers should also be required to develop and submit to DEQ a mercury reduction plan.
- ✓ Facilities with boilers that emit mercury should be encouraged to use the pollution control tax credit program to cover costs of switching to a cleaner fuel, connecting to a utility, or putting in pollution control devices.

Crematories

As part of the cremation process, the mercury in body tissue and dental fillings can be released to the air. Data collected in the U.S and Europe show a wide range of mercury emission rates from crematories. The lowest reported estimate is 0.00094 grams/body and the highest is 5.6 grams per cremation (Reindl, 2001).

A study conducted by the U.S. EPA and the Cremation Association of North America (CANA) concluded that average mercury emissions from a crematory with emission controls were 0.23 grams per hour of operation (CANA, 2001). Since one cremation takes about two hours, that equates to 0.46 grams per cremation. However, several reports indicate that the best estimate is in the range of 1 to 3 grams per cremation (Northeast States and Eastern Canadian Provinces Mercury Study, February, 1998), especially since most crematories do not have emission controls.

According to CANA, there are 56 crematories in Oregon, which cremated about 16,400 bodies in 1999. This would equate to about 72 pounds of mercury per year in Oregon (based on an average of 2 grams per cremation). CANA projects an increase in the number of cremations in Oregon over time.

Currently, neither state nor federal regulatory standards address air emissions from crematories. However, EPA is scheduled to establish air quality regulations for several types of combustion, including crematories, in 2005.

Some European countries are currently developing standards for mercury emissions from crematories. There are companies that manufacture mercury control equipment for crematories, and as noted above, emission controls can significantly decrease mercury emissions.

Crematory Strategies

- ✓ Crematories should give their customers the option to choose removal of amalgam fillings prior to cremation. Information about this voluntary program could be part of the information package from the cremation society.
- ✓ Crematories should be required to get a permit from DEQ, which should include a mercury limit and requirements for monitoring.
- ✓ Crematories should develop and submit to DEQ a mercury reduction plan.

Landfills

Landfills, especially older ones, are another source of environmental release of mercury. EPA's 1997 Report to Congress estimated that total mercury emissions from solid waste landfills in the U.S. were 162 pounds per year (EPA, 1997). However, the release of mercury from landfills in Oregon has not been well studied, and cannot be quantified at this time. A more recent 2001 study found that mercury in landfills is chemically converted into the more toxic methylmercury by bacteria commonly found in landfills. These researchers found significant levels of methylmercury in the water vapor that condenses out of gas emanating from a landfill (Lindberg, 2001).

Landfill Strategies

- ✓ Landfills should support strategies that reduce and ultimately eliminate mercury from the solid waste stream *(see Reduction Strategies for Mercury–Added Products)*.
- ✓ Landfills in Oregon should work with local and state governments and mercury–added product manufacturers and recyclers to develop diversion programs that keep mercury–added wastes out of landfills.
- ✓ DEQ should assess mercury emissions from Oregon facilities that burn landfill gas, and if appropriate, establish specific monitoring requirements based on that assessment.

Strategies For Non-Point Sources of Mercury

Dental Offices

For more than 160 years, dentists have used amalgam for the restoration of teeth. Amalgam contains 50% metallic mercury that is bound in a silver alloy. For the past 25 years, alternative restorative materials have been developing. However, because amalgam offers stability, durability, low cost, and is less likely to cause an allergic reaction than resin (white-colored) or gold fillings, it is often the preferred – and sometimes the only – restoration material available (e.g.; in large restorations). Because many patients prefer the aesthetic qualities of alternative materials, amalgam use is declining. More research is needed to develop restorative materials that can offer the benefits of amalgam.

Of the 1,725 practicing dentists licensed in Oregon, it is not known how many use amalgam in their practice. Some listed dentists are retired, and others are in specialties that do not use amalgam (i.e.; periodontics, oral surgeons, etc.). Few measurements have been made in Oregon to estimate the amount of mercury discharged by a dental office into the sewer system. However, the City of Eugene recently sampled for mercury from three dental offices (11 samples) and found a range of 1.6 to 48 ug/L and an average discharge of 21.9 ug/L (Kerst, 2001).

Other municipalities have also conducted such studies, although their estimates of mercury loads are quite disparate because of differing assumptions. Studies from six cities across the U.S. and one in Europe estimate loads from dental offices ranging from 0.035 to 0.27 grams/day/dentist (EIP Associates, 1999). For this document, we relied on studies from two of these cities – San Francisco, CA and Boulder, CO.

To meet EPA's pollution prevention goal of preventing mercury in amalgam from entering the sewage system or the garbage (solid waste system), the Oregon Dental Association and the City of Portland Bureau of Environmental Services developed a voluntary Best Management Practices (BMP) for dental offices in 1996. The Oregon Dental Association has promoted these practices of prevention and reduction of pollutants entering waste streams to dental offices in Oregon.

The amalgam wastes addressed in the BMP Program include:

- Non-contact amalgam (scrap), which is excess mix leftover at the end of a dental procedure;
- Chair-side traps, which capture amalgam waste during amalgam placement or removal procedures. Filters and traps are estimated to capture up to 80% of the amalgam in wastewater;
- Vacuum pump filter or traps, which contain amalgam sludge and water.

The City of Palo Alto determined that much of the mercury in amalgam released from dental offices comes from improper cleaning of traps and filters and the disposal of trapped amalgam down the sink. (Larry Walker Associates, 1997).

The following recommendations for handling waste dental amalgam are included in the Oregon BMP program:

- Install amalgam traps chair–side and in the suction line just before the vacuum pump.
- Flush the vacuum system before changing the chair–side trap.
- Use barrier techniques such as gloves, glasses and mask when handling traps.
- Recycle scrap amalgam and the captured amalgam from the traps.

There are other mercury separation technologies, such as amalgam separators, that claim to remove 95% or more of the amalgam going down the drain (amalgam separators use a settling tank or centrifuge to separate amalgam from wastewater). However, the Oregon Dental Association questions the validity of these claims. In many parts of Europe, amalgam separators are required as a treatment measure before the dentist discharges to the sewer system.

Dental Amalgam Strategies

- ✓ The State should develop a reward or incentive program for dentists who eliminate or significantly reduce their discharge of mercury.
- ✓ The State should provide vouchers, tax credits or a grant program to dentists for equipment that reduces mercury discharges. If possible, existing credits such as the Pollution Control Tax Credit should be expanded for this purpose.
- ✓ The State should develop a state–wide education and outreach program for dental offices focusing on the Best Managment Practices (BMP) program already developed by the Oregon Dental Association and the City of Portland.
- ✓ The BMP program for dental offices developed by the Oregon Dental Association in conjunction with the City of Portland should be encouraged in all Oregon communities and by all Oregon Publicly Owned Treatment Works (POTW) facilities.
- ✓ The existing BMP program should be considered a work in progress with new technology being carefully evaluated as it becomes available. The BMP program should be reviewed every five years by the Oregon Dental Association in conjunction with POTWs and other stakeholders, to assess its impacts and whether any changes are needed.
- ✓ DEQ, POTWs and the Oregon Dental Association should cooperatively maintain a database of amalgam recyclers so that dentists have access to current information on recycling options.
- ✓ The State of Oregon should implement by executive order, legislation or administrative rule, a requirement that all health plans, whether

public or private, who are providing benefits in the state of Oregon, adequately cover the dental costs of all restorative materials.

✓ Resources at the state and federal level should be committed to develop and evaluate new technologies that provide viable, economic and environmentally-friendly alternatives to amalgam.

Health Care Providers

Medical offices and hospitals use mercury in a variety of equipment, such as thermometers and blood pressure cuffs. Mercury is used in certain pharmaceuticals, as well. Mercury enters the environment primarily via the disposal of mercury-added equipment. There are no data available to estimate the amount of mercury from the use of mercury in health care facilities in Oregon.

Mercury-free alternatives to many products and instruments exist, and are beginning to be more widely used. The problem of mercury-added wastes from health care facilities has been widely recognized and is being addressed in many settings. For example, the U.S. EPA and the American Hospital Association signed a Memorandum of Understanding in June 1998, which established two key goals:

- The virtual elimination of mercury-containing waste from the health care industry waste stream by the year 2005, and
- The reduction in the total waste generated by hospitals by 33% by 2005 and by 50% by 2010.

Health Care Provider Strategies

✓ Healthcare facilities and providers should develop a team of key players who influence what products are used, what mercury practices are acceptable, and monitor progress of mercury reduction efforts.

✓ Healthcare facilities and providers should increase general awareness among their staff and patients of the dangers of mercury.

✓ Manufacturers should be required to label or provide other methods of disclosure on all mercury-added products used in healthcare facilities and by providers.

✓ Healthcare facilities and providers should use the Best Management Practices for use of mercury-added products, including but not limited to:

- Proper handling and disposal of mercury products.
- When remodeling or replacing old equipment, properly dispose of any mercury-containing devices and replace with a non-mercury alternative when feasible.
- Recycle mercury-containing products, such as fluorescent lights and batteries, to the extent mercury recycling services are reasonably available.

DENTAL AMALGAM SAFETY

The Solution Team focused its attention on the environmental issues related to the use of mercury in dental amalgam and did not review the literature regarding the safety of dental amalgam. It is worth noting, however, that several Federal agencies including the Food and Drug Administration have concluded that none of the scientific studies they reviewed would indicate that individuals with dental amalgam restorations would experience adverse health effects as a result of exposure to dental amalgam.

- Where practical, phase out mercury–containing products and equipment, such as mercury thermometers, blood pressure monitors, diffusion pumps, mercury oxide batteries, esophageal dialators, Cantor tubes, Miller Abbott tubes as well as histology fixatives and stains.
- Purchase non–mercury alternatives when feasible.
- Use recovered mercury in all products that do not yet have mercury–free alternatives.

✓ The State should work with the healthcare industry to require all health plans, whether public or private, who are providing benefits in the State of Oregon to include the cost to replace mercury–containing products in reimbursement levels.

Laboratories

Mercury is used in laboratories to perform certain types of tests and is found in preservatives, reagents, biocides, and fixatives. It is also used in equipment, such as thermometers and barometers that are necessary to perform tests. Mercury used in laboratories enters the environment either due to breakage or during disposal. There are many types of laboratories in Oregon, including environmental labs, medical labs, university labs, food science labs, and soils labs, all of which may use mercury in some form. Currently there are no data available to estimate the amount of mercury released into the environment from laboratories.

Alternatives to certain uses of mercury, such as mercury–free thermometers, are currently available. However, some tests require mercury, and there are no suitable alternatives. Some laboratories have voluntarily eliminated the use of mercury where possible. For example, Oregon DEQ has eliminated all field use of mercury thermometers. In the laboratories, the agency is phasing out refrigerator and oven use of mercury thermometers, and is working on a plan to deal with other mercury thermometers that are used to audit the accuracy of all other temperature recording devices.

Laboratory Strategies

✓ Laboratories should seek to replace mercury thermometers and other uses of mercury wherever possible.

✓ State and local governments should implement programs to educate laboratories about the proper management and disposal of mercury waste. This should include incorporating mercury education materials into the Oregon Environmental Lab Accreditation Program.

✓ All state operated labs, including those in the university system, should inventory and document mercury usage and disposal.

✓ The sale of elemental mercury in Oregon should be accompanied by a statement that warns the purchaser of limitations on its use, toxicity information about mercury, and advice on proper recycling or disposal.

Wastewater Treatment and Biosolids

The role of the municipal wastewater treatment plants (also known as Publicly Owned Treatment Works or POTWs) is to process wastewater and sewage before it is discharged to an open body of water. Wastewater treatment plants are required to obtain water quality permits from DEQ and meet specific discharge limits before discharging water.

For example, Clean Water Services treats wastewater at two plants in the outlying suburbs of Portland. At the Durham plant they receive influent wastewater containing an average of 0.225 ug/L of mercury and, after processing, the effluent contains an average of 0.0024 ug/L of mercury. At the Rock Creek plant they receive influent at 0.197 ug/L mercury and the effluent they discharge contains 0.0027 ug/L (Greeley, 2001).

Mercury is not generated by any aspect of the wastewater treatment process. However, mercury is passed into the wastewater treatment plant from household, commercial, and industrial processes and products within the wastewater collection system. The majority of mercury is from household and commercial sources. National studies have identified human waste as one of the largest significant sources of mercury that wastewater plants receive (AMSA, 2000). The sources of mercury in human waste include consumption of fish, leaching from dental fillings, and low levels of mercury in food products.

In Oregon, no study has been conducted to determine the relative contribution of mercury to wastewater treatment plants from all sources. However, the sources of mercury to wastewater treatment plants have been reasonably well studied in other parts of the country. For example, the City of Palo Alto estimated that 47% of the mercury discharged to their wastewater treatment plant came from dental offices. The City of Palo Alto determined that much of the mercury released from dental offices comes from improper cleaning of traps and filters and the disposal of trapped amalgam down the sink (Larry Walker Associates, 1997).

Others have found somewhat lower percentages from dental offices. For example, the Massachusetts Water Resources Authority (MWRA) calculated that dental facilities contributed about 13% of the total load to their plant (MWRA, 2001). A 1991 Seattle Metro study and a 1992 San Francisco study reported that about 12–14% of the mercury load to wastewater treatment plants originated from dental clinics (Stone, 2000).

During the process of treating wastewater, a liquid phase and a solid phase are produced. Most of the mercury that is introduced into municipal wastewater collection systems ends up in the biosolids (treated sewage sludge), or the solid phase. The DEQ promotes the beneficial use of biosolids for agricultural production in Oregon and regulates this practice under Section 503 of the federal Clean Water Act. These regulations limit the amount of mercury allowable in biosolids that are land–applied. Some local sewerage agencies, such as the Metropolitan Wastewater Management Commission (MWMC) for Eugene and Springfield, have set lower mercury performance standards for biosolids.

Many believe that land application of biosolids, following all state and federal regulations, is the most environmentally responsible method of disposal. If this disposal option were not available, biosolids would have to be disposed of in landfills – where mercury concentrations would accumulate in the leachate – or be incinerated – resulting in mercury releases into the air.

About 60,000 tons of biosolids are generated by POTWs each year, almost all of which are applied to land used to grow crops.

The National Academy of Sciences recently convened a committee to review information on the land application of sludge and evaluate the methods used by the U.S. EPA to assess risks from chemical pollutants and pathogens in sludge. The committee will review the risk–assessment methods and data used to establish concentration limits for chemical pollutants in sludge to determine whether they are the most appropriate approaches.

Since biosolids and wastewater are not true "sources" of mercury, but reservoirs for mercury from other sources, the strategies for mercury elimination must focus on preventing such pollution in the first place. Reduction of mercury in raw wastewater will result in reduced mercury concentrations in both treated wastewater discharges and in biosolids. Local governments have generally found that pollution prevention programs designed to give useful, effective technical assistance to the targeted sector work best to reduce pollutants.

Further, since mercury concentrations are very low in both "raw" and treated wastewater, expensive "ultra–clean" sampling and analytical detection methods must be used to accurately determine mercury concentrations. Although mercury reduction efforts may be successful, demonstrating numeric reductions may be difficult. Use of surrogates to track mercury reduction efforts may be beneficial.

Wastewater Treatment Strategies

In general, the best way to reduce mercury in wastewater systems is to focus on:

- ✓ Restricting mercury concentrations in commercial and household products,
- ✓ Providing information on recovery programs so mercury never enters the wastewater,
- ✓ Implementing the Best Management Practices (BMP) Program for dentists, and
- ✓ Replacing or removing mercury from laboratories (school, public, and commercial) and in the health care system.

More specifically, the Team recommends:

- ✓ Local governments should support efforts to reduce mercury in wastewater through voluntary efforts including:
  - ▸ Pollution prevention programs such as the BMP Program for dental offices
  - ▸ Effective fish advisories to reduce mercury intake by humans in the food chain,
  - ▸ Reducing the use of mercury–containing thermostats and thermometers.

- ✓ Increase education and outreach to all Oregonians on the sources of mercury and effective ways to reduce releases to the environment.
- ✓ The State of Oregon should require accurate and complete labeling for all consumer products so informed consumers can reduce the amount of mercury released to wastewater plants.
- ✓ POTWs should help develop and support voluntary programs to reduce mercury contaminants in the waste stream (e.g; collection of mercury–added products).
- ✓ Product stewardship programs should be significantly increased so that consumer goods with significant amounts of mercury can be returned to manufacturers or their representatives for proper dismantling and disposal.
- ✓ The State should provide more technical support to POTWs working to prevent mercury discharges.

Fertilizers

Common fertilizers used in agriculture, by homeowners, and others may contain toxic waste from industrial facilities. Fertilizer manufacturers often recycle wastes from industries such as steel mills, blast furnaces, and pulp and paper mills into fertilizer products (U.S. EPA, 1999). While recycling is environmentally beneficial, this particular practice can pose a threat to human health and the environment because industrial wastes are often laden with toxic metals like lead, mercury and cadmium and long–lived organic pollutants like dioxin. In recent years, pollution prevention and source reduction programs have reduced some of these contaminants.

Exposure to toxic chemicals in fertilizers is a health concern for farmers and others who handle these products and are most directly exposed. Toxics in fertilizers can also cause health and environmental problems when plants absorb these contaminants and are then eaten by people, or when they contaminate water via runoff.

To address these concerns, the 2001 Legislature passed legislation that requires the Oregon Department of Agriculture to develop standards for toxic chemicals in waste–derived fertilizers. These standards are required to be protective of human health and the environment, and must be implemented by January 1, 2003.

Fertilizer Strategies

- ✓ Oregon Department of Agriculture (ODA) should require reductions in allowable mercury concentrations over time so that no mercury–containing materials can be used as fertilizer by 2020 at the latest.
- ✓ ODA should insure that the new standards are stringent enough to ensure that there is no net increase of mercury in soil over time from the use of fertilizers.
- ✓ The State should charge higher registration rates for fertilizers the contain mercury.

Conclusion

Mercury is a serious environmental toxin, and more effort must be spent on reduction and elimination of mercury releases to our environment. OEC and Oregon's Mercury Solution Team hope that by implementing the strategies outlined in this report, we will make significant progress toward eliminating the discharge of mercury from anthropogenic sources in Oregon by 2020. Before reaching that goal much work needs to be done. We are only at the beginning of the process.

This report includes a long list of strategies that the Team recommends be implemented in Oregon. However, not all of these strategies can be implemented immediately. Therefore, the Team has identified the following five top priorities that should be the focus of our efforts as we begin:

- Clean up abandoned mercury mines across the state, which are estimated to be a major, uncontrolled source of mercury to Oregon's waters.
- Continue to phase out products with mercury, promote alternatives wherever possible and ensure full implementation of the Oregon Mercury Reduction Act of 2001.
- Fill gaps in regulations and permits, to ensure the state is adequately monitoring and controlling industrial facilities that discharge mercury.
- Reduce mercury in the waste stream via greater investments in consumer education and outreach and recovery programs.
- Increase the use of Best Management Practices throughout Oregon businesses to reduce non-point source pollution.

Educating others about the problems associated with mercury in the environment and the steps required to reduce mercury releases is vital to implementing these strategies. The Oregon Mercury Solution Team and OEC are dedicated to this education process. This report is the beginning of our attempt to educate others. Through education, support for these strategies will be cultivated.

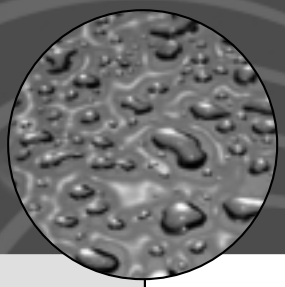
OEC will evaluate the success of these strategies in one year, and is confident that there will be substantial progress over that relatively short time frame. Many of the strategies should be relatively easy to implement and will quickly lead to a reduction of mercury releases in Oregon.

OEC also hopes that the collaborative process used to formulate these strategies can be used as a model for addressing other pollution problems. The success of this effort will demonstrate the effectiveness of a coopera-

tive approach. This is a new and dramatically different approach for reducing toxic pollution because it:

- ✶ Recognizes the complexity of the issue,
- ✶ Brings people together, and
- ✶ Crafts creative solutions.

The Mercury Solution Team process has been successful in developing a broad range of creative strategies while increasing public awareness around this important issue. We invite your support and participation in its implementation.



Appendix I

Calculating the Mercury Load from Abandoned Mercury Mines in Oregon

Several studies show elevated levels of mercury in fish, water and sediments in areas impacted by abandoned mines (Park and Curtis, 1997; Hygelund, et. al., 2000). However, there have been no attempts to quantify the amount of mercury being discharged from abandoned mines in Oregon.

Two abandoned mines, Black Butte and Bonanza, account for about half of Oregon's historical mercury production (Park and Curtis, 1997; Brooks, 1971). Main sources of mercury are tailings pile (spent or used material), waste rock pile (not processed), and tailings that were placed in other areas (such as for building dams, etc).

To calculate an amount of mercury potentially released to the environment from these mines, we determined the size of tailing piles and waste rock piles and multiplied that by the concentration of mercury in those piles. **What follows is an extremely rough estimate and is intended only as a starting point for discussion purposes.** There are a large number of factors that drive how mercury is released into the environment from abandoned mines, none of which were taken into consideration in this estimate. In addition, this calculation does not include mercury emissions that might be coming from abandoned gold mines in Oregon.

At the Black Butte mine, there are 300,000 cubic yards of tailings on site, which hold an average concentration of 100 mg/kg of mercury. In addition, there are 67 cubic yards of contaminated surface soil on site, with an average mercury concentration of 350 mg/kg.

Based on the above figures, one can calculate that there is a total of about 90,000 pounds of mercury at this site.

However, not all of that mercury is immediately available to the environment. Assuming that it could all be released to the environment in no less than 50 years, and no more than 500 years, the amount discharged to the environment is between 180 and 1,800 pounds per year.

For comparison purposes, two California researchers (Whyte and Kirchner, 2000) reported that an abandoned mine site in California of similar size (392,000 cubic yards), with a higher average mercury concentration of 320 mg/kg, released about 180 pounds of mercury in a two month period.

These authors noted that over 75% of the mercury released from the site occurred in less than 10% of the time, indicating that "contaminant transport is highly episodic."

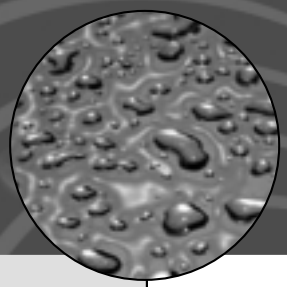
At the Bonanza mine, there are 2,080 cubic yards of tailings on site, with an average concentration of 100 mg/kg. In addition, there are 44,400 cubic yards of waste rock, with an average concentration of 115 mg/kg, as well as 316,000 cubic yards of waste material spread on a road near the site, with an average concentration of 66 mg/kg.

In total, there are about 78,500 pounds of mercury at the Bonanza mine site. Assuming that it could all be released to the environment in no less than 50 years, and no more than 500 years, the amount discharged to the environment is between 157 and 1,570 pounds per year.

Adding these figures from both mines, one calculates that the mercury released from these sites would be expected to range from 337 to 3,370 pounds per year.

Since these two mines account for about half of the mercury mined in Oregon, the amount of mercury coming from mines across the state could be assumed to be twice this, making it a total of between 680 pounds per year up to 6,700 pounds per year.

NOTE: The amounts of tailings and waste rock and the mercury concentrations at the Black Butte and Bonanza mines described above were obtained from DEQ Western Regional Office Staff.



Appendix II

Estimates of Potential Mercury (Hg) Releases from Anthropogenic Sources in Oregon

NOTE: The values listed in this table represent our best estimate based on the information available at the time of publication. Displayed are the source, pounds per year and assumptions used.

AMOUNT IN WASTE STREAM

Thermometers *370 lbs*

17 tons Hg/year in municipal solid waste (U.S.EPA, 1997). There are 105 million households in the U.S. with 1.1 million in Oregon, or about 1.1 %. Total expected thermometer Hg waste in Oregon is therefore about 0.18 tons/year (about 370 lbs.).

Thermostats *220 lbs*

10 tons Hg/year in municipal solid waste (U.S. EPA, 1997). Each thermostat contains 2–3 grams of mercury (U.S. EPA, 1994). Based on population, about 0.11 tons/year (220 lbs.) of Hg is added to the waste stream.

Fluorescent lamps *210 lbs*

About 6 million light tubes are sold each year in Oregon, of which 20% are recycled. Average Hg content of light tubes is 20 mg (Oregon DEQ, 2000). Subtracting the 20% that are recycled leaves about 210 lbs/year of Hg in the waste stream.

Car switches *260 lbs*

Three million cars are registered in Oregon. About 5% are discarded each year (Ecology Center, 2001), which equates to 150,000 cars in Oregon. Assuming an average of one switch per vehicle (some cars contain two switches), with 0.8 grams per switch, that's 120,000 grams or 264 lbs. of mercury.

Computers *270 lbs*

According to the Electronics Industry Roadmap, the average desktop computer is 0.0022% Hg. The Oregon 1998 waste composition study show that 0.23% of the solid waste stream is computer equipment (Bree, 2000). This is equivalent to about 6,200 tons/year. 6,200 tons x 0.0022% equates to 270 lbs of Hg.

Batteries *620 lbs**

There are two major types of batteries that contain Hg – alkaline batteries and button cell batteries. The industry has virtually eliminated the use of Hg in alkaline batteries, but older batteries are still being discarded. The National Electric Manufacturers Association (NEMA) estimates that nationally 25 tons and 3 tons of Hg/year are going into the waste stream from alkaline and button cell batteries, respectively. Per capita, this equates to a total of about 620 lbs/year in Oregon from both battery types.

** Mercury in alkaline batteries is declining 50% every two years, according to NEMA. NEMA estimates that levels will be near zero in the 2006–2008 time frame. Federal and state legislation restricts the sale of Hg-containing batteries.*

Blood pressure cuffs *40 lbs*

Assuming the following (Maine Land and Water Resources Council, 1999): 8,428 licensed doctors in Oregon x 70% practicing = 5,900 practicing doctors. 5,900 x 2.5 examining rooms = 14,749 blood pressure cuffs. 4.35 ozs/cuff x 14,749 cuffs = 64,158 oz of mercury ÷ 16 oz/lb. = 4010 lb. Hg. 1% disposed each year = 40 lbs/year.

Manometers *10 lbs*

Used on dairy farms. Each unit contains 3/4 pound of mercury. There are 471 licensed milk producers in Oregon (ODA Website). Estimates are that 20 % of dairy farms in the U.S. use them (Minnesota Technical Assistance Program, 1995).

Assuming about 10% are replaced each year (Maine Land & Water Resources Council, 1999), total contribution of Hg to the waste stream is roughly 10 lbs/year.

AMOUNT APPLIED TO LAND

Biosolids *230 lbs*

Used to make compost and applied to land as a soil amendment. Levels of Hg from the Columbia Boulevard Wastewater Treatment Plant were reported at 1.71 mg/kg (0.00345 lbs./ton) (BES, 1999). In Washington County, the Durham facility reported an average Hg concentration of 2.06 mg/kg (0.00412 lbs./ton) and the Rock Creek facility averaged 2.05 mg/kg (0.0041 lbs./ton) in 1998 (USA, 1999). Estimates are that an average of about 60,000 tons of biosolids are land–applied in Oregon each year. Based on the average Hg concentration from above (0.00389 lbs./ton), approximately 230 lbs/year of Hg are applied to Oregon soils.

AMOUNT IN WATER

Abandoned Mercury Mines *680 – 6,700 lbs*

Based on concentrations of mercury in the tailings piles and waste rock piles at the two largest mercury mines in Oregon – Black Butte and Bonanza mines. Also based on the assumption that all of the mercury at these mines would be released to the environment over the course of 50 to 500 years (see Appendix I for more detail on how this range was calculated).

Human Waste (from dietary intake and dental amalgam) *70 lbs*

65% of population has amalgam fillings (EIP Associates, 1999). Hg in human waste attributable to amalgam fillings = 0.0354 mg/day/person with fillings (EIP Associates, 1999). Expected contribution from Oregonians is (0.65 x 3,300,000 x 0.0354 mg/day/person x 365 days) = 61 lbs/year.

From dietary sources, daily Hg discharge per person = 0.0022 mg/day (EIP Associates, 1999). Annual Hg = 0.0022 mg/day x 365 days/year = 0.802 mg/year (3,300,000 x 0.802 mg/yr = 2.6 kg or 6 lbs/year).

Wastewater Treatment Plants *10–15 lbs*

This estimate is based on the biosolids estimate above, and an estimate that about 95% of the mercury coming into a wastewater treatment plant ends up in the biosolids, with the remaining 5% discharged in wastewater.

Dental Offices *10–40 lbs*

Studies from two cities in the U.S. estimate loads from dental offices ranging from 0.035 to 0.10 grams Hg per dentist/day (EIP Associates, 1999). There are about 1,380 practicing dentists (excluding specialists) in Oregon, although it is not known how many use amalgam (ODA, 2001). To calculate the range, we assumed that as few as 1/3 of these dentists (or 455 dentists) use amalgam (and used the low end of the range above) and as many as 2/3 (or 911 dentists) use amalgam (and used the high end of the range above). The calculation also assumed that dentists work only 200 days out of the year (ODA, 2001)

AMOUNT FROM INDUSTRIAL SOURCES

Municipal Solid Waste (MSW) Incinerators — *60 lbs*

There are two MSW incinerators in Oregon. The Brooks incinerator has the potential to emit 126 pounds/year and the Coos Bay incinerator can emit up to 40 pounds/year (Oregon DEQ, 1999). Actual test results show lower emissions. Brooks emits less than 42.2 lbs. per year (Ogden, 1999) and Coos Bay emits about 19.6 lbs/year (based on a Feb 2000 annual report).

Coal–fired Power Plant at Boardman — *220 lbs*

PGE estimates that mercury emissions from coal combustion is 220 lbs/year, based on 100% plant capacity (165 lbs emitted to the air and 55 lbs retained in the ash).

Cement Kiln — *110 lbs*

Ash Grove estimates that their cement kiln in Durkee emits this amount each year.

Steel Mills — *10 – 1,070 lbs*

Scrap metal is often contaminated with mercury, as Hg is used in auto switches and other equipment that is recycled in electric arc furnaces in steel mills. Based on data collected recently by three facilities in Ohio and NJ, the authors of "Toxics in Vehicles: Mercury" (Ecology Center, 2001) calculated an average emissions factor for steel mills with electric arc furnaces of 0.00069 lbs Hg/ton, and determined that the two steel mills in Oregon release about 838 lbs per year. However, the same report shows that in 1992, 19 mills reported a much lower average emissions factor of 0.000008 lbs Hg/ton in response to an EPA request for information. The authors note that it is not known if these tests were performed using EPA methods. To calculate the range shown here, we used the low emissions estimate from the 1992 data for the low end, and a high end emissions factor of 0.0014 as reported more recently by Marion Steel in Ohio.

Commercial and Industrial Boilers — *380 lbs*

Based on DEQ data, about 380 pounds of mercury per year are emitted by all boilers across the state (not including the Boardman plant, Ash Grove Cement and the MSW incinerators). Of the 380 pounds, about 190 lbs are from 72 facilities that burn natural gas.

About 110 pounds are emitted by all "permitted" facilities in the state which burn wood, coal or oil. In addition, there are over 300 "un–permitted" sources across the state, which burn oil, kerosene or natural gas. These sources emit an estimated 79 pounds of mercury each year in Oregon.

Crematories — *0.03 – 200 lbs*

Data on mercury air emissions from cremations from the U.S. and several European countries show a large range, from 0.00094 grams/body to 5.6 grams/body (Reindl, 2001).

According to CANA, there are 56 crematories in Oregon, which cremated about 16,400 bodies in 1999.

Using the range above, the total 1999 emissions in Oregon from crematories ranges from 0.015 (0.03 lbs) to 92kg (200 lbs).

Total Mercury Released to Air, Water and Land in Oregon Each Year — 3,600 – 10,600 lbs*

All values are rounded to the nearest 2-digits.

OTHER SOURCES NOT QUANTIFIED

The following products and processes contribute mercury to the environment, but were not quantified in the table above due to a lack of data:

- Laboratories: A general laboratory contributes 0.3 parts per billion to 5.4 parts per billion of Hg to wastewater. (Western Lake Superior Sanitary District, 1997). However, the number of labs in Oregon is unknown.
- Hospitals
- Fertilizers
- Novelty products
- Landfill gas
- Worldwide transport (i.e: sources outside Oregon)
- Miscellaneous measuring and control instruments, wiring devices and switches
- Ash disposal

* The low end of this range was calculated using all low end estimates from the sources above, and the high end was calculated using all high end estimates. Also, the totals were adjusted to avoid double counting. For example, the amount of mercury from human waste and dental offices would likely be captured in the total amount of mercury in biosolids, the mercury emitted from MSW incinerators is likely captured by the total amount of mercury in the waste stream, and the mercury from auto switches is expected to be captured in the estimate of mercury released from steel mills (however, since the low end estimate for steel mills is lower than the estimate for mercury from automotive light switches, the light switch value was used for the low end calculation, whereas it was not included in the high end calculation).

Appendix III

Office of the Governor
State of Oregon

EXECUTIVE ORDER NO. EO-99-13

ELIMINATION OF PERSISTENT, BIOACCUMULATIVE, AND TOXIC POLLUTANTS

WHEREAS, the quality of Oregon's environment today is the result of many years of combined efforts by the public, government agencies, and industry;

WHEREAS, recent international studies have concluded that contaminants that are persistent, bioaccumulative, and toxic present the greatest risk to human health and the environment, and are not adequately addressed;

WHEREAS these persistent, bioaccumulative, and toxic pollutants (PBTs) are associated with a broad range of adverse human health impacts such as cancer, effects on the nervous system,reproductive and development problems and hormonal disruption;

WHEREAS, PBTs accumulate in the tissues of plants and animals and become increasingly concentrated as they move up the food chain;

WHEREAS, PBTs remain an environmental and health concern long after they are used,generated as waste, or released into the environment;

THEREFORE, IT IS HEREBY ORDERED AND DIRECTED:

1) In order to address the presence of the most threatening chemical substances in Oregon's environment, the Oregon Department of Environmental Quality shall lead a state-wide effort to eliminate the releases of PBTs into the environment.

2. Oregon's initial goals in this effort shall be to:
    - Outline a range of approaches that might be undertaken in Oregon to identify, track and eliminate the release of PBTs into the environment by the year 2020;
    - Evaluate state, national, and international efforts to eliminate PBTs;
    - Use available information to identify which PBTs are generated in Oregon, determine what activities generate PBTs, estimate the amounts being generated, and identify missing data;
    - Identify ways to utilize education, technical assistance, pollution prevention, economic incentives, government procurement policies, compliance, and permitting activities to eliminate PBT releases.

3. All Oregon citizens, businesses, and governments are encouraged to participate in efforts to implement this Executive Order. Done at Salem, Oregon, this 24 day of September, 1999.

John A. Kitzhaber, M.D.
GOVERNOR

Appendix IV

SAMPLE FISH ADVISORY

November 20, 2001
More Information

Media Contact: Bonnie Widerburg, 503-731-4180
Technical Contacts: Ken Kauffman, Department of Human Services 503-731-4015
Eugene Foster, Department of Environmental Quality 503-229-5358

Agencies issue consolidated advisory for consumers of Willamette River fish

The Environmental Toxicology Section in the Oregon Department of Human Services (DHS), in cooperation with other affected state agencies, are extending and clarifying existing fishing advisories for the mainstem of the Willamette River. Today's advisory is a consolidation of previous advisories and is not based on additional or different test data.

Based on mercury tests of edible fish tissue dating back to 1969, DHS advises that all species of resident fish in the mainstem of the Willamette River should be eaten only in moderate amounts. This advisory does not relate to migrating ocean fish such as salmon, steelhead, shad or lampreys.

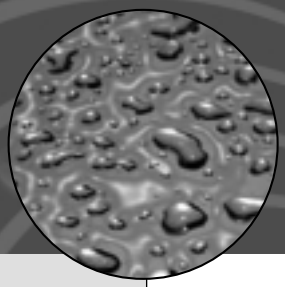
DHS recommends that consumers limit their consumption of resident fish from the Willamette River as follows:

* Children 6 years of age or younger should not eat more than one 4-ounce fish meal every 7 weeks;
* Women of childbearing age, especially those who are pregnant or planning to become pregnant and breastfeeding mothers, should not eat more than one 8-ounce fish meal per month;
* Women past the age of childbearing, children older than 6 years and all other healthy adults may safely consume up to one 8-ounce fish meal per week.

In addition to limiting the amount of fish eaten from the Willamette River, all consumers should carefully clean, skin and fillet fish before cooking or eating them. Back fat, belly fat, skin and internal organs should be trimmed and discarded. Fillets should be cooked by methods that allow fats and oils to drip off the meat, so the drippings can be discarded. Eating of internal organs or eggs from Willamette River fish should be avoided.

Mercury in the fish is believed to come from natural volcanic and mineral sources in the headwaters of the river and possibly from a number of man-made sources along the river. In many areas of the world, airborne mercury from coal-burning is a significant source of mercury in soil, surface water and fish. This may be one of the sources impacting Oregon. Some of the PCB's, dioxins and chlorinated pesticide residues may be from widely distributed sources over the entire earth and some are from human activities throughout the Willamette River and the Columbia River watersheds. New restrictions on the uses, storage or disposal of these compounds have been imposed in recent years in Oregon and nationally. State agencies and the federal government continue to evaluate and clean up known contaminated sites. It is hoped that these efforts sufficiently reduce many of these contaminants in Oregon waterways so that fish advisories will no longer be needed.

This advisory consolidates advice first issued by the Oregon Health Division in 1997 due to mercury contamination found in fish tissue and further consumer advice issued by the agency on December 5, 2000 based on findings of additional contaminants including PCB's, organochlorine pesticides and dioxins in resident Willamette River fish of all species. Both advisories continue to be necessary, and this notice merely combines the two previous ones. It includes and replaces all earlier fish advisories issued for the Willamette River.



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Disclaimer

A statement of support for the contents of this report by a member of the Oregon Mercury Solution Team does not necessarily mean the member supports every statement or recommendation contained in the report. Rather, a statement of support indicates support for the goals of the Solution Team.

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