MWRA / MASCO PHASE II
END-OF-PIPE SUBCOMMITTEE
MERCURY WORK GROUP
PRETREATMENT GUIDANCE MANUAL
December 1997

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1.0 INTRODUCTION

This Manual is a product of the Phase II MWRA/MASCO Mercury Work Group, End-of-Pipe Subcommittee, Pretreatment Guidance Subgroup. It should be used as a reference by industrial facilities owners in the development of an action plan to solve a sewer discharge compliance problem. The plan of action may involve initiation of a source reduction program or enhancement of an existing one, and it may also involve implementation of an industrial wastewater pretreatment strategy. This Manual is intended to help facilities to understand the various steps that may be entailed in a comprehensive source reduction program and in the selection, design, installation, and operation of an industrial wastewater pretreatment system.

The wastewater pretreatment discussions in this Manual are directed toward all types of pretreatment systems and are then focused on additional considerations specific to pretreatment systems that include mercury removal processes. Therefore, this Manual may be especially valuable to facilities in the health care industry. The following topics are discussed:

- Pretreatment Background
- Steps to Achieve Discharge Compliance
- Selecting a Consultant
- Source Reduction Concepts
- Wastewater Characterization
- Coordinating Source Reduction, Segregation, and Pretreatment
- Pretreatment System Economic Analysis
- Types of Pretreatment Systems
- Pretreatment System Bench-Scale Testing
- Pretreatment System Pilot Testing
- Pretreatment System Implementation and Operation
- Permitting and Licensing Issues

The Pretreatment Guidance Subgroup hopes that this Manual will be a valuable and practical tool for many facilities, providing insight into the many variables associated with the selection, design, installation, and operation of industrial wastewater pretreatment systems, including those incorporating mercury removal technologies.

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2.0 BACKGROUND INFORMATION ON PRETREATMENT

In areas served by municipal sewers, pretreatment of industrial wastewater discharges is often required to limit the discharge of toxic, corrosive, or other pollutants into the sewer system and associated sewage treatment facilities. Sewage treatment facilities that are owned by states and municipalities are known as Publicly Owned Treatment Works (POTW). For purposes of this Manual, pretreatment means the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. The reduction or alteration may be obtained by physical, chemical, or biological processes, process changes or by other means, except not by dilution.

In most districts, both general and specific discharge limits are applied to all industrial users of the POTW system. In general, industrial wastewater sewer discharges must be controlled to prevent:

- Harm or interference with the sewer system or any POTW treatment process, including sludge use, management, or disposal.
- Passage (pass-through) of untreated pollutants through the POTW that could cause a violation of any federal or state law or permit.
- Any violation of water quality criteria from the POTW effluent or adverse effects on the receiving waters.
- Threat of endangerment of the life, health, or welfare of any person or persons (including sewer and POTW workers) or of the public health, safety, or welfare, or the environment, or public property (including fire or explosion hazards in sewers or the POTW).

As part of the EPA National Pollution Discharge Elimination System (NPDES) permit system, the operator of a POTW is periodically required to evaluate the specific discharge limits it sets for industrial wastewater relative to existing federal and state environmental quality criteria. These specific industrial discharge limits are called Local Limits. To conform with federal and state guidelines, an evaluation of Local Limits must be based upon a substantial body of analytical data including the quantity and quality of industrial sewer discharges, non-industrial sewer discharges, treatment plant pollutant removal rates, and residual biosolids (sludge).

In the Boston Metropolitan Sewerage Service Area, the MWRA found in its Local Limits evaluations that specific industrial discharge limits were required for several heavy metals and organic compounds and, furthermore, that prohibitions were required for industrial discharges of pesticides, polychorinated biphenyls, phenanthrene, and mercury. The applicable Local Limits and discharge prohibitions are included in the MWRA Sewer Use Regulations (360 CMR 10.000) and appear as requirements in all MWRA sewer use permits issued to industrial dischargers.

For mercury, the MWRA developed an enforcement limit for the prohibition that requires that samples of an industrial discharge show a maximum mercury concentration of 1.0 micrograms per liter (µg/L)[1]. The basis for this enforcement limit is a statistical evaluation that determined that mercury would be present if detected in a wastewater sample at a concentration greater than 1.0 µg/L (*i.e.*, five times the typical analytical laboratory detection limit of 0.2 µg/L). Thus, adoption of the enforcement limit eliminates the possibility of a false positive analytical result for which the MWRA would take a noncompliance enforcement action.

To comply with the MWRA Local Limits, each permitted industrial facility should study its proposed or existing wastewater discharges to find the most economical and practical approaches to meet the Limits. For some facilities, compliance with all Local Limits may be achieved by implementation of a source reduction program. For other facilities, source reduction combined with pretreatment, or pretreatment alone, may be required. Often, the lowest capital and operating costs for a new pretreatment system are achieved when the system at each discharge point is integrated with source reduction, source segregation, and other aspects of facilities management.

[1] The concentration unit of (µg/L) is often referred to as "parts per billion" (ppb).

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3.0 STEP-BY-STEP APPROACH TO DISCHARGE COMPLIANCE

A facility that experiences a problem complying with sewer discharge limits should develop a plan of action. As mentioned in the previous section, some facilities can achieve compliance with all discharge requirements by implementation of a source reduction program within the facility. For other facilities, a source reduction program must be combined with a wastewater pretreatment system to achieve compliance.

While no one plan of action to achieve compliance will be appropriate for all facilities or situations, the following generic step-by-step approach may be considered. The approach is depicted in Figure 1, Ten Steps Toward Industrial Wastewater Discharge Compliance. The first eight steps of the generic approach can be considered source reduction activities.

As shown in Figure 1, the first step is to study the possible pollutant sources within the facility. Each process activity should be examined for chemical or reagent usage and discharge. Verifying and quantifying pollutant sources (Step 2) can sometimes be completed by contacting the chemical or reagent manufacturers and reviewing their product data.

Tracking pathways of pollutants within the facility (Step 3) can involve the facility architectural design drawings and can be assisted by the development of flow diagrams for each industrial process and the building waste piping systems. Targeted monitoring to find pollutant pathways in the facility (Step 4) can require the installation and use of sampling ports in waste piping systems at points upstream of the final regulated discharge location. Information generated by the targeted monitoring can be fed back to Step 3 to help track pollutant pathways and further back to Step 1 to supplement the inventory of known pollutant sources.

With the information generated, candidate source reduction options can be developed and investigated (Step 5). The source reduction options that are found to offer good pollutant reductions and cost savings should be implemented. Since certain source reduction actions may require changes to current operating procedures, employee training might be needed for effective and continuing implementation of these actions (Step 6). Experiences gained from the training program can feed the further development of source reduction options (Step 5).

In addition to such source reduction activities, it may be appropriate to conduct a wastewater characterization study (Step 7) to more fully define the nature of the wastewater being discharged. The results of the study can be used to feed the further development of source reduction options (Step 5) and to define pretreatment requirements and possible interfering pollutants (Step 9). Wastewater characterization is discussed in Section 6.0 of this Manual.

The information derived from pollutant tracking and the wastewater characterization study can be used to identify specific wastestreams that are already meeting discharge standards. Other specific wastestreams might be identified that could cause problems for a specific pretreatment technology. The least cost solution to these situations could be to segregate the complying and problem wastestreams from the main wastewater stream (Step 8). These types of wastestream segregations can favorably affect the size, performance, and cost of the pretreatment system. If implemented, the wastestream segregations may also affect the available source reduction options (Step 5) and the character of the main wastewater stream (Step 7). Coordinating source reduction, source segregation, and pretreatment is discussed in Section 7.0 of this Manual.

Pretreatment technologies can be evaluated and implemented if required (Step 9). The steps of a pretreatment technology evaluation process are discussed in later sections of this Manual. Once the pretreatment system is selected, designed, and installed, the effluent from the pretreatment system should be monitored to meet discharge permit requirements and evaluate system performance (Step 10). The results of these evaluations can be used to optimize operations of the pretreatment system and can be fed back to help in the development of additional pretreatment process steps (Step 9) and source reduction options (Step 5). The evaluations can also help in the regular review and inventory of pollutant sources in the facility (Step 1).

This step-by-step approach to achieving discharge compliance can be an iterative process. Feedbacks during the source reduction, wastewater characterization, and pretreatment steps can dramatically affect the results. In particular situations, some of the above steps may be skipped or combined, and the order of some steps can be reversed. An experienced consulting engineering firm can provide invaluable services in the execution of this process. For more information, refer to the following sections of this Manual.

FIGURE 1

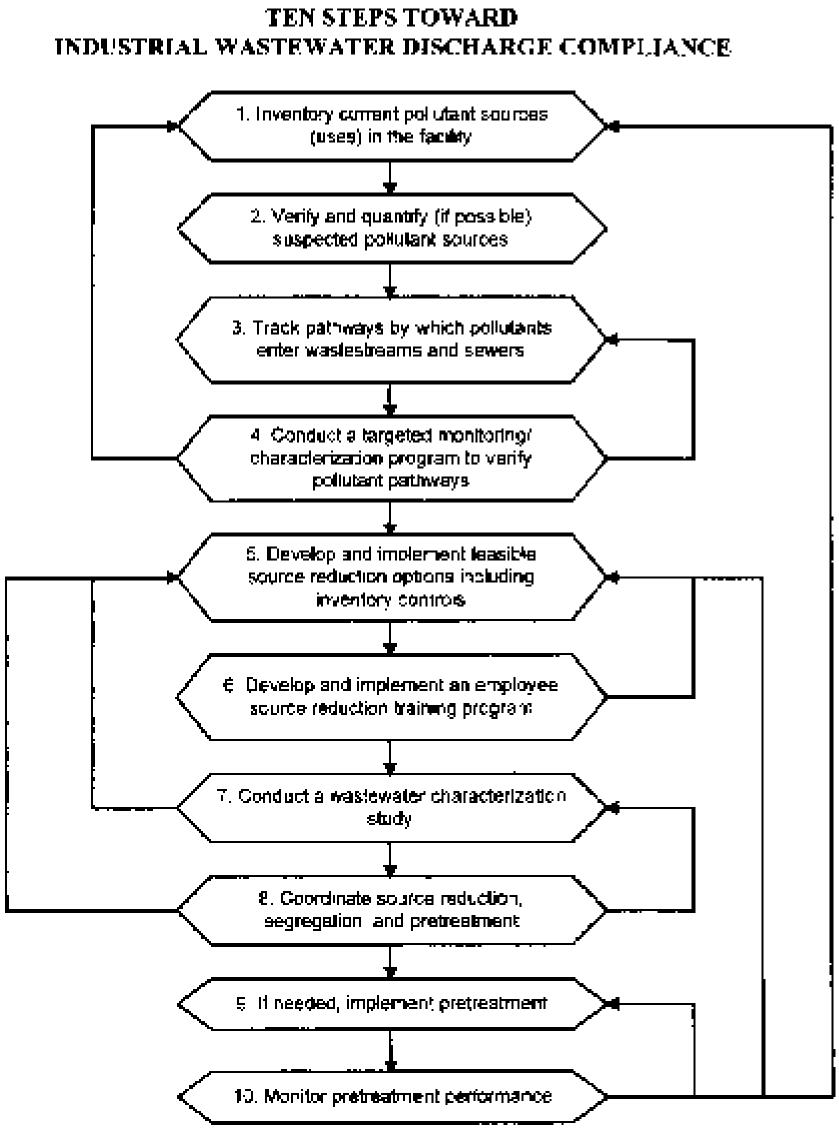

Figure 1

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4.0 SELECTING A CONSULTANT

4.1 General Considerations

As mentioned in the previous section, in response to a sewer discharge compliance problem, a facility may develop a plan of action that consists of a series of multi-faceted and complex steps. In each of these steps, an experienced consultant or consulting engineering firm can provide invaluable services.

If it has been determined that an existing pretreatment system needs to be modified or upgraded or that a new pretreatment system needs to be installed, owners/operators of a facility should understand before selecting or engineering a pretreatment system what initial steps should be undertaken, what information should be gathered, and what technical, regulatory, and permitting issues should be addressed.

A three-step sequence of feasibility and treatability testing of pretreatment technologies is an accepted practice of the engineering community in the selection of a particular pretreatment technology. For each application, the sequence begins with a technology and system supplier search, goes on to bench-scale feasibility testing (and possibly treatability testing) by several suppliers, and concludes with the selection of one or more suppliers for pilot system installation, testing, and optimization.

An experienced consulting engineering firm can significantly help in this process. The firm can specify feasibility, treatability, and pilot testing protocols; evaluate test data; recommend a process technology supplier for the full-scale pretreatment system; design the system interfaces with the facility; and perform oversight roles during system installation, testing, start-up, and operation.

The selection of the proper consulting firm for a particular project is an important issue and is not always an easy task. The consulting firm should ideally have recent experience in the design of pretreatment equipment and systems similar to the type being planned. Since the firm will use various staff members to do the design work, it is important to obtain the names and qualifications of the firm's proposed project manager and all key supporting personnel. Also, it is a good practice to ask for and check references regarding the design and project management ability of the consulting firms that are being considered.

Beyond the necessary technical expertise, your engineering consultant should have superior knowledge about the regulatory and permitting issues that will affect the system design, installation, operation, and possible effluent monitoring. Knowledge of the proper procedures and regulatory requirements can prevent delays and additional costs. As an example of special requirements, the regulating authority may require the installation of effluent pH and flow monitoring equipment that may not be required by local building codes.

In Massachusetts, wastewater piping systems for laboratories and industrial activities are also required to meet the Massachusetts State Plumbing Code as codified in 248 CMR 2.13. The "special wastes" from these activities can contain, besides mercury, organisms with recombinant DNA molecules, radioactivity, acids, alkalies, solvents, volatile organics and other chemical wastes that may be detrimental to the public sewer system and do not comply with the discharge limitations established by the local POTW.

The consulting engineer who is responsible for the design of the pretreatment system should be a registered Professional Engineer (PE) licensed by the state in which the project is located. In Massachusetts, the licensing and practice requirements for PE's are codified in 250 CMR 3.00. The PE is required to limit his practice to the particular branch of engineering in which he is licensed. It is highly advisable that drawings of pretreatment system components and of associated facility modifications be certified (stamped) by a PE licensed in the appropriate specific discipline. For instance, a PE licensed in electrical engineering would certify the electrical system design needed to support the pretreatment system.

Proper communication between the company and the pretreatment system consulting engineering firm is critical to the success of a pretreatment project. The proper selection of a pretreatment system is dependent upon the accuracy of the information given to the consulting engineer. For example, all company individuals that operate processes generating wastewater must be informed of the project and how their activities may relate to its success. They should be asked to provide accurate information to the consulting engineer about all individual process operation schedules and associated wastewater quantities and characteristics. The personnel should also understand that all expected changes in operations should be reported to, and approved by, the individuals who will be responsible for pretreatment system operations after the system is installed.

4.2 Required Engineering Documents

The design of pretreatment equipment and systems, whether for a new installation or for renovations or upgrade of an existing system, will require the production of engineering drawings and specification documents to meet construction, permitting, and other regulatory requirements. In general, engineering design documents should include:

- Facility and pretreatment system layout drawings
- Piping & instrumentation diagrams
- Equipment foundation drawings and support system details
- Mechanical, piping, electrical, instrumentation, controls, and operational drawings and specifications
- Specifications for installation coordination, testing, and demonstration of system performance.

Design drawings and specifications should be prepared in a format also usable for permitting purposes. This insures that documents will be available for timely submissions to pertinent regulatory agencies. If document submittals are required, this dual use of the prepared documents may reduce costs.
Engineering drawings are often electronically prepared using a computer-assisted design (CAD) system. CAD drawings allow for rapid, inexpensive retrieval and reproduction when design modifications or additions are needed.

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5.0 SOURCE REDUCTION CONCEPTS

Since source reduction may be a significant part of the solution to a sewer discharge compliance problem, it is important to understand the concepts of source reduction. Source reduction is defined in the federal Pollution Prevention Act of 1990 as:

> ...any practice which:
>
> (i) reduces the amount of any hazardous substance, pollutant, or contaminant entering any wastestream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and
>
> (ii) reduces the hazard to the public health and the environment associated with the release of such substances, pollutants or contaminants.[2]

In source reduction, pollutants or contaminants are eliminated or reduced within the process before they enter the wastestream. Many people interchangeably use the terms source reduction, pollution prevention, and waste minimization.

For an industrial process, a source reduction "opportunity" means any input of raw material, reagent, or energy; any loss or waste of that input; or any generated byproduct or waste material. A source reduction "option" means a possible means to achieve the reduction of an opportunity. The first step in a source reduction program is to identify source reduction opportunities. Then, a number of possible source reduction options to address each identified opportunity should be conceived (developed) and studied for implementation.

During development of the options, source reduction literature can be examined. The literature typically explores only a few options for a given opportunity. Thus, companies should attempt to identify source reduction options that suit their own operational methods.

It is generally accepted that all source reduction options can be defined, in order of priority, as procedural changes, material changes, technology changes, and recycling and reuse.[3]

5.1 Procedural Changes

This category of source reduction options involves changes to operating practices in a facility. The development of such changes is sometimes called the development of "Best Management Practices." Procedural change options are usually given the highest priority because they involve no capital expenditures and are often the easiest to implement.

Identification of procedural change options requires a detailed study of operational steps of the process under review. Company procedures that would typically be studied for implementation of source reduction include:

- Inventory control
- Material handling
- Production scheduling
- Preventive maintenance
- Process documentation
- Spill and leak prevention

5.2 Material Changes

Source reduction literature often limits this category of options to finding a specific less toxic substitute for a current reagent or compound. For example, aqueous cleaners are often examined as substitutes for chlorinated or organic solvents.

Actually, the material change option category can include material purification and dilution[4] as well as substitution. Moreover, material change options can include product material changes as well as input material changes. Product material change methods include substitution, conservation, and change in product composition.

For cleaning operations, which often produce large amounts of wastes and, therefore, can offer major source reduction opportunities, there are three types of materials involved: substrate, dirt, and solvent. All three of these materials can possibly be changed in a source reduction effort. As an example, if the base material of a product can be changed from metal to plastic, the need for a surface cleaning step before a finish coating step may be eliminated.

To accomplish material changes, a facility would begin by conducting a survey of all materials used in each area including operating and maintenance materials. Then, material compositions and contaminations would have to be identified. At this point, studies would be done to learn how each product is used so that possible elimination, replacement, or minimized use could be evaluated.

For mercury, material change options can be difficult to identify if the effort is intended to reduce mercury concentrations in process wastewater discharges below 1.0 µg/L (ppb). The major reason for this difficulty is that contaminant concentrations in the ppb range are usually considered "trace" contaminations and information on trace contaminants of most products and reagents is not readily available. For example, Material Safety Data Sheets (MSDS) issued by suppliers of products are required by law to list a chemical constituent only if it constitutes at least 1 percent (or 10,000,000 µg/L (ppb)) of the product.

In 1995, the Operations Subcommittee of the MWRA/MASCO Mercury Work Group compiled a list of hospital laboratory reagents and other products in a database called the Mercury Products Database. Approximately 5,500 chemicals were listed with actual mercury data available for about 700 products. The database is being updated in the Phase II Work Group activity. The updated database will have mercury data for more than 800 products.

5.3 Technology Changes

This category of options can involve changing the equipment used in the process operation or using another technological approach to achieve the same product or result. For example, a new, efficient washing machine may be substituted for an old, inefficient washing machine. In surface cleaning, mechanical cleaning methods may be used instead of solvent cleaning. For laboratory test equipment, a new analytical instrument may require smaller sample sizes or may reduce or eliminate the use of certain reagents.

Technology change options can also include:

- Process changes
- Equipment, piping, or layout changes
- Changes to process operational settings
- Additional automation
- Energy conservation measures
- Water conservation measures

5.4 Recycle and Reuse

Although this category of options may not be considered as source reduction to the pollution prevention purist, recycle and reuse options can reduce water usage and quantities of toxic materials discharged to sewers or shipped from a facility for disposal.

Recycle and reuse options can include:

- Recycling or reusing portions of a waste stream within the original process.
- Using a waste stream as a raw material in a different process or facility.
- Treating a waste stream to reclaim portions for recycle or reuse within the original process or a different process or facility.

Under this category, separation technologies are often used on wastewater streams to reuse the water or to remove constituents of regulatory concern for recycling to the process as material inputs. For example, formaldehyde-bearing waste streams can sometimes be distilled to recover and reuse the formaldehyde.

5.5 Option Feasibility Analyses

Once several possible source reduction options have been conceived and initially explored, those holding promise of the greatest waste minimization opportunities or cost savings would be evaluated. For each selected option, the evaluation would examine technical, environmental, and economic feasibility issues.

Technical feasibility analysis would attempt to decide if the option will work in the particular process application being assessed. Key considerations include product requirements, maintenance requirements, space requirements, compatibility with existing operations, and operator training and safety. Vendor consultations or pilot-scale testing may be needed to complete the analysis.

If a proposed source reduction option passes the technical feasibility analysis, it is necessary to evaluate its environmental feasibility. An environmental feasibility analysis would attempt to gauge effects of the option on all aspects of environmental compliance including emissions to air and water, generation of solid waste, possible judgments or fines, and future liabilities.

Once a proposed option passes the technical feasibility analysis and is found to have a favorable environmental feasibility, it is necessary to evaluate its economic feasibility. Profitability indicators such as payback period, return on investment, and net present worth can be used. The economic evaluation would usually involve both capital and operating cost estimates.

Capital cost estimating data may include equipment purchase costs, site preparation costs, support material costs (such as foundations, piping and instrumentation), installation costs, engineering costs, startup and training costs, initial permit fees, and raw material inventory costs.

Operating cost data would generally be calculated as incremental higher or lower costs from the current situation. Operating cost categories may include annual permit fees and reporting costs, waste disposal costs, raw material costs, utility costs, insurance costs, operating and maintenance costs, overhead costs, revenues from sale of byproducts, and revenue from increased or decreased production.

The measure of payback period is frequently calculated by source reduction assessors because of its relative simplicity. An example is the payback period analysis found in Appendix B prepared for a printing facility regarding the option of installing a fixer recirculation system in its photoprocessing operation. Corporate financial officers often prefer to use the economic measures of return on investment or present net worth for making investment decisions. Additional discussion of economic analyses can be found in Section 11.0 of this Manual.

5.6 Option Implementation

In the implementation stage of a source reduction program, necessary resources would be obtained, equipment would be installed, procedural changes would be made, and performance would be evaluated. Typically, a company would pursue implementation of those options that are low in initial costs and offer a combination of benefits including reductions in material uses and environmental discharges, improvements in occupational health and safety or in energy efficiency, and an overall savings in plant operating costs.

Since the idea of changing an existing process often meets with resistance from departmental supervisors and staff, the source reduction implementation stage might also involve considerable managerial effort. Successful approaches have used policy directives and delegations of authority by upper management to a source reduction team drawn from all departments of a facility.

After experiencing initial successes, the source reduction team has credibility within the facility and may then go on to implement more difficult or more costly options. This means that ways to measure program effectiveness need to be in place. Waste reduction is the ultimate goal and the key factor in measuring effectiveness.

In addition, employee training programs on process operations and waste management have successfully been used during implementation of source reduction programs and as a means to assure continued benefits after implementation. While such training programs should be tailored to meet specific needs at each facility, the following topics should be considered:

- regulatory agencies
- sewer discharge regulations/prohibitions

- plumbing infrastructure information
- pretreatment systems information
- source reduction goals and techniques
- mercury source list
- procedures for purchasing mercury-containing materials
- product substitutions
- material handling techniques
- wastewater sampling protocols
- wastewater pH monitoring
- waste management procedures
- recycling opportunities
- spill prevention and containment
- waste disposal protocols

The operations and waste management training programs should be presented to all affected facility personnel. Ideally, newly hired personnel should be trained within thirty days of hire. All staff members should be retrained annually, at a minimum. In addition, an audit program should be developed to learn if the operations and waste management training programs are effective. Periodic unannounced inspections should take place throughout the year to detect staff compliance with the operations and waste management policies of the facility.
To keep personnel up-to-date on all waste management issues, facility managers may want to develop newsletters, informational postings, publish articles, or use other appropriate means of communication with the staff. The key to a successful training program is to keep employees informed of waste management policies and to help them understand that individual actions can make a substantial difference in the overall environmental quality and impact of their workplace. The overall source reduction program cannot be a one-time effort but should become an ongoing part of the overall manufacturing process. The need for repeated source reduction assessments becomes especially important when there are:

- Changes in raw materials or product requirements
- Changes in waste management costs
- New technologies become available
- Changes in regulations
- Major environmental events such as spills or accidental acute employee exposure

A truly successful source reduction program, therefore, is a continuing process of assessment, implementation, measurement, and reassessment. The success of source reduction may be measured by reduced costs in production and environmental compliance including pretreatment.

[2]42 USC 13102.

[3]In Massachusetts, the Toxics Use Reduction Act (MGL 21 I), enacted in 1989, classified six types of toxics use reduction options: input substitution, product reformulation, process redesign, process modernization, improved operations and maintenance, and in-process recycling and reuse. These six types of options are covered by the four broader types of source reduction options discussed in this Manual.

[4]Dilution is used here in reference to a process stream. Dilution of a wastewater stream to achieve a discharge limit is prohibited by federal regulations (40 CFR 403.6(d)) and MWRA regulations (360 CMR 10.025).

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6.0 WASTEWATER CHARACTERIZATION

6.1 General Considerations

An important step in a source reduction program and in the selection of a pretreatment system is to learn the physical and chemical characteristics of the process wastewater stream in question. The complexity of the characterization effort may vary depending upon the nature and size of the facility and upon the type and extent of the discharge problem. The study of the wastewater stream's characteristics may help identify contaminants that are present in the various contributing industrial processes. The measured levels of these contaminants can be compared with the limits of applicable sewer discharge regulations.

Beyond the contaminants subject to regulation, some contaminants can interfere with the proper operations of certain wastewater pretreatment systems. If individual process waste streams contain interfering contaminants, the waste streams could be either reduced, segregated from the other streams, or eliminated. On the other hand, the pretreatment system may be designed to work effectively with the identified interfering contaminants.

A wastewater characterization study that examines these issues can help to set an overall approach to achieving compliance with regulations. Such an overall approach may involve a combination of source reduction, source segregation, and pretreatment. An experienced consulting engineering firm may be employed to perform the wastewater characterization study and to help in the development and execution of the overall approach.

Because of the potential for cost savings, source reduction possibilities would usually be examined first for reducing or removing the regulated contaminants. Technically and economically feasible source reduction options would be determined and implemented.

Therefore, one might consider conducting a source reduction and water conservation audit in conjunction with a wastewater characterization study conducted in some form both before and after the audit. The source reduction and water conservation audit may yield the following results:

A better understanding of the materials used and discharged from the facility.

- Opportunities for product substitution may be found.
- Options to reduce pollutant loads may be found making possible a simpler, less expensive pretreatment system than originally planned.
- Possibilities for achieving compliance without pretreatment may be identified.
- Processes where water is being wasted or could be reused may be revealed.

The wastewater characterization studies should be done by a qualified professional using a certified analytical laboratory. Certified analytical laboratories must meet minimum performance standards and must pass periodic proficiency tests. Certified laboratories can be identified by referring to the Massachusetts DEP. Analytical laboratories can also be found in the local phone directory or over the Internet. The laboratories can be asked to verify that they are certified in the desired wastewater analyses. The analytical methods used by the laboratories should conform to EPA approved methods. Ideally, several laboratories should be investigated and their costs compared. If desired, a contract can be prepared, with review by an attorney.
To conduct the wastewater characterization study, identify a representative site to sample the wastewater stream that may be connected to a pretreatment system. The wastewater sampling site should be selected that is specific to the process and is not mixed with sanitary wastes or any other non-process wastes. This site should be upstream of any existing pretreatment operations

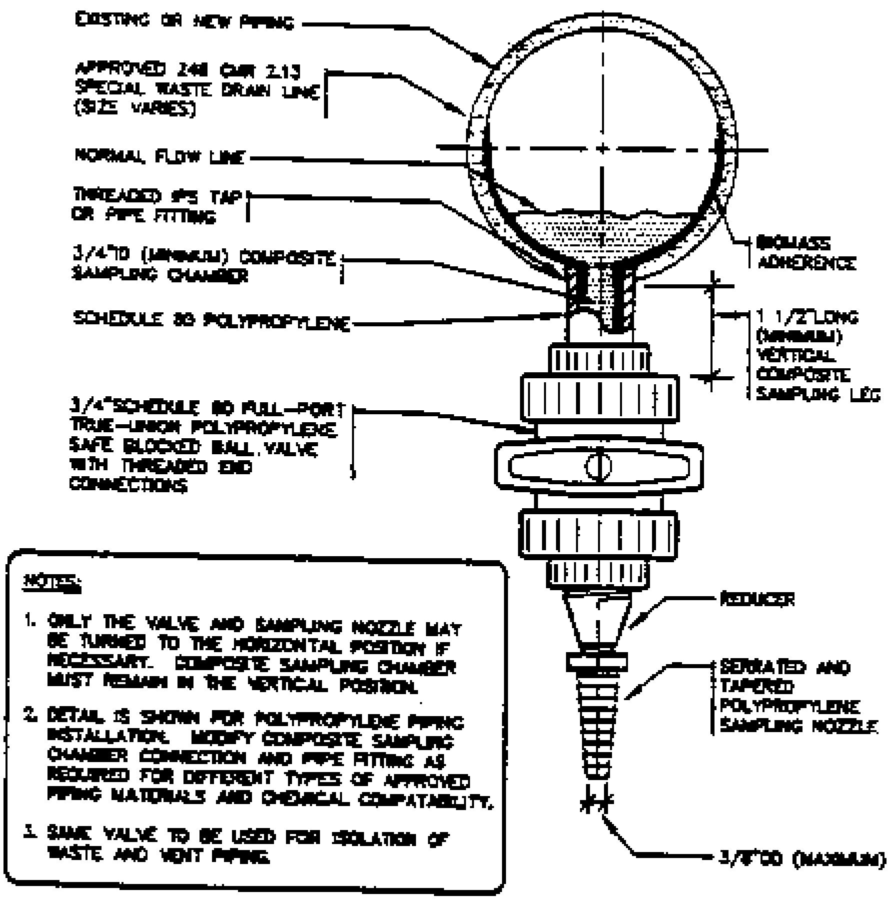
and should be easily accessible by sampling personnel. Ideally, the site should have electric power nearby for lighting and sampling equipment operation.

At the selected site, a spigot fitted with a 3/8 inch barb (maximum O.D. size) should be installed. As shown in Figure 2, Recommended Sampling Port for Special Wastes, the spigot may be placed at the bottom of the pipe to allow sampling of low wastewater flows. If the spigot is installed in this manner, a volume of liquid (that may contain settled particles) should first be purged to obtain representative and uncontaminated samples of the waste stream.

To collect the samples, Silastic or Teflon tubing is often connected to the barb. Sampling should be done during high and low flow periods of the process day. It is best to sample each site on several different days to help identify variations in waste stream characteristics.

Recommended Sampling Port for Special Wastes

Figure 2



Note: This figure is derived from the 1995 Infrastructure Subcommittee Maintenance Guidebook of the MWRA/MASCO Mercury Work Group. A sampling port for other types of piping systems may be similarly installed.

Composite samples are taken as time or flow proportional samples. Such sampling is a collection or "composite" of individual samples taken at regular intervals of time or flow during a process day (up to 24 hours). Composite samples are often collected by an automatic sampling unit programmed to collect individual samples of wastewater at selected intervals. Generally, the sampling unit automatically purges the sample connection and tubing before collecting a sample. Flow proportional sampling is the preferred method of composite sample collection, but this is not always possible since the required flow meters may not be available. Properly taken composite samples are usually considered to represent the wastewater over the course of a process day.

In the automatic sampler, the individually collected wastewater samples are often deposited and held in a single clean glass jar packed in ice (a temporary preservation medium). When the sampling event is complete, the composite wastewater sample is measured for pH and temperature and is poured into appropriate sample bottles. These bottles can be made of plastic, clear glass, or amber glass depending on the analysis to be done on that particular sample. The samples are then chemically preserved, if necessary, and put on ice for transfer to the analytical laboratory. Some parameters that are preferably measured using composite samples are total suspended solids (TSS), biochemical oxygen demand (BOD), sulfates, semi-volatile organics, and heavy metals (total and dissolved) including mercury.

Grab samples are single, instantaneous collections of wastewater that represent the composition of the wastewater being analyzed at a particular sampling location and time. Certain parameters including pH, volatile organics (VOA), petroleum hydrocarbons (PHC), and fats, oil, and grease (FOG) must be taken as grab samples to avoid losses or other changes in sample characteristics. If a wastewater stream is highly variable or intermittent, grab samples may be selectively taken and analyzed during a specific operating period to obtain an accurate characterization of the changing wastewater composition including its extremes. Before collection of a grab sample, it is important that sample connection and any connected tubing be thoroughly purged so that the sample represents the waste stream.

Batch discharges may require special sampling techniques to obtain representative samples. Typically, a batch discharger collects process wastewater over a portion or an entire day in a holding tank. The collected wastewater is discharged to the sewer after being neutralized or treated for compliance with permit requirements. In such cases, after the batch has been thoroughly agitated or mixed, grab samples can be taken at the beginning, middle and end of the discharge and can be used to prepare a manual composite (average) sample of the collected and treated wastewater.

6.2 Mercury Species in Wastewater and Mercury Speciation Testing

For wastewater containing mercury, a wastewater characterization study should include determination of the chemical species and physical forms of mercury that may be present. Mercury in wastewater may exist in three chemical species: metallic, ionic, and organic. These mercury species should be understood because some pretreatment technologies can effectively remove only certain species. In addition, the various species of mercury may bind to particulate matter in the wastewater to form physical agglomerates containing mercury.

Metallic mercury is typically found in thermometers, manometers, sphygmometers, fluorescent lamps and switching devices. This form of mercury is a silver-colored liquid at room temperature with a specific gravity of 13 (*i.e.*, it is 13 times heavier than water), and it is only slightly soluble in water. Metallic mercury slowly vaporizes at room temperature and can cause dangerous vapor concentrations in enclosed rooms. The vapor form of metallic mercury is readily absorbed through the lungs and is very toxic. Metallic mercury may be combined with other metals to form amalgams (alloys).

Ionic mercury exists when mercury atoms form covalent bonds with halogens and other inorganic ligands (complex ions). Ionic mercury can exist in two forms. With a single atom and an overall +2 charge (Hg^{++}), the ionic mercury is in the mercuric form. The mercurous form is diatomic with an overall +2 charge (Hg_2^{++}). The mercuric form readily forms salts (e.g., mercuric chloride - $HgCl_2$) that are soluble in water. Mercuric chloride and Calomel (mercurous chloride - Hg_2Cl_2) are often used in medical applications.

Organic mercury (typified by methyl mercury) consists of mercury atoms covalently bonded to organic groups. Often called organomercuric compounds, these forms of mercury are quite soluble in water and wastewater and are extremely toxic to aquatic life. These compounds are readily absorbed by fish from their aqueous environment and tend to become highly concentrated (bioaccumulated) in the fish tissues. If fish having bioaccumulated organic mercury are consumed, there can be major human health concerns. In addition, inorganic mercury in the environment can be converted by microbiological activity into methyl mercury compounds that can be absorbed by fish.

The various species of mercury can bind to the particulate matter that may exist in ambient water or wastewater. Particulate-bound mercury can move through the food chain through ingestion (filter feeding organisms) or through re-conversion to dissolved forms. Mercury-laden particulate matter can range in size from tens of microns to sub-micron (colloidal). Typical EPA methodology (Methods 200.7, 200.9, and 245.1) separate dissolved from particulate mercury by filtration through a 0.45 micron (µm) membrane filter.

As a physical species of mercury (instead of the previous chemical species), particulate mercury can often be a significant fraction of total mercury in a wastewater stream. Moreover, accumulations of metallic mercury or mercury-laden solids in plumbing systems (at elbows, traps, and other points) can cause chronic mercury contamination of the wastewater stream.

In analytical testing of wastewater samples, total mercury concentrations are usually determined by analytical laboratories using EPA Method 245.1. Analytical laboratories typically achieve a detection limit of 0.2 µg/L (ppb). This EPA method is the analytical method of choice because most applicable federal, state, and local regulations address total mercury concentrations.

For the various mercury species that may be present in a wastewater stream, concentrations of particulate mercury are the easiest to quantify. Particulate mercury concentrations in wastewater samples are not directly measured, however, but are determined as mathematical differences in analytical test results of total mercury and dissolved mercury. Dissolved mercury concentrations are determined using EPA Method 245.1 on wastewater samples that have been initially filtered through a 0.45 micron (µm) filter[5]. Standard EPA methods dictate that a 0.45 micron (mm) filter be used for this filtration step, although some laboratories recommend an additional test with a smaller filter such as 0.2 mm because particulate mercury is such an important species of mercury in wastewater.[6]

Analytical tests that separate the chemical species of mercury (*i.e.*, metallic mercury, methyl mercury, free ionic mercury, and loosely complexed mercury) are not routine or standard laboratory procedures as compared with the above applications of EPA Method 245.1. The mercury speciation techniques combine inorganic (inductively coupled plasma (ICP) and cold vapor atomic absorption (CVAA)) and organic (high pressure liquid chromatography (HPLC)) techniques to separate and quantify the various species of mercury. In some instances, the techniques include quantitative / qualitative tests and intuitive interpretation of the results. An alternate technique to EPA Method 245.1 has been proposed in EPA Method 1631 that uses bromide reduction of the various mercury compounds and pre-concentration with a gold amalgam before cold vapor analysis. With the gold amalgam concentration step, laboratories such as Frontier Geosciences, Inc. of Seattle, WA, can measure mercury concentrations in ambient water samples to detection limits of 0.00005 to 0.0002 µg/L (ppb).

The following is a brief description of the advanced speciation techniques. Elemental mercury can be determined by direct amalgamation onto gold and atomic fluorescence analysis. "Free" mercury (free ionic or loosely bound inorganic mercury) in a sample can be determined by using a mild reduction of mercuric ions to elemental mercury before the direct amalgamation step. In addition, but of lesser importance, methyl mercury can be determined through distillation (most common) or solvent extraction. These methods of mercury speciation will tentatively identify the important species of mercury in a wastewater stream. The methods require proficient and careful laboratory techniques that will be more time consuming than EPA Method 245.1, resulting in higher analytical costs.

As an alternative to using these rigorous analytical methods to detect mercury speciation, the following qualitative procedure may be used as part of a source reduction audit of a facility. (Please note that this approach will not yield the same high quality results as the above methods.) EPA Method 245.1 should first be used on properly-collected samples of the wastestream to measure the typical total mercury concentrations. Dissolved mercury levels could also be determined as described above. Then, identify all mercury-containing compounds discharged into the wastewater stream from each process operation. For each of these mercury compounds, assign a mercury speciation.

For example, if the only known mercury-containing chemical in the wastewater stream is thimerosal, assume that most of the mercury will be present as an organomercuric compound. Similarly, if reagents are known to contain mercuric salts, then mercuric ions will be present. Usually, most waste streams will contain several forms of mercury that may change over time. Even so, for purposes of selection of candidate wastewater treatment processes, it is helpful to estimate the percentage of each form of mercury that is likely to be present in the wastestream.

[5]Typically, dissolved mercury would be comprised of ionic mercury and any mercury compounds that can pass through the filter.

[6]Refer to the MWRA/MASCO Mercury Work Group, Technology identifiction Subgroup Report, for further information on mercury speciation testing relative to a bench-scale mercury removal feasibility test project.

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7.0 COORDINATION OF SOURCE REDUCTION, SEGREGATION, AND PRETREATMENT

Source reduction, wastestream segregation, and wastewater characterization as discussed above are practical steps to pursue before the design and installation of a pretreatment system. For the greatest benefit, these steps should be part of a coordinated effort. Figure 3 depicts a conceptual coordinated source reduction, segregation, and pretreatment plan for the special case of mercury in wastewater[7]. Implementation of such a plan involves some or all of the following steps:

Continue source reduction activities, *i.e.*, identify mercury-containing products and reagents, reduce their usage, or find non-mercury or low-mercury alternates. In addition, investigate procedural changes, technology changes, and recycling and reuse to reduce the amount of mercury discharged.

Determine which process wastewater streams have <u>non-detectable concentrations of mercury</u> and separate them from wastewater streams containing mercury. Separation may involve waste piping changes, relocation or consolidation of process operations, and/or manual collection and transfers. The segregated mercury-free wastewater streams would be routed beyond a mercury pretreatment system to reduce its size and capital cost.[8]

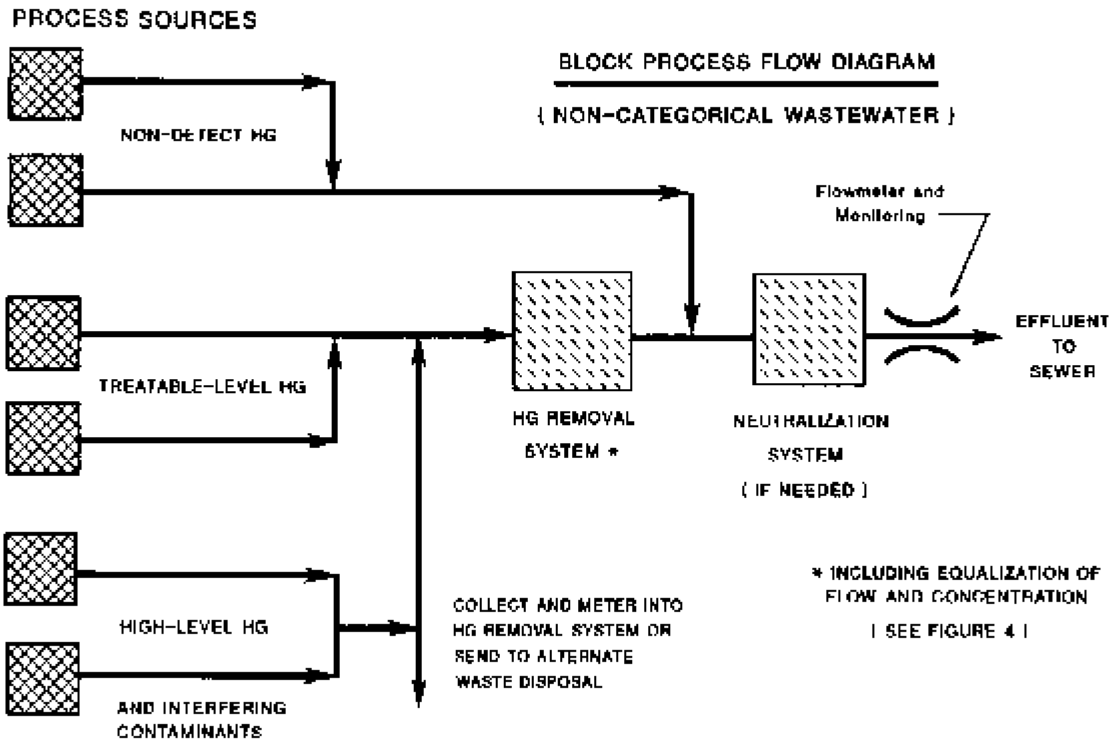
Determine which process wastewater streams have <u>high concentrations of mercury</u> and segregate them from other mercury-bearing wastewater streams to reduce the size, capital cost, and operating cost of a mercury pretreatment system. These high mercury streams could be disposed of as medical or hazardous waste. If it is determined that alternate disposal is not economical, these streams could be collected into a tank for continuous metering into the other mercury-bearing wastewater streams. The mercury pretreatment system would be designed accordingly.

Determine which mercury-bearing wastewater streams have other pollutants that could cause interferences with your mercury pretreatment system. Interferences with specific mercury removal processes can sometimes occur from chlorine, detergents, solvents, oil and grease, phosphates, or heavy metals. Replace or reduce the use of any problem reagent sources or separately collect the potentially offending wastewater streams for disposal as medical or hazardous waste.

For the remaining mercury-bearing wastewater streams that can be effectively pretreated, implement equalization of (*i.e.*, reduce the variations in) the flow rate and pollutant concentrations before a mercury pretreatment system. Figure 4 depicts a possible configuration of an equalization tank that can reduce variations in both flow rate and pollutant concentrations of a wastewater stream.

Take the equalized wastewater stream into your mercury pretreatment system. Typically, the pretreatment system would be installed only after bench-scale feasibility and treatability tests on samples of actual wastewater and after on-site pilot system optimization tests. Combine the treated and untreated process wastewater streams for final neutralization, flow metering, monitoring, and discharge to the sewer.

FIGURE 3

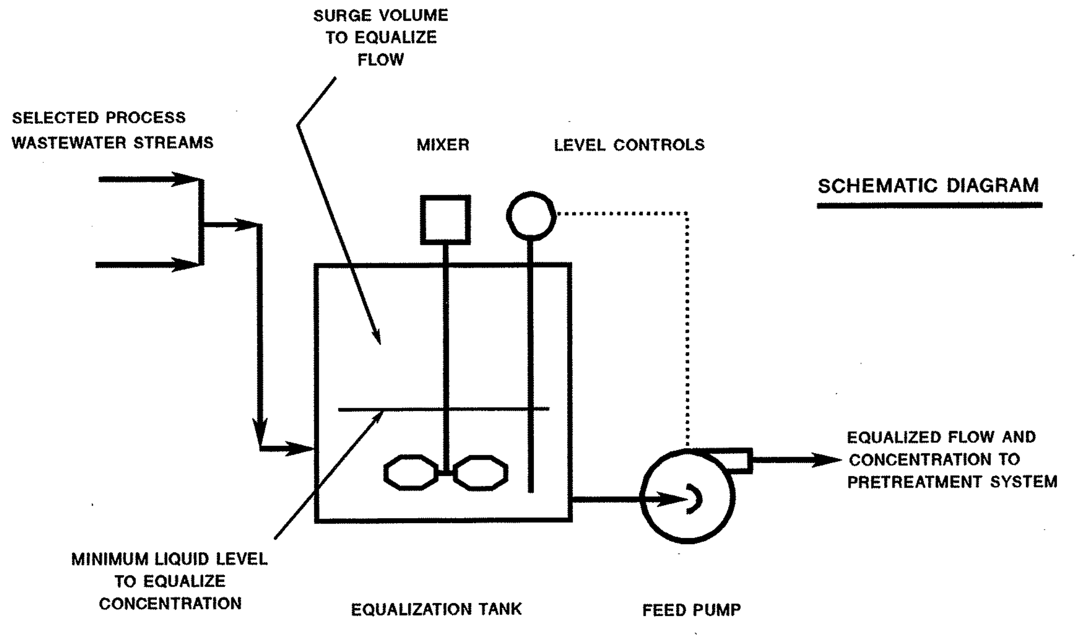


HG SOURCE REDUCTION, SEGREGATION, AND PRETREATMENT PLAN

9/11/97

FIGURE 3

FIGURE 4



EQUALIZATION OF WASTEWATER FLOW AND CONCENTRATION

FIGURE 4

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8.0 TYPES OF PRETREATMENT SYSTEMS

8.1 General Considerations

There are many different types of wastewater pretreatment systems that can treat specific and multiple contaminant problems. The complexity and installed cost of a complete pretreatment system will depend on many factors, including:

- the volume and nature of the wastewater
- the allowable contaminant levels in the final discharge
- the desired degree of pretreatment system automation
- the difficulty of system installation within an existing facility.

For example, one might imagine that a laundry facility would require a relatively simple pretreatment system for its wastewater. A local industrial laundry, however, recently installed a wastewater pretreatment system that consisted of seven different unit operations to remove regulated contaminants from its wastewater. The unit operations were equalization, solids removal (screening), pH adjustment, oil skimming, dissolved air flotation with chemical treatment, sand filtration, and activated carbon filtration.

A facility that must remove heavy metals from a wastewater stream might use pH adjustment to precipitate the metals from solution. Most heavy metals will precipitate out of solution as hydroxide salts at higher (alkaline) pH levels when sodium hydroxide is used as a pH adjustment reagent. Hexavalent chromium, on the other hand, is very soluble in wastewater and must be chemically reduced at lower (acidic) pH levels to the trivalent form before precipitation is attempted. Thus, the need for two different pH conditions for the chromium reduction and precipitation steps means that a pretreatment system for hexavalent chromium must have two separate reaction tanks. Often, a third tank is needed for final neutralization before discharge.

In addition, heavy metal removal to low levels (in the µg/L or ppb range) can be achieved by reverse osmosis (RO) or ion exchange pretreatment processes. If there are organic compounds or bacterial activity in the wastestream, however, the RO membranes or ion exchange resins may become fouled, thus reducing flow through the system or allowing the metals to pass through the system, respectively. Therefore, the offending organic compounds or bacterial activity should be controlled prior to these pretreatment processes.

The levels of organic compounds can be reduced or eliminated by implementing a source reduction program or by an initial pretreatment step such as carbon adsorption. A source reduction approach is generally preferred since it can lower the capital and operating costs of the pretreatment system. Bacterial activity can be controlled by chemical additions (i.e., oxidizers such as bleach or peroxides), high intensity ultraviolet light, high temperature exposure, or even filtration.

At times, a wastewater stream may contain chemical agents that can interfere with the heavy metal removal process. These chemical agents are called chelators or complexing agents. Source reduction steps may be needed to reduce or eliminate these agents. Alternately, the specific wastewater streams that contain these agents may have to be segregated from the main wastewater stream. The segregated streams could then either be piped into a separate specialized treatment unit within the pretreatment system or be collected and shipped to a licensed disposal facility.

Some form of pretreatment system for mercury removal may be needed if source reduction efforts alone fail to solve the problem adequately. Since mercury is a complex wastewater contaminant, multiple pretreatment unit processes may be necessary to reduce mercury levels sufficiently to reach compliance with discharge limits. For example, filtration would be an excellent candidate for an initial pretreatment unit process because mercury readily binds with particulate matter in wastewater. Depending upon the performance of the filter system in reducing mercury concentrations, subsequent pretreatment system unit operations may be smaller, have lower operating costs, or may be eliminated altogether.

For more detailed information on the characteristics of mercury in wastewater and on the performance of several pretreatment technologies in bench-scale feasibility tests on a clinical laboratory wastewater, please see the MWRA/MASCO Mercury Work Group, Technology Identification Subgroup Report, which is a companion to this Manual.

8.2 Types of Pretreatment Unit Operations

Usually, processes used in a wastewater pretreatment system can be placed into four categories as follows:

Biological Processes - Processes where living microbial organisms are used to metabolize organic wastes into carbon dioxide, water, methane gas, simple organic acids, and microbial matter. Aerobic microbial organisms require oxygen for their metabolisms. Anaerobic microbial organisms live in oxygen-limited environments. For municipal wastewater treatment, POTW's use both aerobic and anaerobic biological processes.

Chemical Processes - Processes that alter the chemical structure of the constituents of the wastewater so they can be removed from the wastewater stream before discharge. An example is heavy metal precipitation by pH adjustment.

Physical Processes - Processes that separate components of wastewater without altering the chemical structure of the constituent materials. Examples are dissolved air flotation (DAF), reverse osmosis, and filtration.

Thermal Processes - Processes that operate at high temperature to reduce the volume of wastes and breakdown the toxic components into simpler less toxic forms. These processes are typically expensive to operate because of high energy costs, but they can be very efficient for certain types of pollutants.

The following are specific types of unit operations used in wastewater pretreatment systems:

1. Aerobic or Anaerobic Pretreatment - Operations that use aerobic bacteria or anaerobic bacteria to reduce organic wastes in wastewater. Levels of the organic wastes are usually measured in terms of wastewater biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Aerobic pretreatment requires a source of oxygen and can produce significant quantities of biomass (sludge). At times, high levels of organic wastes can more economically be treated by an anaerobic process. Many inorganic contaminants, such as heavy metals, can be adsorbed onto the biosolids produced during the treatment process. Because of sensitivity of the bacteria to sudden changes in conditions, protection of the bacteria by various initial physical or chemical process operations may be needed.

2. Disinfection (chemical, thermal, or UV sterilization) - Used to reduce or eliminate bacterial or viral activity in a waste stream. Chemical methods usually involve the use of oxidizers such as hypochlorite (bleach), permanganate, and peroxides. Some unit operations - such as ion exchange and membrane filtration (see below for descriptions) - can be adversely affected by oxidizers. Thermal disinfection is highly effective, but is usually impractical for large streams because of cost considerations. Ultraviolet light (UV) sterilization is especially useful and economical for smaller flows, but may be ineffective on cysts and spores.

Depending upon the specific pretreatment technology, disinfection may be used before a mercury removal step. In some systems, disinfection by oxidizers can serve a dual purpose: prevention of biological growth in the adsorbent media and oxidation of complexed mercury species to more readily removed ionic forms.

3. Clarification - Used to remove settleable solids from a wastewater stream. At times, this gravity separation process is chemically enhanced by adding polymers under controlled conditions to cause agglomeration of the solids into larger particles for faster and more efficient settling.

4. Simple Filtration - Used to remove particulate matter (usually greater than 5 microns in size) from a wastewater stream. Filtration systems in this category would include bag type, depth or fiber wound cartridges, and graded sand and diatomaceous earth filter media. Filtration is often used for wastestreams high in particulate matter that could disturb subsequent unit operations. Since mercury has a high tendency to bind to particulate matter, coarse and fine filtration may be routine as initial unit operations in a mercury pretreatment system.

5. Membrane Filtration (micro or nano) - Used to remove smaller particulate matter, down to the 0.1 micron range. These systems can employ organic membranes (cellulose-based) or synthetic membranes. The organic membranes can be adversely affected by organic solvents, chlorine, and other oxidants. The membrane pore size can be compared with 0.45 microns that is typically defined in laboratory analyses of wastewater samples as the differential point between dissolved matter and suspended solids. Membrane filtration has been successful in applications of precipitated metals and free oil removal from wastewater.

6. Reverse Osmosis (RO) - Used to remove sub-micron particulate and high molecular weight ions. Hospitals often use RO units for desalinization of incoming city water (often used with ion exchange processes). In wastewater pretreatment applications, RO membranes can readily be fouled by oil and grease and suspended solids. The membranes can also be adversely affected by organic solvents and chlorine or other oxidants.

7. Ion Exchange - Used to remove dissolved ionic compounds. Ion exchange resins usually require specific pH ranges for good operation and tend to be expensive, require regeneration, and are susceptible to degradation by oxidizers and to fouling by suspended solids, oil and grease, and organic compounds.

8. Dissolved Air Flotation (DAF) - Used to remove light particulate from a waste stream by infusing fine air bubbles into a holding tank. The air bubbles attach to the particulate and lift them to the wastewater surface where they can be skimmed off. DAF treatment is often used for fats, oil, and grease (FOG) removal after de-emulsification.

9. Adsorption - Used to remove high molecular weight compounds from air and wastewater streams. The process uses a surface-active medium, the most common of which is activated carbon. Often used for removing low concentrations of volatile and non-volatile organic contaminants (solvents, pesticides, PCB, and phenols) and inorganic contaminants (such as mercury and other heavy metals) from wastewater.

10. Chemical Precipitation/Redox Reactions - Conversion of a dissolved pollutant to an insoluble form. Typical of these reactions is hydroxide precipitation of heavy metals from metal finishing wastewater. The reactions are usually followed by a particulate separation process, such as gravity clarification or filtration, to remove the formed solid particulate from the waste stream.

11. Neutralization - A unit operation that adjusts the pH of a wastewater stream by adding acids or alkalies to produce a solution that is near neutral (pH = 7 standard units (su)) or within an acceptable range for discharge. The MWRA has an allowable discharge pH range of 5.5 to 10.5 su.

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9.0 PRETREATMENT SYSTEM BENCH-SCALE TESTING

If it has been determined that a pretreatment system is required, a critical step in the selection and design of the system is bench-scale testing of the proposed individual unit operations. Because bench-scale testing can be relatively low in cost, this type of testing usually precedes the selection, pilot testing, and design of a proposed pretreatment system. Since the tests are done with small amounts of wastewater, the test setup is typically small enough to place and operate on a laboratory bench, thus the name "bench-scale."

Usually, the first bench-scale tests are performed to find out if a given pretreatment technology can reduce the level of targeted contaminants in specific wastewater samples. This type of bench-scale testing, called feasibility testing, can be used to screen pretreatment technologies for their potential to solve a wastewater discharge quality problem. Whenever possible, the feasibility tests should be performed on actual wastewater samples.

Bench-scale feasibility testing of a proposed wastewater pretreatment system is typically done with individual pieces of laboratory equipment used in sequence to replicate the expected unit operations of the system. At times, the testing is done with several pieces of laboratory equipment linked together as a scaled-down version of the proposed continuous system.

After feasibility of the tested pretreatment technologies has been demonstrated, further bench-scale testing of the successful technologies can be used to find expected process operating conditions. During this effort, the need for and selection of initial and concluding unit operations in the pretreatment system can sometimes be determined. In addition, the physical sizes and chemical dose rates for each unit operation can be evaluated. This type of testing is often called treatability testing. Besides the determination of design factors, treatability test results are often used to develop capital and operating cost estimates.

Bench-scale tests are frequently done by technology suppliers at a nominal price because the suppliers usually wish to cover basic testing costs. The suppliers could be asked to furnish bench-scale test results along with recommendations or proposals for treatability testing and pilot scale testing and with preliminary cost estimates of a full-scale system.

The MWRA/MASCO Mercury Work Group, through its Technology Identification Subgroup of the End-of-Pipe Subcommittee, recently used bench-scale feasibility testing to evaluate six different pretreatment technologies for mercury removal. The feasibility test work was done by vendors using samples of a clinical laboratory wastewater stream. Refer to the Technology Identification Subgroup Report for more information on the Bench-scale Feasibility Testing Project. This report is available from the MWRA[10] or can be accessed on the Internet at the following Web-site address: *http://www.masco.org/mercury*.

[10]Massachusetts Water Resources Authority, Toxic Reduction and Control Department, 100 First Avenue, Boston, MA 02129 (617-242-6000 x4900)

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10.0 PRETREATMENT SYSTEM PILOT TESTING

The results of bench-scale testing of different pretreatment systems can provide a good starting point for an onsite pilot testing program. In fact, it is better to start pilot testing when there is some understanding about the pretreatment unit operations that are likely to be needed for the proposed feasible pretreatment systems. Each pretreatment system might require different unit operations that might include equalization, pre-filtering, softening, pH adjustment, chemical additions, and removal of interfering matrices or contaminants by, for example, sterilization or adsorption.

The purpose of pilot testing is to find out how best to design and operate each element of the future full-scale pretreatment system and not only to determine possible effluent quality. The issue of possible system performance should have been addressed during a wastewater characterization effort and bench-scale feasibility and treatability testing. In addition to determinations of design parameters, the pilot testing of complete, but small-scale, pretreatment systems can also help identify any problems that may occur during long-term operations of the full-scale systems. Possible operating problems that could occur during pilot testing include reductions in performance from media fouling or from contaminant buildup. During testing, therefore, it may be necessary to make and test modifications or additions to the pilot system.

Therefore, pilot pretreatment systems should run for extended periods, *i.e.*, for several weeks or months, so that the full range of actual facility wastewater can be experienced and comparative information can be developed. For each tested system, all equipment should go through all operating cycles at least once and preferably several times. These cycles would include, for example, membrane cleaning, filter backwashes, or resin column and activated carbon regenerations. After each of these cycles, measurements should be taken to learn if there has been any decrease in normal operating performance. The measurements would help determine the long-term suitability and life cycle costs of each unit operation of the proposed systems.

If the pilot system is a batch type, processing one batch of wastewater at a time, it is often convenient to operate the batch system once per day. For a complete test, however, the system should be run on wastewater produced at different times and on different shifts. A batch-type pilot system should not be considered if a continuous full-scale pretreatment system is anticipated. For continuous pilot systems, a qualified operator should be available throughout all periods of operations.

Pilot pretreatment systems should be run on all anticipated waste streams, including all minor waste streams and periodic backwash and blowdown streams, floor cleaning wastewater, and other infrequent minor flows from likely maintenance operations. These streams can contain compounds that could upset a pretreatment system. Also, possible daily, weekly, and seasonal fluctuations in the waste stream composition should be considered.

The effects of all operational variables should be investigated and understood (flow, pressure differential, current density, recycle rate, pH, oxidation/reduction potential (ORP), feed concentration, etc.). After pilot system optimization, scale up information should be developed and operational ranges should be established (chemical dosages, settling rates, sludge generation volumes and densities, reaction times, floc characteristics, etc.). These operational factors should be determined routinely for the duration of the testing. Often, they are expressed on a normalized basis, *i.e.*, per square foot, cubic foot, psi, ampere, or other system size or driving force parameter. Effluent quality should also be verified under various operating conditions.

All residuals generated by each unit operation of the pilot system should be carefully considered and the ultimate fates and disposal methods should be determined. At the same time that effluent quality is tested, analytical tests of the residuals should be performed for the contaminants of concern. In addition, hazardous material determinations (corrosivity, reactivity, toxicity, and the EPA Toxicity Characteristic Leaching Procedure (TCLP)) should be performed. Residual handling operations (such as evaporators, filter presses, sludge thickeners, centrifuges, etc.) should be bench-scale tested or, preferably, pilot tested. Mass balances on key parameters should be done to obtain a full understanding of the fate of pollutants (*i.e.*, is the pollutant of concern destroyed, is it transferred into the sludge, is it volatilized, or is it accumulating and will it eventually foul the system?).

Energy consumption should be investigated to gauge any extra costs of the system. Inductive (motors) and resistive (heating) electrical energy requirements should be estimated for the full scale system. These considerations especially apply to high pressure unit operations such as reverse osmosis and to high temperature unit operations such as evaporation. The requirements for other utilities (*e.g.*, steam, gas, water, compressed air, and space heating and ventilation) should be identified as to quantity and quality. Floor space and headroom requirements for the full scale system should also be estimated. Noise and odor concerns should be explored. Accessibility requirements for the equipment should be defined.

Facility personnel who will be working with the full scale pretreatment system should be trained to operate the pilot equipment. Requirements for operators as to required skill level and training, including necessary licenses, should be determined. Training should include the theory behind the wastewater pretreatment process and contaminant removal and the mechanics of the equipment and controls. The training issue should be addressed early so the operations personnel will have completed training and be certified by the time the full scale treatment system equipment is in place. In addition, this type of employee involvement generates a sense of pride, security, and ownership, which is helpful during any planned changes in daily routines and operational procedures.

At some point in this process, full scale system capital and operating costs can be fairly closely estimated. An economic analysis could be done to compare competing pretreatment technologies. If only one pretreatment system is pilot tested, the results of the economic analysis could still be used to familiarize the facility management of the scope of the project and to compare the pretreatment project with possible alternatives.

It should be understood that a complete bench-scale and pilot testing program may not be needed if a wastewater stream consists of easily treated wastes. For example, some wastewater streams may contain no buffering agents and may require only pH adjustment (neutralization) to meet discharge regulations. A good source of information may be similar facilities and types of businesses that already have pretreatment systems. During initial planning stages, first-hand recommendations, endorsements, and criticisms for both engineering firms and vendors may be invaluable. Remember, however, that no two wastewater streams will be exactly alike, and pretreatment requirements may differ.

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11.0 PRETREATMENT SYSTEM ECONOMIC ANALYSIS

Before the purchase of any pretreatment system, economic and environmental impacts related to the installation and operation of competing proposed systems should be evaluated. The results of bench-scale feasibility and treatability tests, along with those of on-site pilot tests, can provide insights into the expected costs of competing pretreatment systems. The various pretreatment system costs can also be compared with the implementation of source reduction options, alternative wastewater disposal, and a "do nothing" approach that may involve various levels of regulatory agency enforcement actions.

In the economic analysis, it is common practice to apply accounting techniques in which economic impacts are separated into direct costs and indirect costs. These cost categories are used to calculate various economic measures for input into an investment decision process.

11.1 Direct Costs

Direct costs refer to expenditures that are directly associated with the delivery, installation, and operation of the pretreatment system. Direct costs include the following:

<u>Capital Expenses</u>

- Equipment and installation materials.
- Facility - building floor space; site preparation; and HVAC, plumbing, and electrical requirements.
- Engineering, procurement, and installation labor.
- Permit and inspection fees.

<u>Operation and Maintenance Costs</u>

- Labor.
- Waste disposal (hazardous and nonhazardous) including transportation and storage.
- Equipment spare parts and facility maintenance.
- Annual permit fees, monitoring and reporting costs (see below).

11.2 Indirect Costs

Indirect costs are those not directly associated with a production line or product, such as administrative costs. In traditional accounting, these types of costs are frequently included in the category of plant overhead. Often, regulatory costs (including the costs of permitting and monitoring) were considered as indirect costs.

The traditional practice of classifying manufacturing costs into direct labor, direct material, and plant overhead generally masked many relevant environmental costs needed for a thorough economic evaluation. For purposes of both source reduction analyses and pretreatment system evaluations, hidden environmental costs should be extracted from the overhead category and applied directly to the wastestream or pretreatment system being evaluated.

Operation and maintenance costs, which may have to be extracted from the overhead cost category, can include both labor and material costs as follows:

- Spill/leak incident reporting
- Monitoring
- Manifesting and disposal costs
- Labeling and labeling supplies
- Inspections
- Permitting

- Right-to-Know training and training supplies
- Insurance and liability protection
- Protective equipment
- Laboratory services and other analytical costs

11.3 Payback Period

In evaluations of source reduction projects, the calculation of payback period is the simplest method for evaluating the associated capital investments. The payback period is calculated as a ratio of the required investment to the estimated cost savings rate. A payback period is usually expressed in months or years and represents the time that the cost savings will take to recover initial cash outlays. For pretreatment systems, it is often difficult to calculate a payback period because cost savings (such as penalties and fines for noncompliance) may be intangible. Sometimes the cost of a pretreatment system can be compared with that of shipping the untreated discharge for offsite disposal.

If the payback period is much less than the economic lifetime of the project, then the project should be considered financially acceptable. If the payback period is equal to or greater than the economic lifetime of the project, then the proposal is financially unacceptable. However, since the payback period is not a very sophisticated economic measure, payback period calculations are usually not the sole method of project evaluations.

11.4 Depreciation

Depreciation is an accounting method used to recover the costs of assets such as a facility structure, equipment, and fixtures. Some of each asset cost is charged as an expense in each accounting period that the asset provides service to the business. The financial manager of the facility should be consulted when deciding to use depreciation in an economic analysis, because each company usually has a specific method of calculating depreciation.

11.5 The Time Value of Money

Financial analysts and company managers usually obtain a better comparison of costs of various project options by evaluating costs over time. The evaluation period is usually the projected economic lifetime of the project. If money is spent or received at different points in time, the value of the money will vary. For example, because of expected inflation and investment performance, a sum of money received today is worth much more than that same sum of money received ten years from now.

Therefore, sums of money paid or received at different times need to be discounted accordingly to make them comparable with each other. It is common practice to adjust the sums mathematically to reflect their current value. A factor called the Discount Rate, which varies by company, is usually used to specify the time value of money for a company.

Two common economic analysis methods that account for the time value of money are called Net Present Value and Rate of Return. For example, two projects can be compared by calculating their Net Present Values. The project having the higher Net Present Value would be favored. Also, a project having a positive Net Present Value would be a profitable venture.

The calculation of the Rate of Return of a source reduction project is a way to measure the potential profitability of the project. If the calculated Rate of Return meets company investment policies, a proposed project may easily receive the needed approvals for implementation.

11.6 Qualitative Considerations

A full assessment of a proposal requires a consideration of non-monetary factors. Factors with costs that cannot be quantified and verified should be described in a narrative. A rule-of-thumb whether a factor is *quantitative* is as follows:

- Is the factor verifiable?
- Is the factor defensible?
- Is the factor relevant to the project?

An evaluation of *qualitative* factors that can affect pretreatment system selection would include some of the following:

<u>Intangible Factors</u>

- Market share (consumer reactions to company products and decisions)
- Employee/union relations
- Shareholder reactions (to company products and decisions)
- Corporate image
- Community standing

Potential Liability

- Waste Disposal
- Chemical and Waste Storage
- Transportation
- Civil actions
- Economic losses (say, from site remediation activities)
- Fines/Penalties
- Criminal Actions

In the qualitative assessment, owners/operators of a facility should attempt to characterize the nature and extent of the changing or variable factors. Some factors to be considered are the sensitivity of customers to the company's continued use of toxics in product manufacture, the fact that a similar company experienced a decrease in market share attributable to toxics use, or shareholder reaction to the company's announcement of cleaner production processes.

If a company is publicly owned, has shareholders, or is dependent on venture capital and bank financing, its concerns are also the concerns of "outside interests." Detailed estimations of potential liability may be problematic because of various regulatory disclosure requirements and the difficulty of making reliable liability estimates.

The Securities and Exchange Commission and the Financial Accounting Standards Board have disclosure requirements regarding potential liability. Recent legal precedents suggest that attempts at estimating liability values can sometimes lead to unrealistic or unreliable estimates. Moreover, a cost estimate of environmental liability may require the company to make a cash allocation to a reserve account to cover the potential liability.

Therefore, the estimate of a company's potential liability should be restricted to a non-monetary characterization of risk. In other words, a company should characterize potential sources of risk within the company without attaching a loss figure. The discussion of potential liability in the qualitative section of the plan might cite the risk source (*i.e.*, hazardous waste storage) and the potential consequences of an event.

For example, when discussing the risk associated with the onsite storage of trichloroethylene (TCE), the case for the implementation of a source reduction program can be furthered. Storage of TCE would increase the probability of a TCE explosion, a TCE spill incident, or an acute employee exposure. The preparation of a list of these possible events may be sufficient for purposes of qualitative project evaluations.

For pretreatment systems, both the quantitative and qualitative evaluations of a project can take place well before pretreatment system vendors are contacted. The evaluations would provide guidance on whether source reduction, pretreatment systems, and/or alternate wastewater disposal methods should be used to solve a sewer discharge problem.

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12.0 PRETREATMENT SYSTEM IMPLEMENTATION AND OPERATION

Bench-scale feasibility and treatability testing and onsite pilot testing may vary in the time required to get the desired results. Good records need to be maintained during this phase because the records may be needed at times when referencing regulatory authorities, waste disposal vendors, or using the information for full-scale system selection, design, installation, and operation. Some items that need to be addressed during full-scale pretreatment system implementation and operation are:

- Purchase orders and contracts must be developed for the selected pretreatment system, supporting equipment and systems, piping, valves, instruments, controls, electrical power and lighting systems, and installation materials. The consulting engineering firm, an architectural-engineering firm, and a general contractor may be used during this phase.
- The project manager must be sure that all the proper permits and licenses have been addressed and granted before the installation and operation can take place (please review the section in this Manual about licenses).
- The equipment, once in place, should be thoroughly tested for proper performance. Performance testing requirements should be detailed in construction contracts. The contracts should also include provisions for training of licensed operator(s) in the functions and maintenance requirements of the equipment and controls.
- Log books (including wastewater discharge volumes and times), standard operating procedures, licenses, and sampling results must be maintained onsite for regulatory inspections and for your own information and comparisons.
- Equipment repair and parts lists and service and inspection logs should be kept on hand in case of a breakdown. These documents usually include lists of parts known to fail after extended use, or have a known service life. The list would also feature parts that would be changed periodically as part of normal maintenance (filters, screens, membranes, chemicals, gaskets, etc.). Often, pretreatment system vendors supply spare parts for a one year period as part of a purchase order. If the spare parts are not properly used, the service contract and warranty can be negated and, more important, could cause the system to malfunction.
- The company must take compliance samples of the treated effluent, according to the discharge permit requirements established by the regulatory agency or with the requirements of any noncompliance enforcement order. Usually, the required frequency of effluent sampling is specified in the permit or enforcement order. For the MWRA, the sampling must be done by trained and certified individuals and analytical testing must be done by a Department of Environmental Protection (DEP) approved testing laboratory using approved methods. Equipment and process warranties and various liability issues should be thoroughly considered to help reduce risks if the pretreatment system does not function as promised.
- If there are pretreatment system performance problems or discharge violations, the steps taken to address the discharge problem should be reviewed and verified. Corrective actions can include additional source reduction considerations, wastestream segregations, and pretreatment system additions or operating procedure modifications. Sometimes, an iterative process of source reduction and changes in pretreatment may be needed before compliance can be achieved. All pretreatment system additions should be approved by the licensing authority before installation and operation, and the status of the facility may be reviewed for possible site and operator upgrading.
- To avoid notices of noncompliance, fines, or other enforcement actions (including public listing as being in "significant noncompliance"), submit all required monitoring reports and pay all annual permit and user fees to appropriate agencies. Failures in this area may "flag" your facility and bring unnecessary attention to your operation.
- Inspections by MWRA inspectors may be possible anytime. The MWRA monitoring staff also may make periodic unannounced visits to take compliance monitoring samples of

the wastewater discharge. MWRA discharge permits require facilities to provide proper effluent sampling locations and safe access to those locations.

- The type of pretreatment system may impose additional concerns for facility owners/operators concerning employee health and safety for workers at or near the wastewater pretreatment equipment and systems.
- Considerations should be given to the development of an employee hazard notification program, health and safety manual, spill containment plan, evacuation plan, and Best Management Practices (BMP's).
- Provide for implementation of "Right-to-Know" policies at your facility in accord with local and Federal employee training requirements. Any wastestreams determined to be hazardous will require the development and posting of instructions on proper handling and disposal techniques.

These are merely some basic issues to be considered when operating a wastewater pretreatment system. Remember that every operation is different and no single pretreatment system can be universally effective.
Wastewater characterization; pretreatment system feasibility, treatability, and pilot testing; and the design, installation, and operation of a full-scale pretreatment system can all involve considerable financial expenditures. Since there are many possible definitions of a problem and many possible approaches toward its solution, it is important for all involved parties to have a good understanding of the issues.

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13.0 PERMITTING, LICENSING, AND REGULATORY COMPLIANCE ISSUES

Some or all of the permits listed in Appendix A may be required for the installation and operation of a wastewater pretreatment system. Other permits may be required as well. An experienced consulting engineering firm can advise you further in this area.

Most permit submittals require certain supporting materials to accompany the basic permit application. Often, the supporting materials may be the major portion of the permit application submittal. Care should be exercised in the preparation of the applications and supporting materials because many rules and regulations may apply that are not readily apparent from the application form itself. For example, an extensive Federal regulation (40 CFR 136) exists on the procedures that must be followed in performing an analytical characterization of wastewater.

Additionally, for all permitting or compliance monitoring purposes, the MWRA requires that only Massachusetts DEP-certified analytical laboratories be used for the analytical testing of wastewater. Analytical test reports will not be accepted if an analytical laboratory has only a provisional DEP certification. Extensive project delays could result if submittals are filed with supporting data that later is deemed invalid for regulatory reasons.

A successful permitting effort will rely on the sensible and effective timing of all the various required submittals. For project scheduling purposes, using the longest times allowed by law is generally advisable for estimating regulatory review periods (such as for DEP permits issued under the provisions of the timely action and fee schedule, 310 CMR 4.00). It is also advisable to plan for meetings and to include contingencies in the schedule such as time for preparing responses to possible agency requests for further information.

Additional requirements apply to, and submittals are required for, wastewater discharges from "categorical" industrial processes covered by federal regulations (Title 40, Chapter I, Subchapter N, or 40 CFR 405 to 474). On the other hand, some permit applications to the Massachusetts DEP are no longer required within the MWRA Sewer Service Area because of a Memorandum of Understanding adopted by the MWRA and DEP concerning Sewer Connection Permits and wastewater pretreatment Plan Approvals. Applicants should keep in mind that many permit conditions can be appealed (typically within 30 days after receipt) and that a careful analysis of all permit requirements should be undertaken immediately upon receipt.

If wastewater discharge standards are not being met, the noncompliance should first be reported to the pertinent regulatory agency in a timely manner. The situation should be discussed at a meeting with the regulatory agency so that all parties understand the full magnitude of the problem. All facts and requirements should be documented in writing, if possible. The facility management should be completely informed of the situation and give full commitment to resolving the issue on a timely basis.

If pretreatment is ultimately selected to achieve compliance, the goal should be to achieve the lowest installed cost for a pretreatment system, with the lowest operating cost, while meeting all discharge requirements. The Pretreatment Guidance Subgroup hopes that this Manual can help many facilities to address and achieve this goal.

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APPENDIX A

Selected Permits and Licenses Required for Sewer Discharge and Pretreatment System Installation

Baseline Monitoring Report -

Regulation: 40 CFR 403.12 (b)

Enforcement: EPA, Local Control Authority (POTW with "approved" pretreatment program)

Requirement: A discharger must file a report that characterizes the proposed discharge in terms of flows and concentrations of pollutants. The report discloses the operator of the facility, information on the water supply, manufacturing processes, production quantities, wastewater discharge streams, monitoring techniques, pollution prevention procedures and compliance schedules. Requires certification by management individual.

Applicability: Applicable to all "Categorical" Industrial Dischargers.

Timing: Baseline Monitoring Report (BMR) must be filed a minimum of 90 days in advance of the discharge.

Fee: None

- ***90-day Compliance Report -***

  Regulation: 40 CFR 403.12 (d)

  Enforcement: EPA, Local Control Authority (POTW with "approved" pretreatment program)

  Requirement: The discharger must file a report that assesses the extent of compliance with the applicable effluent discharge standards established. The report includes average and maximum flow measurements during discharge and laboratory analysis characterization of the wastewater effluent discharged to the sewer.

  Applicability: Applicable to all "Categorical" Industrial Dischargers.

  Timing: Report must be filed within 90 days of commencement of discharge.

  Fee: None

- ***Periodic Reports of Continuing Compliance -***

  Regulation: 40 CFR 403.12 (e)

  Enforcement: EPA, Local Control Authority (POTW with "approved" pretreatment program)

Requirement: The discharger must submit a report with effluent analytical data detailing permit compliance every six months, unless other schedules are required by the regulatory agency.

Applicability: Applicable to all "Categorical" Industrial Dischargers.

Timing: Report must be filed in the months of June and December, unless otherwise stipulated.

Fee: None

- ***Sewer Connection Permit -***

  Required in Massachusetts for Industrial Users and sanitary discharges of greater than 15,000 gallons per day. The Massachusetts Department of Environmental Protection (MA DEP) delegated the execution of the Industrial User portion of this program to the Massachusetts Water Resources Authority (MWRA) within their sewerage service area under the terms of a Memorandum of Understanding (MOU). Thus, this permit is not required in the MWRA Sewer Service Area for industrial dischargers but may be required to make a physical connection to the sewer.

  Regulation: 314 CMR 7.00

  Enforcement: MA DEP; Receiving POTW

  Requirement: A permit is required for any activity resulting in any discharge of industrial pollutants to a POTW or discharges of new sanitary flows greater than 15,000 gallons per day.

  Applicability: Outside the MWRA Sewer Service Area, if facility has any industrial related discharges to the sewer, then an application must be filed with the MA DEP. The confirmation of adequate capacity of the sanitary sewer system to convey, and the POTW to treat, the discharged sewage is determined during the review of this permit application. Discharge limitations for flow and wastewater constituents are assigned at the issuance of this permit (BWP IW 10, BWP IW 12 or BWP IW 33 for Industrial Wastewater, BRP WP 18 for sanitary sewage greater than 15,000 gpd).

  Timing: Timing is in parallel with Pretreatment System Plans Approval

  Fee: Included in Pretreatment Facility Plans Approval,

  BWP IW 33 (no pretreatment facilities) $600.

- ***Wastewater Pretreatment Facility Plans Approval -***

  Required for any type of industrial pretreatment facility, Type I or Type II. The MA DEP delegated the execution of this program to the MWRA within their sewerage service area under the terms of the MOU. The MWRA does not require Plans Approval within its Sewer Service Area.

Regulation: 314 CMR 12.00 and 257 CMR 2.00

Enforcement: MA DEP; Receiving POTW

Requirement: Submit an Engineering Report and IWWT Plans and Specifications to the MA DEP Regional Office, Industrial Wastewater Program.

Applicability: Outside the MWRA Sewer Service Area, facilities proposing wastewater pretreatment systems are required to obtain approval of an Engineering Report and industrial wastewater treatment system Plans and Specifications. The Engineering Report must describe the general operation of the facility, provide a facility water balance, discuss the principal wet processes, water quality requirements, water conservation measures, wastewater characteristics and effluent limitations. It must also provide a discussion of suitable pretreatment alternatives, a description of the selected wastewater treatment alternative, and an analysis of the impacts of the discharge on the receiving sewer system and POTW.

The plans and specifications are to provide information on the collection and pretreatment equipment, including: material specifications, sizes, design bases, scaled layouts, profiles and sections and instrumentation and alarms. The Engineering Report and Plans and Specifications are to bear the seal and signature of a Massachusetts Registered Professional Engineer.

Timing: Applications will be processed by the MA DEP as follows: administrative completeness review - 30 days; technical review - up to 240 days; public notice - 30 days; public comment review - up to 90 days. Total time line - up to 390 days (if no technical deficiencies are identified during the initial technical review period and no significant public comment is received, the total time line could be reduced to 210 days, total.)

Fee: $1,200 for a Type I facility (BWP IW 12); $1,500 for a Type II facility (BWP IW 10).

- ***Special Waste Piping Plans Approval -***

  Local Plumbing Inspector approval is required for all special waste piping systems installed in Mass.

  Regulation: 248 CMR 2.13

  Enforcement: Local Plumbing Inspector.

  Requirement: File a petition with the Local Inspector of Plumbing for approval of the "special waste" piping systems to be used to convey and pretreat industrial wastewater discharges to the sanitary sewer system. The owner must provide a notarized letter stating the chemicals to be discharged to the system that will form the basis for the engineer’s design for both the conveyance and IWWT systems.

  Applicability: Design documents and specifications for the "special waste" system(s) that are to be installed must be reviewed and approved by the Town's Plumbing Inspector before installation. Establishing the adequacy of proposed pretreatment to conform to applicable discharge standards may occur during preparation of this submittal. Submitted design documents must bear the seal and signature of a Massachusetts Registered Professional Engineer (PE).

Timing: Application must be submitted and approved before installation of any components of the "special waste" system.

Fee: None

- ***MWRA Sewer Use Discharge Permit -***

  Required for all Industrial Users and for any "categorical" industry no matter whether or not it discharges to the sewer within the MWRA Sewer Service Area.

  Regulation: 360 CMR 10.000 (360 CMR 10.007(1))

  Enforcement: EPA, MA DEP, MWRA Sewerage Division, Toxic Reduction and Control Department.

  Requirement: File an application with MWRA for a Sewer Use Discharge Permit.

  Applicability: Industrial wastewater dischargers are required to file an application with the MWRA describing proposed operations and discharge activities.

  Timing: Application must be filed a minimum of 90 days in advance of the discharge.

  Fee: Dependent upon assigned MWRA Category per 360 CMR 10.104. Payable before permit is issued, not with application.

- ***Industrial User Discharge Permit, non-MWRA -***

  Required for all Significant Industrial Users (SIUs); may be required for any industrial user.

  Regulation: Local Pretreatment Regulations, 40 CFR 403, Local Sewer Use Ordinance

  Enforcement: Local Control Authority (EPA or EPA approved Pretreatment Program, MA DEP, POTW).

  Requirement: File an application with the Local Control Authority for an Industrial User Discharge Permit (IUDP).

  Applicability: Industrial wastewater dischargers may be required to file an application with the Local Control Authority describing proposed operations and discharge activities.

  Timing: Application typically must be filed a minimum of 90 days in advance of the discharge.

  Fee: Varies.

- ***MWRA Sewer Use Discharge Permit Modifications, 360 CMR 10.055 -***

  Required for any action that substantially changes the volume or nature of discharge. Notification must be provided to the MWRA a minimum of 30 days before the substantial change. Any change to pretreatment facilities requires MWRA notification, and process changes that affect the volume or nature of discharge require notification. MWRA will use notification information to decide the need for any Sewer Use Discharge Permit modifications.

- ***Wastewater Pretreatment Works Grading and Certified Operators -***

  All wastewater pretreatment works in the Commonwealth of Massachusetts must be classified and staffed with the appropriate number and grade of certified operators. Many other states have similar requirements.

  Regulation: 314 CMR 12.00, 257 CMR 2.00, 360 CMR 10.006 (4)

  Enforcement: MA DEP; MWRA

  Requirement: Facilities where industrial wastewater pretreatment facilities will be installed are required to employ personnel who have been certified by the MA Board of Certification of Operators of Wastewater Treatment Facilities to operate them. In addition, these regulations impose minimum requirements for the number and Grade of operators to be employed (staffing), the type of records to be maintained and reports to be filed.

  Applicability: An industry with pretreatment works will be required to file an application with the MA DEP, Millbury office describing the proposed IWWT process in application for a Facility Grade Assignment (FGA). Depending upon the grade assigned (1 to 4), licensed operators of an equivalent grade must be on-site at the commencement of discharge activity. A staffing plan (314 CMR 12.04 (3)) must also have been filed with the Board of Certification of Operators before this time. An Operations and Maintenance (O&M) manual (314 CMR 12.04 (1)) and as-built engineering drawings (314 CMR 12.03 (11)) for the IWWT do not have to be submitted to the Department but must be available on-site upon the commencement of the discharge.

  Timing: Applications are typically reviewed by the Board on the last Thursday of each month. Depending upon the number of applications received, submitting is advisable at least 60 days before the discharge to help ensure the Board has had sufficient time to act on the request.

  Fee: None

- ***Permit to Install a Non-Hazardous Industrial Wastewater Holding Tank -***

  Required in Massachusetts for the discharge of an industrial wastewater to a tank for "bulking out" purposes.

  Regulation: MA DEP Policy, Authority to regulate by Statute

  Enforcement: MA DEP

Requirement: Permit for a tight tank (BWP IW 29) is required for discharge of industrial wastewater to a tank before off-site disposal.

Applicability: The alternative of discharging industrial wastewater that is not a hazardous waste to a tight tank for off-site hauling (bulking out) instead of sewer discharge requires the application for and issuance of a DEP permit, BWP IW 29. It is the general policy of the MA DEP not to consider applications for this method of disposal if sewer access is available. The MA DEP may make a policy exception if the facility cannot achieve sewer discharge limits.

Timing: Up to 210 days.

Fee: $ 350.

- ***MA DEP Public Water Supply Cross Connection Permit -***

Connections to potable water system must be protected by approved and permitted backflow devices.

Regulation: 310 CMR 22.22

Enforcement: MA DEP Regional Office, Division of Water Supply. The local public water supply owner may be an approved authority for the administration of the MA DEP Cross Connection Program.

Requirement: No person shall maintain upon premises that they own or occupy a cross connection between the distribution system of a public water supply, the water of which is being used for drinking, domestic, or culinary purposes, and the distribution system of any unapproved water source, unless the installation has been reviewed and approved by the MA DEP and permits have been issued.

An annual plan approval and test are required for each backflow prevention device. Application for the plan approval must be made on the MA DEP application form on or before January 1 of each year and must be accompanied by the appropriate fee and the annual owner Inspection and Maintenance Report Form.

Applicability: Back-flow protection may be required at the point of public water supply connection to a facility. In addition, such hazards as sinks with hose threads or inlets or reservoirs for cooling tower or other recirculating systems may require back-flow protection. The locations shall be determined by the existing or potentially existing health hazards. Simple installations, such as internal hazards, may be proposed by a licensed plumber. Only approved devices (manufacturer and model number) may be used and the selection of a particular device must be based on the specific application. Design documents (plans and specifications) for more complex installations (such as those for fire protection and dual distribution systems (potable and process waters)) must bear the seal and signature of a Registered Professional Engineer.

Timing: Applications (Form BRP WS 09) will be processed by the Public Water Supply/MA DEP as follows: administrative completeness review - 30 days; technical review - 60 days. Total time line - 90 days. (Providing no technical deficiencies are identified during the technical review. If so, the time line could be extended by up to 60 additional days).

Fee: $50 per device

- ***Air Pollution Source Emissions, Plan Approvals -***

  Sources of Air Pollution from wastewater pretreatment facilities may require operating permits or control plan approvals.

  Regulation: 310 CMR 7.00

  Enforcement: MA DEP

  Requirement: Varies according to air pollutants emitted, total potential to be emitted and other factors.

  Applicability: All sources of air pollution above *de minimis.*

  Timing: Varies

  Fee: Varies

- ***Hazardous Waste Generation Notification and EPA Identification Number -***

  Wastewater pretreatment "hazardous" residuals must be handled in accordance with regulations.

  Regulation: 310 CMR 30.000

  Enforcement: MA DEP

  Requirement: Handling and disposal of hazardous waste must comply with all aspects of the hazardous waste regulations provided as 310 CMR 30.000. Hazardous waste disposed of off-site must be manifested using the generator's hazardous waste generator number.

  Applicability: Applicable to all wastes categorized as hazardous by characteristic or by listing.

  Timing: Can begin immediately.

  Fee: None

- ***Other Permits, Local Building Department Permits, Approvals, Inspections -***

  Besides the permit categories listed above, other permits may apply as well. Such specialized permits a Radiation Discharge Permits or Licenses may be required for institutions that use low level radioactive materials. There are also other federal and state requirements that may apply, including the federal "Right-to-Know" regulations and the Massachusetts Toxics Use Reduction Act.

Local construction permits and inspection services, including building permits, plumbing permits, electrical permits, and street opening permits, may also be required.

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APPENDIX B

SAMPLE PAYBACK PERIOD ANALYSIS
APPENDIX B - SAMPLE PAYBACK PERIOD ANALYSIS

OPPORTUNITY: PHOTOGRAPHIC CHEMICAL USE

OPTION: FIXER RECIRCULATION

COST DESCRIPTION	SPECIFIC ITEM	COST ($)	COMMENTS
• **Capital and One- Time Costs of Option Implementation**			
1. Equipment	Recirculating silver recovery unit	3320.00	Current List Price
2. Installation	Performed by distributor	200.00	Quoted price
3. Other	120VCircuit	100.00	Estimated cost
• Sum of Capital and One-time Costs = **3,620.00**			
• **Net Change in Annual Operating Costs (-) and Revenues (+)**			
. Materials/Reagents	Fixer usage	+2423.25	$7.00/gal, 277 dpy, 2.5 gpd less 50%
	Special fixer additive	-375.00	1 qt / 10 gal of fixer
2. Treatment/Disposal	Credit for recovered silver	+159.50	15 % increased silver recovery at $3.40/troy oz.
3. Labor	Mechanical maintenance	-60.00	Assume 15 minutes/mo @ $20/hour
4. Utilities	Electricity	0.00	Assumed negligible
5. Regulatory		0.00	No impact
• Sum of Annual Operating Cost Changes = **2,147.75** (Total Yearly Savings)			
PAYBACK PERIOD ANALYSIS	**CALCULATION**	**PAYBACK PERIOD (YEARS)**	**COMMENTS**
Total Capital & One-time Costs / Total Yearly Savings	3,620.00 / 2,147.75	**1.69**	Reduced fixer is largest factor

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