List of Attachments:

Patricia Magnuson

Session: Dental Clinics: Reducing Mercury in Wastewater & Solid Waste Monday

Title: Reducing Mercury in Dental Office Wastewater: King County's Experience 1990 - 2005

In 1990 King County initiated a dental office wastewater program to quantify mercury discharges from dental offices and investigated potential treatment technologies. In 1994 the County proposed a regulation to require the installation of amalgam separator units that was withdrawn prior to implementation. King County then moved into a five-year voluntary program where the King County Local Hazardous Waste Management Program (LHWMP) worked with the Seattle King County Dental Society (SKCDS) to provide resources to recycle amalgam waste and to encourage the use of Best Management Practices (BMPs) and the installation of pretreatment technology known as amalgam separator units (ASUs). Through data collected on amalgam separator unit installation it was shown that in 2000, after five years of intensive outreach, less than one per cent of the dental offices in the county had installed amalgam separator units. King County implemented a regulatory program and in 2001 notified dentists within the sewer service area that they were required to comply with local ordinances limiting the concentration of mercury in dental office wastewater by July 1, 2003. The County's LHWMP Public Health inspectors visited dental offices in King County to provide information and technical assistance and by December 2003 they had determined that 94 per cent of the general practice dentists within the King County sewer service area had installed an ASU. Dentists practicing in King County but outside of the sewer service area were not required to install an ASU but received the same informational site assistance visits as the dentist within the sewer service area. 44 per cent of this group installed ASUs. Currently, an estimated 97% of the dental offices within the sewer service area are in compliance. Mercury in biosolids at King County's two treatment plants, declined by almost half, from an annual median mercury concentration of 2.58 ppm in 2000 to 1.3 ppm in 2004.

Mercury Reduction Efforts at Wastewater Treatment Plants

Paper #2069

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ABSTRACT

Direct discharge of mercury at wastewater treatment plants (WWTP) throughout the country is becoming a major regulatory issue especially in the Great Lakes States. Major efforts to reduce the sources of mercury discharged to WWTP have also been occurring in order meet the very strict limitations in discharge permits. Source reduction and discharge reduction activities are occurring across the country, including efforts to reduce amalgam waste discharge from the dental profession.

INTRODUCTION

Wastewater discharges have been regulated through the Clean Water Act and the National Discharge Elimination System (NPDES) since the 1970s. Historically the conventional pollutants, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), pH, phosphorus, and dissolved oxygen were the parameters that were regulated through permits. Today a much longer list of pollutants can be included in the NPDES permit limits. If the ambient water quality has the potential to exceed state or federal water quality standards for a specific pollutant, that pollutant is likely to have a numeric limit in the discharge permit.

Water quality standards may be based on either acute or chronic (long-term) standards and may be driven by impacts on human health, aquatic organism, or wildlife; the most restrictive standard applies to a discharge. At one time only direct exposures of the organisms to polluted water were considered. For instance, the human health risk from mercury for a person consuming municipal drinking water meeting mercury standards is negligible; even the exposure of aquatic organisms living in most ambient waters shows little impact. However, when a pollutant has the ability to bioconcentrate in each step of the food chain the impacts on the predator species may be affected by consuming fish that are high on the food chain.

The present water quality standards for mercury in the Great Lakes Basin are based on the guidance recommended in the Water Quality Guidance for Great Lakes Systems commonly known as the Great Lakes Initiative (GLI). The most restrictive standards are based on impacts of fish consumption on people or wildlife. Many other states outside the Great Lakes Basin are also adopting water quality standards based on fish consumption and the EPA is moving toward a similar nationwide standard.

Until 2001 the method approved by the US EPA for testing mercury was not sufficient for detecting mercury in ambient waters or most municipal wastewater effluents. With the promulgation of EPA Method 1631[1], the detection limit of the "approved" method dropped from 200 ng/l to 1 ng/l. This test method allowed the mercury levels in waste discharges and the receiving waters to be documented thus allowing a determination of the potential to exceed the water quality standards. If there is a potential to exceed the standards this will result in a limit in the discharge permit. Since the fish consumption based standards are very low, most all dischargers into the Great Lakes Basin will end up with numeric limit in their NPDES permit or a requirement to conduct a pollutant minimization effort at their facility.

SOURCE REDUCTION ACTIVITIES

Because of the incorporation of the Great Lakes Water Quality Agreement standards into the Minnesota Water Quality Standards (for those waters within the Lake Superior Basin), a strict mercury standard now applies. In 1993 the Western Lake Superior Sanitary District (WLSSD) conducted a study to determine the cost of compliance with this strict standard[2]. The study found that end-of-pipe treatment would double the total cost of wastewater treatment, which would be cost prohibitive. WLSSD chose instead to conduct intensive source identification and reduction activity in order to try to eliminate the sources of mercury to the wastewater treatment plant and the solid waste/sludge incinerator.

Some of the sources of mercury to WLSSD's plant were very unique and some are similar to those found in small cities throughout the country.

The first and largest source of mercury at WLSSD was the wet scrubber water from the wastewater sludge/ solid waste incinerator. The scrubber water was returned to the treatment plant and caused extremely high loadings of mercury to the plant from the incinerator feed stocks: wastewater treatment plant sludge and refuse derived fuel (RDF). The acid atmosphere of the incinerator emitted ionic mercury, which is water-soluble. Therefore, the wet scrubbers were very efficient at capturing the mercury from the stack and transferring it back to the treatment plant and eventually to the effluent. Over a number of years this problem was solved by treating the high mercury scrubber water to remove the mercury as a precipitate, followed by dewatering, and land filling in a Class A landfill. By the time the incinerator was shut down in 2001 the loading of mercury to the wastewater treatment plant from the scrubber had dropped from 90 to 20 percent. This source may be relevant to discharges from wet scrubbers from any incinerator that may have mercury in the feedstocks such as waste incinerators or coal-fired boilers.

A second source of mercury we discovered being discharged to our plant was from industrial customers that used large volumes of chemicals (sulfuric acid and, to a lesser extent, caustic soda) that were contaminated by mercury. A paper mill using mercury-contaminated sulfuric acid to make bleaching chemicals discharged over 60 grams of mercury per day. Today after finding a clean source of sulfuric acid they discharge less

than 0.2 grams of mercury per day[3]. This would only be relevant to facilities that use large volumes (tank trucks or railroad tank cars) of chemicals.

The previous two examples of success were large and relatively easy to correct. Very early on in our source reduction efforts we recognized that much of the mercury coming to our plant was not coming from industrial sources but rather commercial and residential sewer service areas. We noticed that some sewer lines contained concentrations of mercury over 50 times higher than other sewer lines. This case turned out to be caused by a large medical/dental profession building. We also noticed that sewer line cleaning activities in such areas also increase the mercury loading from the area. Since then, many studies have identified discharge from dental clinics as a major source of particulate mercury from amalgam particles discharged through dental suction systems.[4-6]

The WLSSD started its cooperative work with dental clinics in 1993 by working with the leadership of the local Northeast District Dental Society, the Minnesota Dental Association, and the American Dental Association. The leadership of the local dental society convinced us that they would be willing to work with us to solve this problem. We conducted surveys, in-office audits, developed best management practices for waste management (BMPs), developed BMP manuals, and conducted trainings both at meetings and at all the offices in our service area. All these activities were conducted with input, cooperation, and support from the local dental society. Financial assistance from the state and federal agencies helped fund the activities. Documenting mercury reductions by implementing these BMPs and educational activities is not easily done since several source reduction activities were happening at the same time. The mass of mercury from the large clinic previously mentioned was reduced by two thirds during the time these activities were occurring. This is not surprising since many office personnel admitted that dumping of amalgam waste down the toilet was common practice prior to our training effort.

Further opportunities allowed the WLSSD and the local dental society to apply for grant funding for the purchase of amalgam separators. These systems, most of which use simple sedimentation technology to capture fine amalgam particles that traditionally get discharged to the sewer, were installed in all dental practices over a period of a few years. Previous pilot testing in a few offices had shown that they did not interfere with the practice of dentistry where they had been used. The separators capture approximately 95-99% of the amalgam wastes that would have previously been sewered from the suction system vacuum pumps.

The WLSSD also has provided programs for the public, the residential wastewater and solid waste customer, to minimize their potential mercury release into the environment. The WLSSD household hazardous waste (HHW) facility and the *Clean Shop Program* (for small businesses) collect waste from its customers, some of which may contain mercury. Historically mercury has been used in many products by these customers: paints, thermometers, fluorescent bulbs, and amalgam waste from dentists make up the majority of the wastes that could add to the mercury load at a treatment plant. The HHW facility collects up to 1000 pounds of mercury waste per year and over 20,000 fluorescent

bulbs per year. Public education also plays a part in WLSSD's efforts to reduce mercury. Most recently WLSSD has been involved with fever thermometer exchanges and the mercury free schools program in order to educate the public about what they can personally do to reduce or eliminate their environmental impact.

The healthcare industry has also been a historic user of mercury containing items and chemicals. WLSSD has promoted the use of non-mercury equipment in hospitals and prohibits discharge of mercury containing chemicals from hospital laboratories if they are still used.

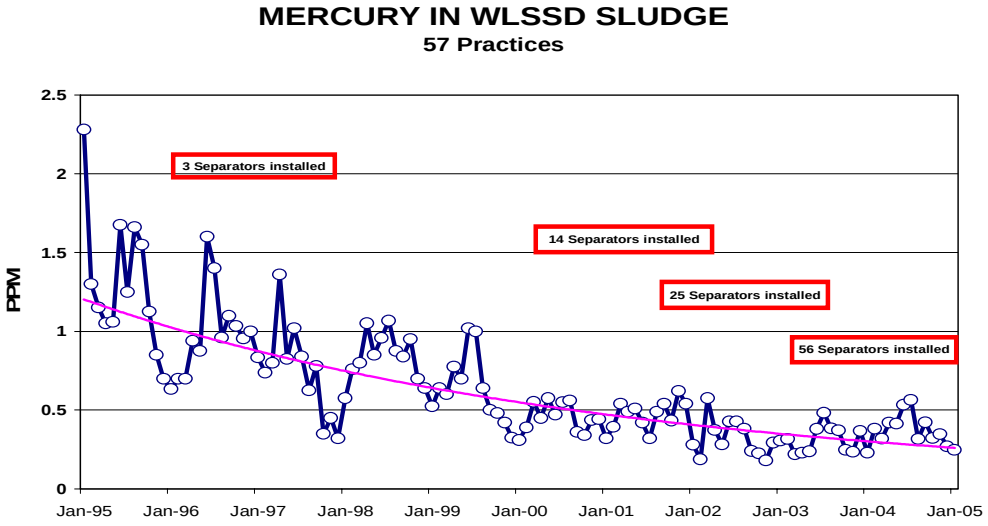
RESULTS AND DISCUSSION

Most wastewater treatment plants do not have the huge opportunities for source reduction of mercury that WLSSD has had. There are some activities common to all communities that may reduce the amount of mercury discharged to their treatment plant.

WLSSD found that historic waste management practices at dental practices were not a priority within that profession prior to 1990. Today many of the Best Management Practices (BMPs) developed in the early 1990s are now standard throughout the profession. The ADA is even developing an ANSI standard for these waste management practices. These improvements should continue to have a positive impact on the discharges from dental offices verses historic practice.

The impact of the use of amalgam separators on the loadings of mercury at the wastewater treatment plant is difficult to measure because multiple reduction efforts were occurring simultaneously. The data at our plant appears to show a positive trend based on the use of separators. (Figure 1) However, the positive trend was occurring prior the installation of the separators. The present trend seems to be leveling off, but this too may be caused by factors unrelated to amalgam separators.

Figure 1. WLSSD Mercury Trends

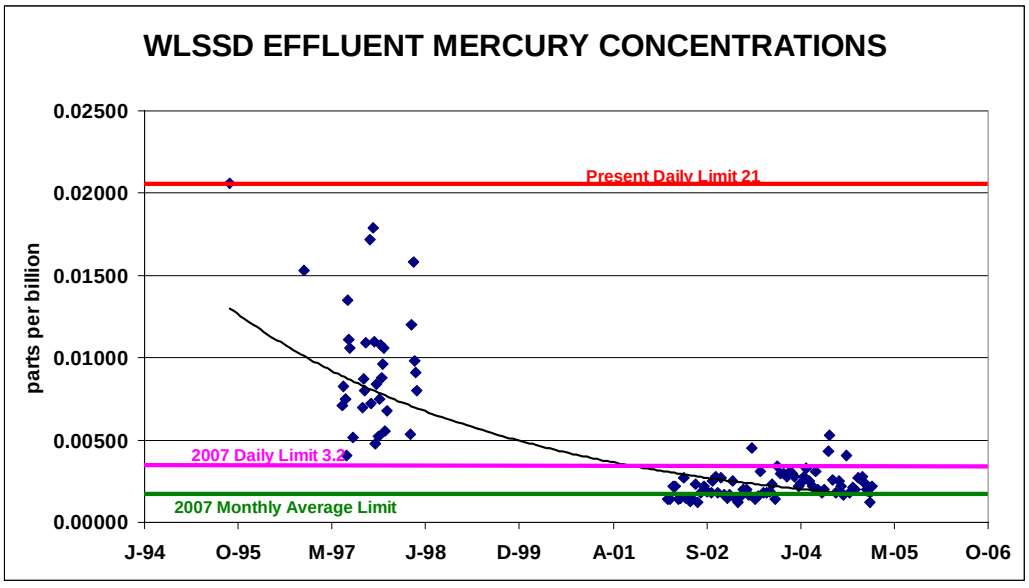


A dentist from Denmark collected data on mercury concentrations in wastewater sludge from 33 wastewater treatment facilities before and after separators had been used for 10 years. It was found that 50 percent of the wastewater plants showed significant reductions of mercury. Of those that showed a reduction, between 14 and 80 percent less mercury was observed[7]. The Association of Metropolitan Sewerage Agencies is also in the process of measuring the effectiveness of amalgam separators in cities where they are being used. They are using low-level analytical techniques to measure the changes in influent, effluent, and sludge concentrations as the use of the separators increases in those cities.

We (WLSSD and the dentists in our service area) have come to the conclusion that amalgam separators are the best practical treatment technology for dental office suction water. Many cities have instituted regulations requiring amalgam separators. The WLSSD has been able to work in a cooperative manner with the dental professionals to achieve the same outcome without the expense of a regulatory program. The Minnesota Dental Association has also committed to a similar program to try to get dental practices to install amalgam separators voluntarily. So far roughly 80% of the practices state-wide have committed to install separators.

Most wastewater treatment facilities remove approximately 95% of the mercury entering the plant in the wastewater stream. All of the captured mercury is transferred to the wastewater treatment plant sludge. WLSSD wastewater influent mercury concentrations in the last 3 years have been 80-100 ng/L. WLSSD's removal rate remains at 97% over the last 3 years. The resulting concentration in the effluent has been 1.2-5.3 ng/L (n=70, mean=2.3); slightly above the projected 2007 mercury discharge limit of 1.8 ng/L. (Figure 2.) In an AMSA study in 2000, the average mercury concentration in domestic wastewater was 138 ng/L[8] compared to WLSSD's samples from residential neighbor hoods at a mercury concentration of 60 ng/L. With a 97% removal rate at WLSSD, an effluent discharge concentration of 1.8 ng/L could be expected.

Figure 2. WLSSD Effluent Trends



Another factor that may be an issue in removing mercury through the WLSSD treatment facility is that the dissolved component of mercury in the WLSSD effluent is approximately the same as the mercury discharge limit of 1.8 ng/l-monthly average. (See Table 1) This factor could add significant costs if end-of-pipe treatment options were required to meet future limits.

Table 1. Species of Mercury in WLSSD Effluent

Date	Total Mercury ng/L	Dissolved Mercury ng/L	Methyl Mercury ng/L
4/16/2004	2.0	1.4	0.07
7/23/2004	1.8	1.2	0.10
9/16/2004	4.1	1.9	0.12

It is important to mention that presently the discharge of mercury from WLSSD's facility is at lower concentration than the receiving water, the St. Louis River. In a 2004 mass balance study conducted on the St. Louis River, WLSSD contributed 0.4 grams of mercury per day to the river, which contained 19 grams per day at a site upstream from the WLSSD discharge point. Only three data points were included in this mass balance; however the data analyzed is representative of the river and the discharge.

CONCLUSION

WLSSD has conducted extensive source reduction activity with industrial, commercial, and residential sewer customers. It appears the strict fish consumption based water quality standards are still **just** out of reach much of the time. Because of the density of particulate sources of mercury that have been historically discharged to the sewer, the time required for particulate bound mercury to work its way out of the sanitary sewer system may be significant. This also means sewer line cleaning will also add to the mercury load at a treatment plant. Source reduction activities including identification and reduction of possible dissolved mercury sources may be a very important factor in meeting Great Lakes standards. Solids removal through a wastewater treatment plant must be exceptional since most of the mercury received at a treatment plant is captured in the sludge.

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