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Final Report

Laboratory Waste Management Guide

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Technical Assistance and Pollution Prevention Team

This report was prepared by the Local Hazardous Waste Management Program in King County, Washington. The program seeks to reduce hazardous waste from households and small quantity generator businesses in King County by providing information and technical assistance to protect human health and the environment.

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INTRODUCTION

The first edition of this management guide, published in 1994, was prepared by representatives from several groups: the King County Water and Land Resources Division, the Local Hazardous Waste Management Program in King County, the Northwest Laboratory Coalition, and the Washington Biotechnology Association. Baz Stevens from King County's Industrial Waste Section (formerly the Municipality of Metropolitan Seattle) was one of the original authors.

The management guide is part of a comprehensive program to reduce the amount of hazardous waste generated by businesses and the metals and chemical contaminants improperly disposed into waters and landfills. This is the fourth edition of the management guide.

This edition addresses a broader range of issues and waste streams than was covered in the original document. The practices recommended in these guidelines will help analytical, medical, teaching, and biotechnology labs properly manage hazardous materials and reduce hazardous waste.

The guidelines also help businesses and agencies in King County decide whether their waste may be acceptable for discharge to the sewer. For more help, see the contacts listed in the *For More Information* section of this report. Though the specific focus is King County, many of the recommendations are applicable to labs anywhere in the United States.

These guidelines do not provide authorization under Permit by Rule (WAC 173-303-802) to allow discharge of hazardous chemicals to the sewer. They serve, in part, as a guideline to assist businesses and agencies in King County in determining whether their waste may be acceptable for discharge to the sewer.

FACILITY MANAGEMENT

Drain Protection

Solutions discharged into the sewer system flow to wastewater treatment facilities that have limited capacity to remove chemical contaminants. Most areas in King County discharge to facilities that are maintained and operated by King County Department of Natural Resources and Parks. Rain and other runoff into storm drains usually flow directly to creeks and waterways that drain to Puget Sound with no treatment. It is important to protect both storm drains and the sewer system from chemicals and other pollutants. In a sense, all the best management practices in this handbook are intended to provide "drain protection"--or water quality protection.

To protect your drains:

- Do not hold or store chemicals in sinks. Use tubs, containers or storage lockers instead.
- Post laminated signs by sinks listing wastes that cannot be poured down the drain from nearby lab processes.
- Provide spill and leak protection around all sinks, especially cup sinks on countertops and under hoods where hazardous materials are used or stored.
- Provide secondary containment trays or tubs for reagents being temporarily stored in fume hoods with cup sink drains.
- Block floor drains in areas where chemicals are used or stored.
- Keep enough material on hand to prevent and clean up spills. These supplies may include absorbents, drain plugs, acid and base neutralizers, goggles, gloves, respirators with chemical specific cartridges, and waste collection containers. Make sure clean-up materials and copies of the emergency response plan and emergency phone numbers are readily available.
- Provide secondary containment for carboys and bottles on floors holding analytical reagents and wastes from analytical instruments.
- Periodically flush cup sink drains with water to keep sewer gases from passing through a dry p-trap.

Safety Showers

Prevent spilled chemicals from reaching safety shower drains. Possible methods include:

- Eliminate the drain.
- Cover or plug the drain when not in use to prevent accidental discharge.

- Install a temporary plug that opens automatically when the safety shower is turned on (this can be done by linking the lever action that activates the shower to one that lifts the plug.)

- See the *Spill Management* section for information on preventing spilled chemicals from spreading.

Should contaminants washed off a person during emergency use of a safety shower be allowed in a drain? When hazardous chemicals are spilled on a worker, the first priority is to flush the contaminants off the person. If steps can be taken to limit the amount of hazardous chemicals entering the floor drain without interfering with speedy emergency response, do so.

If not, as soon as possible notify the local sewer agency that there has been a release. Post the local sewer agency's phone number near the safety shower and in your spill response guide. Check in the blue pages of your phone book for this phone number and look for the words "Sewer" or "Wastewater" under the name of your city or county.

Chemical Storage

Laboratories generally use a variety of toxic, corrosive, reactive and flammable materials. If these are stored close together in fragile containers, there is a risk of breakage and spills that release materials to the environment. Proper storage of chemicals requires the use of prudent handling and storing practices and a well-constructed lab facility.

Components of a Safe and Effective Chemical Storage Area

- Maintain an inventory of chemicals stored in each lab.

- Anchor hazardous material storage cabinets to walls.

- Close and latch doors on storage cabinets.

- Provide separate corrosion-free cabinets for flammable liquids, concentrated inorganic acids and caustic liquid bases.

- Keep a Class ABC fire extinguisher near locations where chemicals are stored or used and train employees in its operation.

- Provide secondary containment for chemicals stored on counters and near drains.

Storing and Handling Chemicals

- Store incompatible materials separately. Several concentrated organic acids are combustible and are more safely stored with flammable liquids than with sulfuric acid and nitric acid that are powerful oxidizers. Refer to the *Incompatible Chemicals* section below for further information on safer chemical storage.

- Reduce the risk of bottle breakage. Whenever possible, order concentrated acids and flammable solvents in plastic-coated bottles. Small containers are more durable and less likely to break than large ones. Use rubber or plastic bottle carriers or bottle jackets when transporting glass containers.

- Keep containers closed when not in use so contents cannot evaporate or escape a tipped container.
- Return chemicals to their proper place after use or at least before leaving the work station at the end of the day.
- Properly label containers with the name of the compound and its primary hazards. Chemical symbols alone are insufficient identification.
- Regularly check expiration dates on chemicals. Dispose of them or use them promptly and properly.
- Write the date received on each chemical container that arrives and the date opened on all containers of peroxidizable solvents.
- Avoid storing chemicals in fume hoods. They interfere with the air flow, clutter work space and could potentially spill into cup sink drains.
- Avoid storing chemicals on bench tops.
- Properly store or dispose of all hazardous materials before leaving the workstation.
- Avoid storing chemicals under sinks.
- Do not store flammable liquids in domestic refrigerators or freezers. Use only “lab-safe” equipment with external thermostats, manual defrosting, etc.

Systematic Storage of Lab Chemicals

We suggest following the storage and handling guidelines found in *Prudent Practices in the Laboratory* by the National Research Council's Committee on Hazardous Substances in the Laboratory (National Academy Press, Washington, DC, 1995).

Many universities publish diagrams of their chemical storage system on their Web sites. These are often based on the storage system published in the National Research Council's *Prudent Practices in the Laboratory*. Two chemical supply companies, J.T. Baker and Flinn Scientific Inc., also have popular systems for chemical storage that incorporate the concept of “related and compatible storage groups” found in *Prudent Practices.*

These systems are based on a series of codes for functional classes of chemicals. Organic and inorganic chemicals are separated, with sub-groups further separated. The “related and functional storage groups listed in *Prudent Practices*” and the shelf storage codes often assigned to these groups are listed below. (“I” refers to inorganic compounds and “O” refers to organic compounds.)

I-1 Metals, hydrides

I-2 Halides, sulfates, sulfites, thiosulfates, phosphates, halogens

I-3 Amides, nitrates (except ammonium nitrate), nitrites, azides

I-4 Hydroxides, oxides, silicates, carbonates, carbon

I-5 Sulfides, selenides, phosphides, carbides, nitrides

I-6 Chlorates, perchlorates, chlorites, hypochlorites, peroxides

I-7 Arsenates, cyanides, cyanates

I-8 Borates, chromates, manganates, permanganates

I-9 Inorganic acids

I-10 Sulfur, phosphorus, arsenic, phosphorus pentoxide

O-1 Organic acids anhydrides, peracids

O-2 Alcohols, glycols, amines, amides, imines, imides

O-3 Hydrocarbons, esters, aldehydes

O-4 Amines, imines, pyridine

O-5 Ethers, ketones, ketenes, halogenated hydrocarbons, ethylene oxide

O-6 Epoxy compounds, isocyanates

O-7 Organic peroxides, hydroperoxides, azides

O-8 Sulfides, polysulfides, sulfoxides, nitriles

O-9 Phenols, cresols

Flammable liquids must be stored in flammable storage cabinets or fire safety cans. Alphabetical storage is discouraged except within compatible groups.

Most guidelines have adapted this list to create a systematic shelf storage system. Unfortunately, this system is confusing to implement. For example, many of the listed chemicals are hazardous liquids that should be stored in specialized cabinets rather than on shelves. The system is also difficult to implement for secondary schools and other labs with limited storage space: most stockrooms are too small to accommodate a system that has 19 separated shelves (plus storage cabinets.)

For labs with restricted storage spaces, compatible storage can be provided by grouping chemicals with similar hazards together. These labs could use a simplified system like the one illustrated in Table 1.

Table 1 –Shelf Storage Pattern for Small Stockrooms

Inorganic Shelves	Organic Shelves
I-1 & I-10 – Sulfur, phosphorus, arsenic, metals, hydrides (store all away from water!)	O-1 – Dry and dilute organic acids, anhydrides, peracids
I-2 – Halides, sulfates, sulfites, thiosulfates, phosphates, halogens	O-5 & O-7 – Organic peroxides, azides
I-5 & I-7 – Sulfides, selenides, phosphides, carbides, nitrides, arsenates, cyanides	O-6 & O-8 – Epoxy compounds, isocyanates, sulfides, sulfoxides, nitriles
I-4 – Dry hydroxides, oxides, silicates, carbonates	O-9 – Miscellaneous organics: Powdered and alcohol-free stains and indicators.
I-3, I-6 & I-8 – Nitrates, nitrites, borates, chromates, manganates, permanganates, chlorates, chlorites, inorganic peroxides	
	Flammable Storage Cabinet – Hydrocarbons, ethers, ketones, amines, halogenated hydrocarbons, aldehydes, alcohols, glycols, phenol, cresol, combustible organic acids, combustible anhydrides
Corrosive Acid Storage Cabinet – Inorganic acids. Nitric acid stored separately in this or another cabinet	Corrosive Base Storage Cabinet or Cupboard – Concentrated inorganic hydroxides
***Notes**: Keep water reactive metals away from aqueous solutions and alcohols. Use secondary containers to separate yellow and white phosphorus, which are stored under water, from water-reactive metals.*	

Preparing Your Laboratory for Earthquakes

- Lips on shelves provide some restraint for bottles in an earthquake, but are inadequate when there is violent shaking. Having doors on chemical storage cupboards is recommended. Unsecured cupboard doors can open during earthquakes. They should be fitted with locking latches.

- Shelf lips should be between one and two inches in height. Excessively high lips can make it difficult to remove bottles, increasing the risk of losing one's grip on them. Lips that are too low do little to restrain bottles from falling off shelves.

- Some shelf anchors can fail. They should be designed to restrain full, rather than empty, shelves. Additionally, many shelf clips become corroded over time due to exposure to acid vapors. Inspect shelf anchors annually. Those with more than a patina of rust should be promptly replaced.

- Anchor large laboratory equipment and shelves to walls. Incubators, biosafety cabinets, corrosive and flammable storage cabinets, freezers and refrigerators, and storage shelves can fall over or collapse. In addition, these items also have "movement" potential, and can prevent emergency access to, and egress from, occupied spaces.

- On a side note: here's a recommendation from the Stanford School of Medicine's website: *"**A word about biological cultures**: Any earthquake that requires the evacuation of a building can put valuable research material at risk. Very little is more frustrating than to* *come back to a building (perhaps after several days or a week) to find the infrastructure sound, equipment in good shape, but cultures non-viable. Loss of culture material can set back both research and careers if steps are not taken to back up material whenever possible. If lyophilization (and storage off site) is not possible, try to work out a "deal" with out-of-state colleagues to store duplicates of each other's cultures (fires and other Acts-of-God do not respect geographical boundaries)."*

- Small anchoring devices are available, from "thumb-locking" clips to industrial strength Velcro-like strips to assist with anchoring computer printers and other equipment.
- Secure distillation apparatus and other elaborate glassware with straps and install refrigerator door clasps.
- Following an earthquake, use caution when entering rooms with closed doors and when opening cabinets and cupboards. Containers may have broken, and toxic, flammable or corrosive vapors may be in the cabinet, cupboard or room. The first assessment of damage to rooms containing chemicals should be done by personnel trained in emergency response and wearing appropriate personal protective equipment.

Planning for Renovation and New Construction

- Avoid putting chemical storage shelves or cabinets over sinks. Accidental spills or breakage could release chemicals to the sewer.
- If you install a house vacuum system, use dry-seal or non-contact water pumps. Pumps that use contact water may discharge chemicals to the sewer.
- If a safety shower discharges to a laboratory floor drain, construct the drain in an appropriately-sized sump with a standpipe to prevent spilled chemicals from going down the drain while allowing water from the shower to drain. Check with your local building code to determine whether such sumps must be double-contained.
- If available, select a sink that has a lip to provide spill protection.
- Contact the local plumbing inspector early in the process to clearly communicate to them where acidic wastes could accidentally enter drains and where they could not. This could save time and costs from having to stop the process to replace cast-iron piping with acid-resistant piping.
- Passive acid-treatment tanks are often recommended by architects in classrooms and laboratory spaces. For most situations, these systems are very difficult to manage and maintain. Sulfuric acid creates a "slime" layer in contact with limestone that requires physical agitation or high pressure rinsing to remove. Once the slime layer is in place, the limestone chips no longer neutralize acidic wastewaters. This could damage downstream side-sewer lines and lead to very expensive pavement-cutting and sewer repair projects.

Water Conservation

Structural measures, such as those listed below, can significantly reduce water use. In addition, well-trained lab workers can use their ingenuity to save water on the job.

- Install water-saving devices (such as flow restrictors) on sinks and rinse tanks.
- Reduce rinse times if possible (without affecting product quality).
- Recycle water – for example, to air scrubbers and cooling towers.
- Eliminate one-pass or continuous flow cooling systems. Consider installing heat exchangers or re-circulating cooling water systems to conserve waste cooling water.
- Overhaul faulty steam traps on steam sterilizers.
- Reverse osmosis (RO) water is commonly used in lab experiments, but the RO process is very wasteful with as much as 90 percent of the water discharged as wastewater. Some universities have recirculated this water back through the RO system or used the discarded water as non-potable water in other areas. Possible uses include flushing toilets, watering landscape plants or as cooling water for autoclaves.

Training

All laboratory staff should understand the importance of using Best Management Practices for waste reduction and environmental protection. Training for new employees and refresher training for all staff are important.

- Keep your lab's Spill Response Plan updated and available to employees.
- Post emergency numbers.
- Train lab workers in the components of the Chemical Hygiene Plan covering proper chemical handling, storage and disposal.
- Emphasize a commitment to waste prevention and proper chemical management.
- Encourage employees to develop waste prevention and waste stream efficiency ideas and then to implement them.
- Provide regular training in water conservation.

Under Chapter 296-824 WAC, any business using hazardous chemicals must develop an emergency plan that anticipates and develops responses to emergencies. The plan must be written and must address pre-emergency planning and coordination with all potential responders. The plan must also define personnel roles and ensure that employees working with hazardous chemicals receive the minimum mandatory training required for awareness of chemical hazards and/or responding to spills. See WAC 296-824-30005 for more information about these requirements. They are enforced by the Washington Department of Labor and Industries.

The Laws and Agency Rules section of the Washington Legislature's Web site at http://www.leg.wa.gov/WAC/index.cfm?section=296-824-100&fuseaction=section links to a flow chart that helps define when training is mandated under Chapter 296-824 WAC.

CHEMICAL SPILL MANAGEMENT

Spill management plans are very dependent on the size and complexity of the facility and the diversity and comparative hazards of the chemicals being used in the lab. Excellent examples of spill management plans are available from many university's environmental health and safety program websites. A few key components should be part of every laboratory's spill response procedures:

- Differentiate between major and minor chemical spills.
- Major spills require immediate emergency response assistance. They are typically identified as difficult to contain, likely to harm personnel or posing an immediate and serious fire risk.
- Prepare for major spills by working with your local emergency responders to develop a notification and evacuation plan. At some facilities, initial response to major spills may be by the facility's trained emergency response team. For many other labs, these spills are beyond the capacity of their staff.
- Minor spills typically will be cleaned up by laboratory staff or facility-based emergency response teams.
- Only clean up minor spills when you know the chemical's name and hazards and have protective equipment and spill kits that can handle it. This points out the importance of proper labeling and spill response training.
- Spill response training should be carefully designed to distinguish between major and minor spills and between similar chemicals with different hazards. Many lab staff can easily clean up a spill of 500 milliliters of 25 percent sodium hydroxide solution. Few lab staff can safely clean up a similar spill of ammonium hydroxide. Both are corrosive bases, but ammonium hydroxide's intensely irritating vapors pose a unique hazard.
- Small labs, such as a high school science lab, should have simple, easy-to-use spill kits. The kit should contain citric acid for spills of liquid bases, sodium carbonate for acids, and granular absorbent for organic solvents. Sand is sometimes applied to increase traction in spills of slippery compounds like sulfuric acid and sodium hydroxide.
- Contact your local sewer agency to learn when they should be notified of a spill entering the sanitary sewer.

MANAGING HAZARDOUS CHEMICALS ON SITE

Incompatible Chemicals

When they come in contact with each other, incompatible chemicals could react by releasing toxic or flammable gases, exploding or spontaneously igniting. Segregate and store chemicals by hazard class to minimize the risk of reactions between incompatible chemicals and label storage cabinets and cupboards with the hazard class of the stored materials. Material safety data sheets (MSDSs) should be available for all chemicals on site. Review them for information about incompatibilities. The following is a partial list of common incompatible chemicals that can react with each other.

Acids and Bases

Store strong acids and bases separately in enclosures made of corrosion-resistant materials.

Oxidizing Chemicals

Oxidizers are materials that yield oxygen readily to stimulate the combustion of organic matter. When oxidizers come in contact with flammable solvents, they can start or fuel fires.

Typical oxidizing agents found in laboratories include chromates and dichromates, halogens and halogenating agents, peroxides and organic peroxides, nitric acid and nitrates, chlorates and perchlorates, and permanganates and persulfates.

- Store oxidizers away from alkalis, azides, nitrites, organic compounds (including acetic acid), powdered metals and activated carbon.
- Avoid contact between oxidizers and common combustible materials such as paper, cloth and wood.

Water-Reactive Compounds

Water-reactive compounds include alkali earth metals such as lithium, potassium and sodium, sodium borohydride, calcium carbide and sodium peroxide. Solutions containing water, such as inorganic acids and alcohols, should be kept separated from these chemicals during storage and use.

- Store water-reactive compounds away from aqueous solutions, inorganic acids, base solutions and alcohols. Though many chemical storage systems recommend water-reactive solids be stored in the flammable storage cabinets, in many cases this would not be prudent since these cabinets often contain alcohols with 30 percent water.
- Keep a Class D fire extinguisher near storage and use areas for these compounds.
- Store these compounds in locations protected from automated sprinklers.

- Alkali metals should be stored in areas where they are free of moisture, contact with oxygen, and, in the case of lithium, nitrogen gas.
- Only the amount of water-reactive materials necessary to perform the work should be removed from storage. Spare materials should be returned to the appropriate storage container, and the container to its appropriate location.
- Storage containers should be labeled with their contents, hazardous properties and type of oil or gas used to inert the metal. Furthermore, these containers should be stored individually or in a manner that allows visual inspection for container integrity.
- Storage areas should be free of combustibles and of ignition sources.
- The portions of the building dedicated as storage area for alkali metals should not be equipped with automatic sprinklers. No other source of water (e.g., showers, sinks) should be in the immediate proximity of the metal.
- Storage areas should be prominently labeled to indicate the presence of alkali metals.

We suggest following the storage and handling guidelines found in *Prudent Practices in the Laboratory* by the National Research Council's Committee on Hazardous Substances in the Laboratory (National Academy Press, Washington, DC, 1995).

Both J.T. Baker and Flinn have established systems for chemical storage.

Potentially Explosive Chemicals

Several classes of chemicals may become explosive when they react with other compounds or may become unstable during storage. Seriously question whether you need these compounds in your facility. These include peroxidizable solvents, potentially explosive dinitro- and trinitro- organic compounds and elemental potassium.

Metal Azides

Inorganic azide compounds, such as sodium azide, can react with metals and their salts to produce explosive metal azide crystals. For example, when azide solutions are poured down drains the dilute solution can react with lead solder and copper pipes to produce explosive lead or copper azide salts.

- If you must use azide solutions, replace metal pipes with PVC or other non-metal piping materials.
- If sodium azide solutions have been discharged to drains having metallic pipes or solder, you should assume your pipes may be contaminated with metal azide salts. Contact the Business Waste Line at 206-296-3976 or Washington Department of Ecology (Ecology) at 425-649-7000 for assistance in determining the proper disposal procedures.

Ethers and Other Peroxide-forming Chemicals

Certain ethers are more susceptible to peroxide formation than others. Peroxides are formed by oxygen that reacts with ethers: R-O-R is ether; R-O-O-R is peroxide. It is the oxygen-to-oxygen bond that makes ether unstable. Generally, the larger the alkyl group (R), the more readily the ether will form peroxides. Ethyl ether and isopropyl ether can react with air to form explosive peroxide crystals. Other solvents such as tetrahydrofuran and dioxane can also produce peroxides.

Peroxides can explode when subjected to heat, friction or shock. Do not disturb or open containers in which peroxides may have formed. A good rule of thumb is to dispose of any container holding a peroxide-forming compound one year after the date it was opened. Label these containers with the words "DATE OPENED" and add the date.

To prevent the formation of peroxides:

- Avoid using peroxide-forming solvents if possible.
- Purchase ether with butylhydroxy toluene (BHT) or ethanol added as an anti-oxidant.
- Label ether containers with the dates they are opened.
- Purchase ether in containers small enough to use all the solvent within six months.
- Check the MSDSs for your solvents to see if any are prone to creating peroxides.

Elemental potassium is a peroxide-former that is commonly used in school laboratories to demonstrate characteristics of period 1 earth metals. Potassium is a water-reactive earth metal that reacts with moisture in air to start the peroxidation process. This process can be observed by physical changes in the color of the potassium sticks. Originally a dull silver color, potassium will oxidize and form white crystals on its surface. As these crystals progressively turn yellow, orange, red and purple, the peroxidation process is advancing and the compound is increasingly at risk of exploding when handled. [Blair, 2000]

Metal Picrates and Picric Acid

Metal picrate compounds and picric acid can become dangerously unstable as a dry powder. Picric acid can dry out and form explosive picrate crystals when exposed to air, especially when contaminated with even minute amounts of metals.

To prevent the formation of explosive picrate crystals:

- Always keep picric acid wet or in solution.
- Avoid contact between picric acid and metals. Metal picrate salts are prone to explode when subjected to friction or shock.
- Never purchase or store picric acid in containers with metal lids.
- Avoid flushing picric acid solutions down drains at concentrations above 0.01 percent.

- Dispose of more concentrated picric acid solutions as dangerous waste.
- Bouin's Fixative contains picric acid and formaldehyde solution (formalin.) Be sure to keep this fixative hydrated with water. Bouin's 2000 is a picric acid and formalin-free alternative available from American Master*Tech Scientific, Inc. 800-860-4073.
- If picric acid solutions have been discharged to drains with metallic pipes or soldered joints, assume the piping is contaminated with explosive metal picrate salts. Contact the Business Waste Line at 206-296-3976 or Ecology at 425-649-7000 for help in finding proper disposal procedures.

Perchloric Acid

Perchloric acid is highly corrosive and typically occurs as a 70 percent solution. When warmed above 150 degrees Fahrenheit, it is a powerful oxidizer. Perchloric acid can form explosive metal perchlorate crystals in combination with heavy metals. Any work with perchloric acid must be done in a specially-designed fume hood with a water wash down system designed to prevent the buildup of metal perchlorates in the duct work. If you have been performing perchloric acid digestions in a fume hood not specifically designed for perchloric acid, contact the Business Waste Line at 206-296-3976 or Ecology at 425-649-7000 immediately for assistance in locating a contractor to evaluate the hood for perchlorate contamination.

- **Spills and other emergencies:** In the event of a perchloric acid spill, neutralize with soda ash (sodium carbonate) or another appropriate neutralizing agent. Soak up the spill with an inorganic based absorbent. Do NOT use rags, paper towels, or sawdust and then put them aside to dry out, as such materials may spontaneously ignite. Likewise, spills on wood may present a fire hazard after the liquid dries.
- If you must use perchloric acid solutions, replace metal pipes with PVC or other non-metal piping materials.
- If perchloric acid solutions have been discharged to drains having metallic pipes or solder, you should assume that your pipes may be contaminated with metal azide salts. Contact the Business Waste Line at 206-296-3976 or Ecology at 425-649-7000 for assistance in determining the proper disposal procedures.
- Regularly inspect your containers of perchloric acid for discoloration. If the acid has turned a dark color and has crystals forming around the bottom of the bottle, there is a potential explosion hazard. Notify an emergency response agency and secure the area. White crystals around the cap are typically an ammonium salt, and small amounts may be washed off the bottle to the sewer using copious amounts of water.

Ammoniacal Silver Staining Solutions

Ammoniacal silver staining solutions are hazardous because they can form explosive silver salts. Whether disposed or deactivated, these wastes are counted against your generator status. See *Appendix C* for information on these and other stains.

Safe use of these staining solutions includes the following procedures:

- Don't allow silver nitrate to remain in ammonium solutions for more than two hours.
- Keep silver nitrate solutions separate from ammonium hydroxide solutions.
- Deactivate these waste solutions by diluting 15:1 with water. Then, while stirring frequently, slowly add 5 percent hydrochloric acid to the solution until the pH reaches 2.
- Add ice if the solution heats up.
- Silver chloride will precipitate out when the pH reaches 2.
- Filter out the precipitate and dispose as hazardous waste, adjust the pH of the solution to 6 to 7 with sodium bicarbonate, then discharge to the sanitary sewer.

HAZARDOUS WASTE REDUCTION AND DISPOSAL

A hazardous waste is a solid, liquid or gas that could pose dangers to human health or the environment. In Washington State, hazardous waste is called dangerous waste and is primarily regulated by the Department of Ecology (Ecology). Several other federal, state and local agencies may regulate a laboratory's hazardous materials and wastes. These include the federal Environmental Protection Agency, the state Department of Labor and Industries, the local fire department, the local air quality authority and the local sewer district.

Not complying with hazardous waste regulations can lead to significant fines and penalties. It is important that laboratory managers take steps to avoid violating regulatory requirements.

- The manager of a laboratory should establish, follow and support a laboratory waste management policy.
- The policy should include written procedures and defined responsibilities.
- Laboratories should have a staff member responsible for coordinating hazardous materials management and ensuring regulatory compliance.

The Occupational Health and Safety Administration (OSHA) requires all laboratories to implement a written Chemical Hygiene Plan. These plans are monitored for compliance with OSHA requirements by the state Department of Labor and Industries. In 29 CFR Part 1910 § 191.1450, Appendix A, OSHA lists the National Research Council's recommendations concerning chemical hygiene in laboratories. Important topics that should be addressed include rules and procedures about:

- Chemical procurement, distribution and storage
- Environmental monitoring
- Housekeeping, maintenance and inspections
- Medical program
- Personal protective apparel and equipment
- Records
- Signs and labels
- Training and information
- Waste disposal

OSHA recommends that a laboratory's Chemical Hygiene Plan include a waste disposal program. The following are specific recommendations (29 CFR 1910 §191.1450):

- Comply with Department of Transportation regulations (CFR 49) when transporting wastes.

- Promptly dispose of unlabeled containers. If partially used, they should not be opened.
- Remove waste from laboratories to a central waste storage area at least once a week and from the central waste storage area at regular intervals.
- Avoid indiscriminate disposal by pouring waste chemicals down the drain or adding them to mixed refuse for landfill burial. This is unacceptable and often illegal.
- Do not use fume hoods to dispose of volatile chemicals.
- Dispose of wastes by recycling, reclamation or chemical deactivation whenever possible.
- Avoid stocking over 2.2 pounds or 1.0 kilograms of “P-listed” chemical products (WAC 173-303-9903.) This could help you stay below large quantity hazardous waste generator status.
- Limit the size of samples you accept and guarantee your ability to return samples to the supplier.

Hazardous waste disposal is a complex issue. Before you attempt to deactivate hazardous wastes for sewer or solid waste disposal, check with the regulating agency to see if the process is acceptable. Written documentation of chemical deactivation activities may be required. Several resources are available to provide guidance in managing your laboratory wastes. The following sections provide guidance on specific waste streams that labs often find challenging to properly manage.

Acetone Used in Glassware Cleaning

Analytical laboratories often use acetone when cleaning glassware. Acetone is ignitable and is a federally-regulated F003 dangerous waste. It may not be rinsed off the glassware and put down the drain. (Flammable liquids are prohibited from sewer disposal.) Instead, collect acetone rinsate and dispose of it as ignitable dangerous waste.

High Pressure Liquid Chromatography Waste

High pressure liquid chromatography (HPLC) analyses are typically done with a mixture of water, acetonitrile and methanol. Both acetonitrile and methanol are flammable solvents. Some methods add 0.1 percent trifluoroacetic acid to the mixture. Acetonitrile concentrations in the resulting liquid waste range from 10 to 40 percent and are prohibited from discharge to the sewer.

There are a number of ways to reduce the volume of solvent waste from HPLC analyses. These include modifying the size of columns used in the process, distilling and reusing acetonitrile, and separating water from the solvent waste. If the water remaining after separation contains <100 milligrams/liter of acetonitrile, it may be discharged to the sewer in King County.

Ethidium Bromide Management

Ethidium bromide (EtBr) is commonly used in molecular biology research and teaching laboratories. While it is not regulated as dangerous waste, the mutagenic properties of this substance may present a hazard when poured down the drain or placed in the trash.

Based on these considerations, the following disposal procedures for ethidium bromide are recommended:

Disposal of Pure Ethidium Bromide

Unused Ethidium Bromide (EtBr) should be collected for disposal with a hazardous waste vendor.

Disposal of Electrophoresis Gels

Trace amounts of EtBr in electrophoresis gels should not pose a hazard. Higher concentrations, e.g., when the color of the gel is dark pink or red, should not be placed in laboratory trash. The disposal recommendations for gels are:

- Less than 0.1% EtBr: dispose as solid waste with approval from Public Health – Seattle & King County
- More than or equal to 0.1% EtBr: place in sealed bags and label for disposal as hazardous waste.

Disposal of Contaminated Gloves, Equipment and Debris

Gloves, test tubes, paper towels, etc., that are contaminated with more than trace amounts of EtBr should be placed in sealed bags and labeled for hazardous waste disposal.

Disposal of Ethidium Bromide Solutions

Aqueous solutions with <10µg/ml (<10 ppm) EtBr can be discharged to the sewer.

Aqueous solutions containing >10µg/ml (>10 ppm) EtBr: Chemically treat using the decontamination procedures listed below and dispose to the sewer or collect for disposal as dangerous waste. All aqueous solutions released to the sewer must meet local sewer discharge requirements for metals, pH, etc.

Solvent solutions containing any amount of EtBr; or EtBr mixed with a radioactive isotope are restricted from discharge to the sewer and should be disposed as ignitable dangerous waste.

Treatment of Ethidium Bromide Waste

Ethidium bromide waste solutions can be treated to increase their concentration before disposal, thereby reducing disposal costs, or deactivated to eliminate their hazardous characteristics before discharge to the sewer. Most universities recommend filtration over deactivation as the safer method.

Filtering aqueous EtBr waste solutions through activated charcoal is simple and effective. The filtrate may be poured down the drain. Commercially available filtration systems include FluorAway™, the S&S Extractor™ and The Green Bag® Kit.

- Filter the EtBr solution through charcoal filter.
- Pour filtrate down the drain.
- Place charcoal filter in a sealed bag (e.g., zip-lock) and collect for disposal as hazardous waste.

A safety note: if using house vacuum to speed filtration, do not use a standard Erlenmeyer or side-arm filtering flask. A filtration flask capable of withstanding vacuum must be used to prevent implosion.

Deactivating EtBr Solutions

All EtBr solutions that are deactivated should be neutralized and poured down the drain with copious amounts of water. Deactivation may be confirmed using ultraviolet (UV) light to detect fluorescence. There are two recognized methods for deactivation, the Lunn and Sansone Method [Lunn and Sansone, 1994, p. 185] using hypophosphorus acid and sodium nitrate, and the Armour Method that uses household bleach. [Armour, 1996, p. 214] Though the Armour Method is the simplest, it is somewhat controversial since found traces of mutagenic reaction mixtures using this method. [Lunn and Sansone, *Analytical Biochemistry,* 1987, vol. 162, p. 453]

Decontamination of Ethidium Bromide Spills

EtBr spills can be decontaminated with a solution of 20 ml of hypophosphorus acid (50%) added to a solution of 4.2 g of sodium nitrate in 300 ml water. Prepare fresh solution the day of use in a fume hood. Wear rubber gloves, lab coat, and safety glasses. Turn off electrical equipment before decontamination.

- Soak paper towel in decontamination solution, place on contaminated surface, and scrub.
- Scrub five more times with paper towels soaked in water, using fresh towel each time.
- Place all towels in a container and soak in fresh decontamination solution for one hour.
- Test squeezings from final towel scrub and mixture for fluorescence; repeat procedure with fresh decontamination solution if fluorescence is present.
- Neutralize with sodium bicarbonate and discard as nonhazardous aqueous waste.
- This procedure has been validated for EtBr-contaminated stainless steel, Formica, glass, vinyl floor tile surfaces, and filters of transilluminators.

Alternatives to Ethidium Bromide

Ethidium bromide (EtBr) is a dangerous compound due to its mutagenicity. SYBR Safe™ is a potentially safer alternative. Data on mutagenicity and EcoToxicity show SYBR Safe™ is much less mutagenic than EtBr and is acceptable for discharge to the sanitary sewer.

Several major institutions have switched from EtBr to SYBR Safe™ with good results in DNA analysis. However, SYBR Safe™ is less effective than the traditional EtBr staining for RNA analysis.

Disposal of Alcohols

Alcohols, such as ethanol, methanol and isopropanol, are common organic solvents used in laboratories. All are flammable and are regulated as ignitable hazardous waste at concentrations above 24 percent in water. Additionally, methanol and isopropanol are category D toxic hazardous wastes under the Washington Dangerous Waste Regulations and are considered hazardous waste at a concentration above 10 percent in water.

Alcohol solutions that characterize as hazardous wastes are prohibited from discharge to the sewer. Dilution of waste alcohol **solely** to bring its concentration below these levels is prohibited. Dilution of alcohol that is done **as part of the "industrial process"** at the lab is allowed and its concentration is not evaluated for waste characterization until the process is complete.

For example, in teaching laboratories, what would be considered "waste" ethanol can be mixed with water to demonstrate the Particle Theory. The final volume of the solution is less than the predicted sum of the volumes of the separate solutions because the alcohol and water molecules arrange in a different geometry that is more closely packed. At the point the demonstration is completed, the ethanol concentration is determined. If the final ethanol concentration is below 24 percent, it will not be considered an ignitable waste and would be acceptable for discharge to the sewer.

Technologies are available for removing stains, dyes and cell debris from reagent grade ethanol, methanol and isopropanol used in Cytology and Histology stain lines, thus permitting the same alcohol to be reused indefinitely. In addition, these systems will remove lipids (fats) and marker inks commonly found in tissue processor waste alcohol. Commercially available systems include the filtration-based Benchtop Alcohol Recycling System™ from Creative Waste Solutions and fractional-distillation-based systems from B/R Instruments, CBG Biotech and CMT Environmental Services. Suncycle Systems has also developed an alcohol cartridge recycling system for tissue processors.

Descriptions of these systems can be found by visiting the Sustainable Hospitals website at http://www.sustainablehospitals.org/cgi-bin/DB_Report.cgi?px=W&rpt=Cat&id=30

Isopropanol is often used as a disinfectant in medical labs. Surfaces are wiped down with a cloth or paper towel holding isopropanol, with much of the isopropanol evaporating off the cloth and counter. When the cloth wiper is no longer useful, put the rag in your shop towel collection container for laundering, or wring out the free liquids into an ignitable hazardous waste collection container. The remaining cloth or paper wiper will typically be acceptable for disposal as solid waste. See *Appendix E, Solid Waste Disposal – Common Questions*, for important information on receiving clearance for disposal of solid waste in King County.

Disposal of 3,3-Diaminobenzidine (DAB)

3,3-Diaminobenzidine lacks toxicity data to allow characterization as a dangerous waste. It is a potent mutagen and should be handled very carefully. Contact with the skin causes burning pain and itching. Inhalation can cause cyanosis (bluish lips.) Because it poses a serious risk to health on contact, DAB is not permitted to be discharged to the sewer or septic tank. It is recommended that DAB be disposed as a hazardous waste or be detoxified prior to discharge to the sewer.

Do not try to detoxify DAB with chlorine bleach (sodium hypochlorite) because the products remain toxic. There are two methods to detoxify DAB. One method is described as follows: [Dapson, 1995, p. 162]

DAB Detoxification Procedure

1. Prepare the following aqueous stock solutions

    - 0.2 M potassium permanganate (31.6 g $KMnO_4$ /liter)
    - 2.0 M sulfuric acid (112 ml concentrated acid/liter)

2. Dilute the DAB solution until its concentration does not exceed 0.9 mg/ml.

3. For each 10 ml of DAB solution, add:

    - 5 ml 0.2 M potassium permanganate
    - 5 ml 2.0 M sulfuric acid

4. Allow mixture to stand for at least 10 hours. It is now non-mutagenic.

Disposal of Wastes Containing Sodium Azide

Some commonly used laboratory reagents contain sodium azide. Sodium azide is a category-B toxic compound due to oral-rat LD50 data, so in a mixture it will designate at a concentration of 0.1%. Any waste containing over 0.1% sodium azide must either be treated to remove the toxicity characteristic or disposed as a hazardous waste. It also can form explosive metal azides, as is discussed in the *Managing Hazardous Chemicals On-site* section below.

Enterococcus Agar

Here is a common list of constituents and concentrations, expressed in amount per liter.

Enzymatic Digest of Casein .... 13.0 g

Enzymatic Digest of Soybean Meal .... 5.0 g

Yeast Extract .... 6.0 g

Dextrose... 3.0 g

Dipotassium Phosphate .... 4.0 g

Sodium Azide .... 0.4 g

Agar .... 10.0 g

Through this calculation: 0.4 grams/liter = 400 mg/L = 400 ppm = 0.04%, we find the final sodium azide concentration to be below the 0.1% concentration where it would designate as a hazardous waste. Therefore, waste *Enterococcus* agars do not have to be counted or disposed as hazardous waste.

Alkaline Iodide Azide (AIA) Reagent for the Winkler Dissolved Oxygen Titration

Here is a common list of constituents and concentrations in the AIA reagent before being added to a water sample for dissolved oxygen analysis.

Water .... 50.0 percent

Potassium Hydroxide................................ 40.0 percent

Potassium Iodide .... 9.0 percent

Sodium Azide .... 0.6 percent

Since the sodium azide concentration is over 0.1% with a pH greater than 12.5, expired or unused stock reagent will be regulated as a corrosive, Washington-state-only toxic hazardous waste. When used as a titrant, it is sufficiently diluted during the analytical process to fall below the 0.1% concentration limit. The waste solution generated by the Winkler Method must be counted as a corrosive hazardous waste if its final pH is over 12.5, but it can then be neutralized under the treatment-by-generator guidelines and disposed to the sewer.

Management of Aldehyde Wastes

The most common aldehyde wastes coming from labs are ten-percent buffered formalin (3.7 percent formaldehyde solution,) two-to-four percent glutaraldehyde solutions and 0.5 percent ortho-phthalaldehyde (OPA) solutions (typically Cidex® OPA.) Formalin is used as a tissue preservative. Ortho-phthalaldehyde and glutaraldehyde are used as cold sterilants.

Formalin

Formaldehyde solutions are regulated in Washington State as category C toxic compounds. Based on equivalent concentration criteria, formaldehyde solutions designate as hazardous wastes at concentrations of 1.0 percent or more in water. However, due to concerns about worker exposure to formaldehyde vapors, the discharge limit to the King County sewer system is 0.1 percent formaldehyde in water. Formaldehyde solutions can never go into septic systems or storm drains. Solutions that are more than 1.0 percent formaldehyde must either be disposed as hazardous waste or chemically treated to reduce the formaldehyde concentration to acceptable levels for sewer discharge.

Chemical Treatment of Formalin

Formalin is readily treatable. Solutions should be diluted with water to fewer than five percent formaldehyde before chemical treatment. Commercially available chemical treatment products that will "detoxify" formalin are listed below (although this list may not be exhaustive):

- "Neutralex™" - produced by Scigen/Tissue Tek 800-725-8723 ext. 7268 (certified as a treatment technology in California)
- VYTAC™ 10F" - by Baxter Healthcare Corp 800-964-5227 (certified as a treatment technology in California)
- "Aldex®" – by Waste & Compliance Management, Inc. 866-436-9264 (turns the formalin into a solid for disposal as solid waste)
- "Formalex®" - by S&S SASCO 800-624-8021 (notes: requires filtering and may require pH adjustment; decertified as a treatment technology in California)
- "D-Formalizer®" - by Surgipath 800-225-3035 (not recommended due to release of low levels of hydrogen sulfide gas)
- "Trans*Form™" – by American Master*Tech Scientific 800-860-4073.

Note that California's treatment technology certification program is no longer funded at the time this edition was written.

According to product data, these compounds will reduce the concentration of a treated sample of formalin to under 0.1 percent formaldehyde, though the times required for this vary. According to product literature, both "Neutralex™" and "D-Formalizer®" will reduce the concentration to less than 25 parts per million (ppm) in 15 minutes.

Since the sewer limit is 0.1 percent residual formaldehyde, the treatment compounds can be diluted below the manufacturer's recommended concentration. For Neutralex™, one packet is described as treating one gallon of buffered formalin to 15 ppm. However, since the sewer limit is 1000 ppm, the packet can actually treat 50 times as much formalin and still have the resulting solution meet the local sewer limit.

Formalin treatment is covered under the treatment by generator guidelines, so log sheets must be kept indicating the amount of formalin treated and the dates the treatment occurred. The amount of formalin generated before treatment must continue to be counted toward your generator status.

Alternatives to Formalin

Another option is to request less hazardous preservatives from suppliers. Safer substitutes for formaldehyde can reduce the risk of harmful exposures and potentially eliminate disposal problems. Be sure to check with the Business Waste Line at 206-296-3976 before purchasing a "safer substitute" to ensure that it really is less hazardous.

Propylene glycol-based solutions are often used for soaking solutions on specimens that have been preserved in formalin. In histology settings, Prefer® or Safe-Fix® have been used as effective substitute preservatives to formalin on small specimens but have been found to be less effective on larger tissues due to their slower penetration rate. Other formalin alternatives include ExCell Plus™ and Optimal*Fix™

Glutaraldehyde

Glutaraldehyde solutions are regulated in Washington State as category C toxic compounds. Based on equivalent concentration criteria, glutaraldehyde solutions designate as hazardous wastes at concentrations of 1.0 percent in water. However, research on biodegradability tests found that two-to-four percent glutaraldehyde sterilant solutions broke down readily to non-hazardous by-products in the sewer system. [Balogh, 1997] Therefore, cold sterilant solutions containing less than four percent glutaraldehyde are acceptable for discharge to the King County sewer system. Glutaraldehyde solutions can never go into septic systems or storm drains. Solutions of over 4.0 percent glutaraldehyde must either be disposed as hazardous waste or chemically treated to reduce the glutaraldehyde concentration to acceptable levels for sewer discharge.

Chemical Treatment of Glutaraldehyde

Glutaraldehyde is readily treatable using the same methods described above for formalin. Dilute solutions with water to less than five percent glutaraldehyde prior to chemical treatment.

Ortho-Phthalaldehyde

O-phthalaldehyde solutions are regulated in Washington State as category C toxic compounds. Based on equivalent concentration criteria, o-phthalaldehyde solutions designate as hazardous wastes at concentrations of 1.0 percent in water. Therefore, cold sterilant solutions containing less than one percent o-phthalaldehyde are acceptable for discharge to the King County sewer system. O-phthalaldehyde solutions can never go into septic systems or storm drains.

One of the most commonly used o-phthalaldehyde-based cold sterilants is Cidex® OPA. Cidex® OPA contains 0.55 percent o-phthalaldehyde and therefore is acceptable for discharge to the sewer at its working strength.

Research has recently been done on the aquatic toxicity of o-phthalaldehyde. Preliminary data indicates that o-phthalaldehyde may be highly toxic to fish, which could lead to it being prohibited from discharge to the sewer untreated.

Chemical Treatment of Ortho-Phthalaldehyde

O-phthalaldehyde is readily treatable by adding the amino acid glycine to it at a rate of 25 grams per gallon of waste o-phthalaldehyde. Treating spent o-phthalaldehyde-based solutions with glycine prior to discharge to the sewer is currently recommended as a best management practice by the Washington Department of Ecology. [Fernandes, 2005]

Aldehyde Spill Management

Glutaraldehyde and formalin spills can be deactivated with one of the commercially-available treatment chemicals listed above. O-phthalaldehyde spills can be deactivated by adding 25 grams of the amino acid glycine to each gallon of spilled material.

Management of Scintillation Fluid Wastes

Scintillation fluids are used to detect weak alpha and beta-emitting radionuclides. This is typically done by mixing the fluid with the radionuclide, which contaminates the fluid.

If the stock fluid contains hazardous materials, the waste produced is by definition mixed waste (both hazardous and low-level radioactive waste.) If the radioactive material concentration is sufficiently low, the fluid can be disposed as a hazardous waste.

In guidance published between 1993 and 1995, the Department of Ecology approved three scintillation fluids for discharge to the sewer:

- Packard / Perkin Elmer (PE) Microscint™ O
- Packard / PE Optifluor™
- National Diagnostic's Ecoscint

At this time, no other products have been approved by Ecology for discharge to the sewer. Generally, if the samples turn out to be radioactive, they are disposed as either a mixed waste or a radioactive waste. Those samples which do not have radioactivity detected (or very low amounts of radioactivity) would be disposed in the sewer if non-hazardous or disposed as a chemical waste or mixed waste if toxic.

Many other products are in the market. The compounds listed below designate as dangerous waste and are prohibited from discharge to the sewer. The surfactants in many scintillation cocktails contain alkyl phenoxy ethoxylates (APEs) or tergitol. Both of these compounds are Category D toxic hazardous wastes. Other cocktails contain xylene, pseudocumene or other solvents that cause them to be regulated as ignitable hazardous wastes.

- Packard / Perkin Elmer: *Microscint™ 20, Ultima Gold, OptiPhase HiSafe, OptiPhase HiSafe 2* and *OptiPhase PolySafe*
- National Diagnostics: *Ecoscint™ A, Ecoscint™ O* and *Ecoscint™ H, Uniscint BD*
- Beckman Coulter: *Ready Safe, Ready Protein+, Ready Gel, Ready Value, Ready Organic, Ready Flow III* and *Ready Solv HP*

Pollution Prevention (P2)

Activities that reduce waste and prevent pollution are strongly encouraged by Ecology, King County Water and Land Resources Division and the Local Hazardous Waste Management Program in King County. Reducing use of chemicals reduces chemical waste. Basic pollution prevention techniques include product substitution, reduced product usage, recycling and reuse of chemicals, modified operations, careful inventory tracking and water conservation.

Pollution prevention best management practices include the following:

- Use analytical methods that do not require hazardous chemicals.
- Substitute hazardous chemicals with less toxic alternatives.
- Use the least amount of chemical required for each experiment or process so that there is less to dispose of as waste.
- Ask if your suppliers offer chemicals in small volumes and buy them in small lots. This can reduce waste and leftover materials in case procedures are changed, expiration dates pass or spills occur.
- Use microscale techniques when available to reduce analytical wastes. Contact the National Microscale Chemistry Center for more information and assistance.
- Microscale chemistry often is too expensive for high school and middle school laboratories. Small-scale chemistry is a less expensive alternative that has been adopted by many schools. Stock solution concentrations are typically reduced to less than 1.0 molar, volumes are measured in drops rather than milliliters and inexpensive plastic equipment is used rather than expensive glassware. Contact the National Small Scale Chemistry Center for more information and assistance.
- Date containers when they arrive so you can see how quickly they are used (if at all). Bar coding systems are now available to track inventory.
- Consolidate or coordinate purchasing authority to reduce duplicate purchases of chemicals and improve inventory tracking.
- Check with suppliers of your laboratory standards. Some will allow you to ship standards back for reuse after the expiration dates have passed. If yours does not, dispose of them properly.

P2 Example: Liquid Chromatography

Solvent recycling in liquid chromatography (LC and HPLC) can be done by the microprocessor controlled S^3 Solvent Saver System®. It uses a sensitive level sensing circuit to shunt the eluant to waste whenever the output from the system detector exceeds a user set level. After the contaminant (normally a component from the sample) has passed and the output from the system detector drops below the programmed level, the uncontaminated solvent will be returned to the solvent reservoir to be used again, reducing both solvent disposal and purchasing costs.

P2 Example: Western Blotting

Western blotting is a technique used by biochemists to electrophoretically transfer proteins from polyacrylamide gels onto a more stable membrane substrate, such as nitrocellulose. The standard conducting solution used during western blotting contains 20% methanol, resulting in the generation of a listed hazardous waste. For many protein transfer applications, particularly those involving high molecular weight proteins, it is possible, and even helpful, to replace 20% methanol, a hazardous waste, with 20% ethanol, a non-hazardous waste, in the conducting solution.

On-site Treatment of Laboratory Wastes

Laboratories are uniquely qualified to treat some of their wastes to eliminate their hazards or reduce the amount of waste needing disposal, thereby cutting costs. Unlike the situation in many other states, the Washington Department of Ecology encourages on-site treatment of hazardous wastes by generators. Six focus sheets have been published by Ecology to provide treatment-specific guidance on carbon adsorption, elementary neutralization, evaporation, filtration, separation and solidification. Ecology's Technical Information Memorandum 96-412 provides guidance on how to conduct these activities.

Specific Standards for On-site Treatment of Wastes

- Before initiating treatment, verify the resulting wastes are acceptable for disposal as solid waste or to the sewer and that the treatment process cannot pose a risk to human health or the environment.
- The container in which treatment occurs must be marked with the date was first accumulated in it and emptied every 180 days for medium quantity generators or 90 days for large quantity generators.
- The containers must be in good condition, compatible with their contents, properly labeled, kept closed and inspected weekly.
- Secondary containment should be provided for wastes awaiting treatment.

The following criteria are condensed from Ecology's Treatment by Generator (TBG) Fact Sheets. [Ecology, 2004]

Carbon Adsorption

- It works well with aromatic solvents, chlorinated organics, phenols, polynuclear aromatics, organic pesticides, chlorinated non-aromatics, high molecular weight aliphatics, chlorine, halogens, antimony, arsenic, bismuth, chromium, tin, silver, mercury and cobalt.

- It works poorly with alcohols, low molecular weight ketones, organic acids, aldehydes, low molecular weight aliphatics, nitrates, phosphates, chlorides, bromides, iodides, lead, nickel, copper, cadmium, zinc, barium and selenium.
- It is allowed when treated effluent and backwash are properly managed and disposed, spent carbon is regenerated or disposed properly, spills and releases are promptly cleaned, equipment is decontaminated as needed and sufficient time is provided for the carbon to adsorb contaminants.

Evaporation

- It is allowed if only inorganic waste mixed with water is treated, all organic vapors from organic solutions are captured, some water content is left to prevent "over-cooking" of sludges, remaining sludges are properly disposed and secondary containment is provided for the evaporator.
- Many schools can evaporate water from waste copper sulfate and other metal solutions as a waste-reduction and cost-cutting technique. By lining the evaporation container with a closable plastic bag, the waste sludge can be easily removed and placed in a small hazardous waste collection container for eventual removal.

Separation

- All separation processes must not change a waste's structure, except to form a precipitate, and cannot generate toxic or flammable gases unless all vapors are captured.

Elementary Neutralization

- This process can only be used on wastes that are regulated solely because they exhibit the characteristic of corrosivity from having a pH of less than or equal to 2.0 or greater than or equal to 12.5.
- The resulting waste must have a pH between 6 and 9 and meet the sewer discharge guidelines listed in Appendix A prior to discharge
- Neutralizing large volumes of concentrated mineral acids is discouraged, since it generates significant heat and fumes which pose serious safety risks.
- Passive limestone acid-neutralization tanks are not recommended. These tanks are hard to maintain, sulfuric acid can significantly reduce their effectiveness and hard-to-reach sediments must be removed and characterized before disposal.

Treatment by Generator Counting Requirements

- Regulated generators must notify Ecology on their Form 2 and in their Dangerous Waste Annual Report that they are conducting treatment by generator activities and whether it is being done in accordance with a specific fact sheet. This notification must occur before initiating treatment.
- TBG activities will not reduce a lab's hazardous waste generator status, but it will typically reduce disposal costs significantly. For annual reporting and generator status determinations, the total quantity (as wet weight) of waste generated prior to treatment and the weight of any remaining material that designates as hazardous waste after treatment must be counted. The waste before treatment and materials remaining after the process must be designated and managed properly.
- Generators must maintain a written log of the quantity of each dangerous waste managed on site, the treatment method and the date treatment occurred.

Permit by Rule

Permit by rule is a second regulatory allowance for on-site treatment of wastes before disposal. One of the common areas of regulatory confusion regards the difference between permit by rule and treatment by generator. Both are available options for laboratories wishing to manage wastes on site.

There are two primary benefits derived from receiving a permit or written authorization that qualifies a process for permit-by-rule exemption.

- The waste that is treated under Permit by Rule is exempt from being counted toward your generator status.
- Waste disposal costs are less because your waste is not hauled off-site

Conditions to Qualify for Permit by Rule (PBR) Exemption

- You must have written permission to discharge the waste to the sewer from the Publicly Owned Treatment Works (POTW.) **NOTE**: This document does not constitute permission under the PBR guidance in WAC 173-303-802.
- Wastes must be properly designated at point of generation, before mixing with any other waste streams.
- If treatment will be in an elementary neutralization unit, wastes must designate as hazardous only because of the corrosivity characteristic.
- In order to qualify as an elementary neutralization unit, treatment must take place in a tank or container.
- The waste must be treated immediately upon being generated. This requires a "hard-piped" system connecting the process that generated the waste to the treatment tank. There

can be no break between the point where the waste was generated and the treatment tank, such as by emptying the waste into a bucket and then pouring it into the treatment tank.

- The generator must notify Ecology that wastes are being treated on-site and indicate on the annual report that PBR activity is being conducted.
- The facility must have a contingency plan and emergency procedures.
- Weekly inspections of the treatment tank's integrity must be done and good housekeeping practiced in the area.
- Staff training must be documented.

Example: PBR for Lab Sample Destruction

- You must meet all the requirements listed above under **Conditions to Qualify for Permit by Rule (PBR) Exemption**. **NOTE**: This document does not constitute permission under the PBR guidance in WAC 173-303-802.
- Laboratory samples are kept under chain-of-custody protocols for an established length of time before being disposed. Some of these samples are of water which has been acidified before analysis to preserve the sample.
- When the protocol no longer requires a sample be stored, it can be disposed. If the sample is hazardous only for the corrosivity characteristic, it can be neutralized and discharged to the sewer. This neutralization can be viewed as treatment by generator or permit by rule depending on the circumstances.
- When treated in batches by adding a neutralizing solution to the sample, it is considered treatment by generator (TBG) and the waste must be counted towards the lab's generator status. This is because the sample becomes a waste as soon as it begins to be treated and the treatment is done in a batch process. For larger labs doing water quality analyses, this could move their generator status up to large quantity generator.
- It is considered immediate treatment under PBR if an entire acidified liquid sample is poured or siphoned directly into a neutralization tank that already contains a basic neutralizing solution. This is considered PBR, and does not count as generated hazardous waste, because the liquid is a viable reference sample until it comes into contact with the neutralizing liquid via a continuous "hard-piped" system.

Example: PBR for Managing Acidic Glass-Washing Solutions

- You must meet all the general requirements listed above to qualify for PBR consideration. **NOTE**: This document does not constitute permission under the PBR guidance in WAC 173-303-802.
- Laboratory glassware is often acid-washed in tubs. This acidic wastewater must be neutralized before discharge to the drain. It is subject to regulation as dangerous waste if its pH is less than 2.0.

- This wastestream, which can also be a significant portion of a lab's entire generated waste, can be viewed as treatment by generator or permit by rule depending on the circumstances.
- If the wastewater from the glass washing tub is directly piped to an elementary neutralization tank, neutralized, then directly piped to the sewer, it will qualify as immediate treatment under PBR and not be counted as generated waste.
- If the glass washing wastewater is treated in batches by adding a neutralizing compound to it, the process is considered TBG and counts towards the lab's generated hazardous waste.

Wastewater and Solid Waste Disposal Guidelines

All wastewater discharged to the sewer system must comply with local, state and federal standards. These are designed to protect surface waters and to maintain the quality of biosolids from wastewater treatment plants. Discharge to a septic tank system is regulated as if the discharge was directly to groundwater, so virtually no wastes may go to a septic tank. Do not discharge laboratory wastes to a septic system. Laboratory operations often generate hazardous wastes that contain dilutions and mixtures of chemicals in very low concentrations or in small quantities. See Appendix A for King County guidelines for disposal of non-hazardous wastes to the sewer system.

Solid waste guidelines are designed to protect local and regional landfills, transfer stations, their customers and their employees. Appendix B lists King County guidelines for solid waste disposal. In general, each component of a waste stream must meet all criteria listed in the relevant appendix to be accepted for discharge to the King County sewer system or disposal as a solid waste.

The guidelines in the appendices are offered as a starting point for proper sewer and solid waste disposal and should not be considered definitive. Many aspects of the dangerous waste regulations, Chapter 173-303 WAC (listed wastes, off-spec chemicals, mixtures, formulations, etc.), are not covered in Appendices A and B. Please refer to WAC 173-303-070 through 173-303-110 for waste designation procedures. The generator has full responsibility for waste characterization and regulatory compliance.

Certain wastes that fail the criteria listed in Appendix A may be suitable for discharge to the sewer under special rules. Under all conditions, obtain written authorization from the King County Industrial Waste Program at 206-263-3000 or a local sewer utility to discharge wastewater that falls outside these criteria. For information on solid waste disposal, call the Waste Characterization Program at Public Health – Seattle & King County at 206-296-4633.

Again, these guidelines do not provide authorization under Permit by Rule to allow discharge of hazardous chemicals to the sewer. They serve, in part, as a guideline to assist businesses and agencies in King County in determining whether their waste may be acceptable for discharge to the sewer.

FOR MORE INFORMATION

Industrial Materials Exchanges

For materials management alternatives, contact the Industrial Materials Exchange (IMEX) at 206-296-4899. IMEX is a free service designed to help businesses find markets for industrial by-products and surplus materials. Through IMEX, businesses with materials they can no longer use can be matched with others who may need the materials. Materials are advertised at no cost.

Hazardous Waste Management--In King County

The Local Hazardous Waste Management Program in King County provides on-site consultation services to businesses in King County. The services are at no charge to the customer and do not have the regulatory authority of enforcement. Information is kept strictly confidential. Call 206-263-3080.

The Business Waste Line provides answers to questions about hazardous waste management. The caller may remain anonymous. Call 206-296-3976 or e-mail bwl@metrokc.gov

The Waste Characterization Program at Public Health – Seattle & King County provides answers about what can go into the landfills. Call 206-296-4633 or e-mail wc@metrokc.gov

Hazardous Waste Management-- Outside King County

The Northwest Regional Office of the Washington Department of Ecology provides technical and regulatory assistance to businesses throughout Washington State. In the northwest part of the state, they can be reached at 425-649-7000. Ask to speak to a hazardous waste technical assistance staff person.

King County Industrial Waste Program

For more information on sewer guidelines in King County, call the King County Industrial Waste Program at 206-263-3000 or your local sewer utility.

Air Quality Management

For more information on air quality guidelines in the Puget Sound region, call the Puget Sound Clean Air Agency at 206-343-8800.

Health and Safety Programs

For more information on health and safety regulations, call the Washington State Department of Labor and Industries, Voluntary Services Program at 206-281-5470. The Voluntary Services Program provides educational assistance to businesses at no charge and does not have the regulatory authority of enforcement. All information is kept strictly confidential.

Resources for Reducing the Scale of Experiments and Analyses

The National Microscale Chemistry Center offers workshops, seminars and publications on the operation and advantages of converting labs to the microscale level. Contact them via phone at 508-837-5137 or at their website at http://www.microscale.orgsilvertech.com/microscale/.

The National Small-Scale Chemistry Center is located at Colorado State University with regional centers across the United States. The focus of small-scale chemistry is the teaching lab. It is currently in use at secondary schools, community colleges and universities. Small scale differs from microscale in its use of inexpensive plastic materials in place of traditional glass apparatus. Both the volumes and concentrations of chemicals are reduced with these substantial benefits:

- Lower costs of materials and chemicals
- Increased safety from use of unbreakable plastic and nonhazardous solutions
- Reduced lab set-up and clean-up times, which allows more hands-on chemistry education

Visit their website at http://www.smallscalechemistry.colostate.edu/ for more information and a free video demonstrating the benefits of small-scale chemistry.

APPENDIX A

KING COUNTY GUIDELINES FOR SEWER DISPOSAL

King County Guidelines for Sewer Disposal

Characteristic or Criteria	Acceptable to sewer if meets ALL of these criteria	Unacceptable to sewer if exhibits ANY of these criteria
1. Flash Point	>65 degrees C or 140 degrees F	<65 degrees C or 140 degrees F
2. Boiling Point	>65 degrees C or 140 degrees F	<65 degrees C or 140 degrees F
3. Corrosivity (pH)	5.5 to 12.0	<5.5 or >12.0
4. Solubility	Water soluble	Water insoluble
5. Reactivity	Non-reactive	Water or air reactive; explosive; polymerizer Creates toxic gas or nuisance stench
6. Radioactivity	Meets WA Dept. of Health limitations[1]	Does not meet Dept of Health limits[1]
7. Persistence (WAC 173-303-100)	Halogenated organic compounds <0.01% Polycyclic aromatic hydrocarbons <1.0%[2]	Halogenated organic compounds ≥0.01% PAH concentration ≥1.0%[2]
8. Toxicity (WAC 173-303-100)	Category X <0.001% Category A <0.01% Category B <0.1% Category C <1.0% Category D <10 % No evidence or Category E =100%	Category X ≥0.001% Category A ≥0.01% Category B ≥0.1% Category C ≥1.0% Category D ≥10%
9. Toxic Mixtures (WAC 173-303-100)	Equivalent concentration <0.001%[3]	Equivalent concentration ≥0.001%[3]

Important Note: These guidelines for sewer disposal are not definitive. Many aspects of Chapter 173-303 WAC (e.g., listed wastes, off-spec chemicals, mixtures, formulations, etc.) could not be covered in this table. Please refer to WAC 173-303-070 through -110 for waste designation procedures. These guidelines are offered as a starting point for proper sewer disposal. The discharger must take full responsibility for waste characterization and regulatory compliance. Certain wastes that fail the criteria listed in the above table may be suitable for discharge to the sewer under rules promulgated by the Washington State Department of Ecology. Under all conditions, obtain written authorization from King County's Industrial Waste Program to discharge wastewater that falls outside these criteria.

[1] Chapter 246 WAC. For specific guidance, contact the Washington Dept. of Health at 425-576-8945

[2] Polycyclic aromatic hydrocarbons (PAHs) include acenaphthene, acenaphthylene, fluorene, anthracene, fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno (1,2,3-c,d)pyrene, benzo(g,h,l)perylene, dibenzo [(a,e), (a,h), (a,l), and (a,l)] pyrenes, and dibenzo (a,j) acridine. Also, carcinogens are not separately regulated.

[3] Small quantity generators of hazardous waste should contact their sewer agency to see if they are partially exempt from the Toxic Mixtures discharge requirements

Toxic Category Table (WAC 173-303-100)

Data can be found in the Registry of Toxic Effects of Chemical Substances (RTECS), NIOSH

Category	Fish LC_{50} (mg/L)	Oral (rat) LD_{50} (mg/kg)	Inhalation (rat) LC_{50} (mg/L)	Dermal (rabbit) LD_{50} (mg/kg)	Example Compounds
X	<0.01	<0.5	<0.02	<2	Organophosphate Insecticides
A	0.01 - <0.1	0.5 - <5.0	0.02 - <0.2	2 - <20	Fuming Nitric Acid, Aflatoxin
B	0. 1 - <1.0	5 - <50	0. 2 - <2.0	20 - <200	Phenol, Sodium Azide Sodium Cyanide
C	1.0 - <10	50 - <500	2.0 - <20	200 - <2000	Stannic Chloride, Sodium Fluoride
D	10 - 100	500 - 5000	20 - 200	2000 - 20,000	Methanol, Stannous Chloride

King County Local Sewer Limits[4]

Substance	Grab Sample Max (mg/L)	Daily Average Max (mg/L)[5]
Arsenic	4.0	1.0
Cadmium	0.6	0.5
Chromium	5.0	2.75
Copper	8.0	3.0
Cyanide	3.0	2.0
Lead	4.0	2.0
Mercury	0.2	0.1
Nickel	5.0	2.5
Silver	3.0	1.0
Zinc	10.0	5.0
Temperature	<150°F	------------
Hydrogen sulfide	10.0	------------
Polar fats, oil and grease (FOG)[6]	No visible FOG floating on surface	------------
Nonpolar FOG[6]	100	100

[4] **Important note**: Your sewer district may have local limits that are different than those listed above. Contact your local sewer district to learn their limits

[5] Daily average is calculated from three samples taken at least five minutes apart. Businesses discharging over 5,000 gallons a day must meet the standards for daily average maximum and grab sample maximum.

[6] Polar FOG is from animal or vegetable sources. Nonpolar FOG is from mineral or petroleum sources. **Important note**: Many sewer districts will have FOG limits that are lower than 100 mg/L. Contact your local sewer district to learn their limits and to verify whether their FOG limits are for Total FOG (polar + nonpolar) or for only nonpolar FOG.

Additional King County Sewer Guidelines	
Substance	**Discharge Limits[6]**
Glutaraldehyde[7]	One percent in water[7]
Formaldehyde	0.1 percent in water[8]
Formalin (treated)[9]	None once formaldehyde concentration is under limit and pH is adjusted as necessary
Ethanol	24 percent in water
Methanol	Ten percent in water
Isopropanol	Ten percent in water
Barium	100 mg/L
Beryllium	10 mg/L
Selenium	1.0 mg/L
Thallium	10 mg/L

[6] **Important note**: These guidelines are designed for small discharges of under 50 gallons. Your sewer district may have local limits that are different than those listed above. Contact your local sewer district to learn their limits

[7] Cold sterilant solutions containing no more than four percent glutaraldehyde may be discharged to the King County sewer provided appropriate BMPs are followed. Contact King County Industrial Waste for a copy of the "Policy regarding discharge of 2-4% glutaraldehyde disinfectant solutions to King County Sanitary Sewer".

[8] Formaldehyde is a category B toxic compound and therefore designates as a hazardous waste at concentrations above 0.1 percent.

[9] See section on formaldehyde treatment options.

APPENDIX B

SEATTLE & KING COUNTY GUIDELINES FOR SOLID WASTE DISPOSAL

Characteristic or Criteria	**Unacceptable** for solid waste disposal at sites in King County
1. Physical State	Liquid
2. Corrosivity (pH)	$\le$2.0 or $\ge$12.5
3. Reactivity	Water or air reactive; explosive; polymerizer. Creates toxic gas or nuisance stench
4. Radioactivity	Does not meet Dept of Health limits[1]
5. Toxicity Characteristic Leaching Procedure (WAC 173-303-090)	Must be less than Dangerous Waste limits for TCLP-listed metals and organics.
6. Persistence (WAC 173-303-100)	Halogenated organic compounds >0.01% PAH concentration >1.0%[2]
7. Toxicity (WAC 173-303-100)	Category X $\ge$0.001% Category A $\ge$0.01% Category B $\ge$0.1% Category C $\ge$1.0% Category D $\ge$10%
8. Formalin Preserved Tissues & Specimens	Residual formaldehyde concentration >1.0 %
9. Toxic Mixtures (WAC 173-303-100)	Equivalent concentration $\ge$0.001%

Important Note: These guidelines for solid waste disposal are not definitive. Many aspects of Chapter 173-303 WAC (e.g., listed wastes, off-spec chemicals, mixtures, formulations, etc.) could not be covered in this table. Please refer to WAC 173-303-070 through –110 for waste designation procedures. The guidelines provided here are offered as a starting point for proper solid waste disposal. The generator must take full responsibility for waste characterization and regulatory compliance. Under most conditions you should obtain a written clearance from Public Health Seattle & King County prior to disposal of contaminated or questionable solid waste. Call 206-296-4633 or e-mail wc@metrokc.gov for more help.

[1] Chapter 246 WAC. For specific guidance, contact the Washington Dept. of Health at 425-576-8945

[2] Polycyclic aromatic hydrocarbons (PAHs) include acenaphthene, acenaphthylene, fluorene, anthracene, fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno (1,2,3-c,d)pyrene, benzo(g,h,l)perylene, dibenzo [(a,e), (a,h), (a,l), and (a,l)] pyrenes, and dibenzo (a,j) acridine. Carcinogens are not separately regulated.

Toxic Category Table (WAC 173-303-100) Data can be found in the Registry of Toxic Effects of Chemical Substances (RTECS), NIOSH					
Category	**Fish** **LC_{50} (mg/L)**	**Oral (rat)** **LD_{50} (mg/kg)**	**Inhalation (rat)** **LC_{50} (mg/L)**	**Dermal (rabbit)** **LD_{50} (mg/kg)**	**Example Compounds**
X	<0.01	<0.5	<0.02	<2	Organophosphate Insecticides
A	0.01 - <0.1	0.5 - <5.0	0.02 - <0.2	2 - <20	Mercuric chloride
B	0. 1 - <1.0	5 - <50	0. 2 - <2.0	20 - <200	Arsenic, Sodium Cyanide
C	1.0 - <10	50 - <500	2.0 - <20	200 - <2000	Phenol, Sodium Fluoride
D	10 - 100	500 - 5000	20 - 200	2000 - 20,000	Sodium Chloride, Stannous Chloride

APPENDIX C

PROPER DISPOSAL OF FIXATIVES & STAINS

Stain Solutions	Constituents	Disposal Option
Acid Fast Stain (for Mycobacteria)		
• Solution 1	Ethanol, basic fuchsin	Ignitable Hazardous Waste
• Solution 2	Organic cleaner	Not regulated as HW
• Working solution	Mix of solution 1 and 2	Ignitable HW
• Decolorizing solution	Ethanol, hydrochloric acid	Ignitable HW, check pH for corrosivity
• Methylene blue counterstain	Methylene blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
Alcian Blue Pas Stain		
• 1% Alcian blue solution	Alcian blue, acetic acid, thymol	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• IN Hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Shiff reagent	Basic fuchsin, sodium metabisulfate, IN hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.55% Potassium metabisulfate solution	Potassium metabisulfate	Not regulated as HW
Alcian Blue Stain, pH 2.5		
• 3% Acetic acid solution	Acetic acid	Corrosive HW
• 1% Alcian blue solution	Alcian blue, acetic acid, thymol	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Nuclear fast red counterstain solution	Nuclear fast red, aluminum sulfate	Not regulated as HW
Bluing Solution for Hematoxylin Stain		
• Ammonia solution	Ammonium hydroxide	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Lithium carbonate solution	Lithium carbonate	Toxic HW
• Celloidin	Ethanol, ethyl ether, celloidin (nitrocellulose, parlodion)	Ignitable HW as a liquid, Flammable Solid HW or Explosive IF DRY
• Glycerin water mounting medium	Glycerin, phosphate buffered solute	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Congo Red Stain (Amyloid)		
• 80% Alcohol & sodium chloride (saturated)	Sodium chloride, ethanol	Ignitable HW
• Alkaline salt solution	80% alcohol, sodium hydroxide	Ignitable HW, check pH for corrosivity
• Stock Congo red staining solution	Congo red, 80% alcohol	Ignitable HW
Elastic Van Gieson Stain		
• Acid fuchsin - 1%	Acid fuchsin	Not regulated as HW
• Picric acid, saturated solution	Picric acid	Corrosive, Flammable Solid HW
• Van Gieson's solution	Acid fuchsin, picric acid	Corrosive, Flammable Solid HW
Fite's Acid Fast Stain		
• Ziehl-Neelsen carbol-fuchsin solution	Phenol, absolute alcohol, basic fuchsin	Toxic HW
• Decolorizing solution	70% Ethanol, hydrochloric acid	Ignitable HW
• Methylene blue counterstain	Methylene blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
Fontana-Masson Stain		
• 10% Silver nitrate	Silver nitrate	Oxidizer HW
• Fontana's silver solution	Silver nitrate, ammonium hydroxide	Corrosive, Oxidizer HW
• 0.2% Gold chloride solution	Gold chloride	Not regulated as HW (but reclaim the gold if possible)
• 5% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Nuclear fast red counterstain solution	Nuclear fast red, aluminum sulfate	Not regulated as HW
Giemsa (Modified Max-Gruenwald) Stain		
• Stock Jenner solution	Jenner dye, methanol	Ignitable and Toxic HW
• Working Jenner Solution	Stock Jenner solution	Ignitable and Toxic HW
• Stock giemsa solution	Giemsa powder, glycerin, methanol	Ignitable, Toxic and Persistent HW
• Working giemsa solution	Stock giemsa solution	Not regulated as HW
• 1% Acetic water solution	Glacial acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit

Stain Solutions	Constituents	Disposal Option
Gram (Modified Brown-Brenn) Stain		
• 1% Crystal violet solution	Crystal violet	Toxic HW
• Grams iodine solution	Iodine, potassium iodide	May be regulated as tissue corrosive
• Stock basic fuchsin solution	Basic fuchsin	Persistent HW
• Working basic fuchsin solution	Stock basic fuchsin solution	Not regulated as HW
Gridley's Ammoniacal Silver Nitrate Solution[1]		
• Ammoniacal silver nitrate solution	Sodium hydroxide, silver nitrate, ammonium hydroxide,	Corrosive, Oxidizer HW. Potentially Explosive HW, can deactivate prior to disposal
• 1% Periodic Acid	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• 2% Silver Nitrate	Silver nitrate	Toxic, Oxidizer HW
• Formalin Solution	Formaldehyde	Toxic HW
• 0.2% Gold Chloride	Gold chloride	Not regulated but reclaim gold if possible
• 5% Sodium Thiosulfate	Sodium thiosulfate	Not regulated as HW
Grocall's Methenamine Silver (GMS) Stain		
• 5% Chemical acid solution	Chromium trioxide	Toxic HW, test for oxidizer, check pH for corrosivity
• Silver nitrate solution	Silver nitrate	Toxic Oxidizer HW
• 3% Methenamine solution	Hexamethylenetetramine	Flammable Solid HW
• 5% Borax solution	Sodium borate	Not regulated as HW
• Stock Methenamine-silver nitrate solution	3% Methenamine, 5% silver nitrate solutions	Toxic Flammable Solid HW
• Working methenamine-silver nitrate solution	5% Borax solution, methenamine-silver nitrate stock	Toxic Flammable Solid HW
• 1% Sodium bisulfite solution	Sodium bisulfite	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.1% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible
• 2% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Stock light green solution	Light green SF (yellowish), glacial acetic acid	Not regulated as HW
• Working light green solution	Stock light green solution	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Hypo (Sodium Thiosulfate)		
• 3% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Lugol's iodine for mercury removal	Iodine, potassium iodide	Corrosive HW
• 2% Hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Nuclear-fast red solution	Nuclear-fast red, aluminum phosphate, thymol	Not regulated as HW
Iron Stain (Prussian Blue)		
• 2% Potassium ferricyanide solution	Potassium ferricyanide	Not regulated as HW but not allowed to sewer
Jones Silver Stain		
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• 3% Methenamine solution	Hexamethylenetetramine	Flammable Solid HW
• Borate buffer solution	Boric acid, sodium borate	Check pH for corrosivity
• 5% Silver nitrate solution	Silver nitrate	Toxic, Oxidizer HW
• Working methenamine silver solution	3% Methenamine solution, 5% silver nitrate solution, borate buffer solution	Test for oxidizer, then test for toxicity
• 0.2% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible
• 3% Sodium thiosulfate	Sodium thiosulfate	Not regulated as HW
Mucicarmine Stain		
• Mucicarmine stock solution	Carmine alum lake, aluminum hydroxide, ethanol, aluminum chloride	Ignitable HW, check pH for corrosivity
• Mucicarmine working solution	Mucicarmine stock solution	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Weigert's iron hematoxylin, solution A	Hematoxylin, ethanol	Ignitable HW
• Weigert's iron hematoxylin, solution B	Hydrochloric acid, ferric chloride	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Weigert's iron hematoxylin solution	Hematoxylin solution A and solution B	Ignitable HW, check pH for corrosivity
• 0.25% Metanil yellow solution	Metanil yellow, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit

Stain Solutions	Constituents	Disposal Option
Oil Red O Stain		
• Oil red O stock solution	Oil red O, 98% isopropanol	Toxic, Ignitable HW
• Oil red O working solution	Oil red O stock solution	Toxic, Ignitable HW
Periodic Acid Schiff Stain (PAS)		
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• IN hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Schiff reagent	Basic fuchsin, sodium metabisulfite, IN hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.55% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
Periodic Acid Shiff Digested Stain (PAS-D)		
• 0.55% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
• Malt diastase solution	Diastase of malt, pH 6.0 phosphate buffer	Not regulated as HW
• Phosphate buffer	Sodium chloride, sodium phosphate monobasic	Not regulated as HW
Phosphotungstic Acid Hematoxylin (PTAH)		
• PTAH working solution	Hematoxylin, phosphotungstic acid, potassium permanganate	Test for corrosivity & oxidizer, otherwise not regulated as HW. Must meet sewer limits
• Eosin Y working solution	Eosin Y, 95% ethanol , glacial acetic acid	Ignitable HW
Reticulin Stain (Gomori's Method) [1]		
• 10% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 10% Potassium hydroxide solution	Potassium hydroxide	Corrosive HW
• Ammoniacal silver solution	Sodium hydroxide, silver nitrate, ammonium hydroxide,	Corrosive, Oxidizer HW. Potentially Explosive HW, can deactivate prior to disposal
• 0.5% Potassium permanganate solution	Potassium permanganate	Test for oxidizer, otherwise not regulated as HW
• 2% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
• 2% Ferric ammonium sulfate solution	Ferric ammonium sulfate	Not regulated as HW
• Formalin solution	Formaldehyde	Toxic HW
• 0.2% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible

Stain Solutions	Constituents	Disposal Option
Reticulin Stain (Gomori's Method) - continued		
• 2% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Nuclear-fast red (Kernechtrot) solution	Nuclear-fast red, aluminum sulfate	Not regulated as HW
Spirochete Stain (Steiner & Steiner Method)		
• 1% Uranyl nitrate solution	Uranyl nitrate	Not regulated as HW or radioactive waste. Meets DOH guidelines for sewer discharge.
• 1% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 0.04% Silver nitrate solution	Silver nitrate	Toxic HW. Test for oxidizer.
• 2.5% Gum mastic solution	Gum mastic, absolute alcohol	Ignitable HW
• 2% Hydroquinone solution	Hydroquinone	Toxic HW
• Reducing solution	Gum mastic solution, hydroquinone solution, absolute alcohol	Ignitable HW
Trichrome Stain – Masson's Method		
• Bain's solution	Picric acid, glacial acetic acid, formaldehyde	Toxic HW, test pH for corrosivity
• Weigert's iron hematoxylin, solution A	Hematoxylin, 95% alcohol	Ignitable HW
• Weigert's iron hematoxylin, solution B	Ferric chloride, glacial acetic acid	Corrosive HW
• Weigert's iron hematoxylin, working solution	Solution A, solution B	Ignitable HW, test pH for corrosivity
• Biebrich scarlet – acid fuchsin solution	1% Biebrich scarlet solution, 1% acid fuchsin, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Phosphomolybdic – phosphotungstic acid solution	Phosphomolybdic acid, phosphotungstic acid	Test for oxidizer, test pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Aniline blue solution	Aniline blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 1% Acetic acid solution	Glacial acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Toluidine blue stain solution (for mast cells)	Toluidine blue	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Vonkossa Stain for Calcium		
• 5% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 5% Sodium thiosulfate	Sodium thiosulfate	Not regulated as HW
• Nuclear-fast red solution	Nuclear-fast red, aluminum sulfate	Not regulated as HW
Fixative	**Constituents**	**Disposal Option**
Miscellaneous Fixatives		
• Alcohol fixatives	Methanol, ethanol	Methanol is Toxic Ignitable HW, Ethanol is Ignitable HW
B-5 Fixative		
• Stock solution	Mercuric chloride, sodium acetate (anhydrous)	Toxic HW
• Working solution	B-5 stock solution, formaldehyde solution	Toxic HW
• Bouin's fixative solution	Picric acid (saturated), 37% formaldehyde solution, acetic acid	Toxic HW, check for corrosivity
Carnoy's Fixatives		
• Carnoy's fixative I	Acetic acid, ethanol	Corrosive, Ignitable HW
• Carnoy's fixative II[2]	Chloroform, acetic acid, ethanol	Corrosive, Ignitable, Toxic HW
• Propionic acid – ethanol solution	Propionic acid, ethanol	Ignitable HW
Formalin Fixatives		
• 10% Aqueous formalin solution	Formaldehyde	Toxic HW
• 10% Aqueous saline formalin solution	Formaldehyde, sodium chloride	Toxic HW
• 10% Neutral buffered formalin	Formaldehyde, sodium phosphate monobasic, sodium phosphate dibasic	Toxic HW
• Formalin alcohol solution	Formaldehyde, ethanol	Ignitable Toxic HW
• Hollande's fixative solution	Copper acetate, picric acid, formaldehyde, acetic acid	Toxic HW
Zenker's Fixative Solutions		
• Stock solution	Mercuric chloride, potassium dichromate, sodium sulfate	Toxic HW, test to see if oxidizer or corrosive
• Working solution	Zenker's stock solution, acetic acid	Toxic HW, test to see if oxidizer or corrosive

[1] Ammoniacal silver staining solutions are hazardous due to their potential to form explosive silver salts. Whether disposed or deactivated, these wastes are counted against your generator status.

- Don't allow silver nitrate to remain in ammonium solutions for more than two hours.

- Keep silver nitrate solutions separate from ammonium hydroxide solutions.
- Deactivate these waste solutions by diluting 15:1 with water. Then, while stirring frequently, slowly adding 5% hydrochloric acid to the solution till the pH reaches 2.
- Add ice if the solution heats up. Silver chloride will precipitate out when the pH reaches 2.
- Filter out the precipitate and dispose as hazardous waste, adjust the pH of the solution to 6 to 7 with sodium bicarbonate, then discharge to the sewer.

[2] A chloroform-free alternative, Carnoy's 2000™, is available from American Master*Tech Scientific, Inc.

APPENDIX D

SOLID WASTE DISPOSAL - COMMON QUESTIONS

What is "Solid Waste?"
- "Solid Waste" refers to materials allowed in local municipal collection systems for garbage and recycling.

Who do I call to find out if my waste is acceptable for disposal as solid waste?
- Contact the Public Health – Seattle & King County Waste Characterization Program at 206-296-4633 or e-mail wc@metrokc.gov.

Who do I call to get my waste cleared for disposal as solid waste?
- Contact the Waste Characterization Program at 206-296-4633 or e-mail wc@metrokc.gov.

What are the guidelines for disposal of biomedical wastes? Who do I call for info?
- Untreated medical wastes are NOT allowed in the landfill. For more information on biomedical waste disposal, contact the medical waste coordinator for Public Health – Seattle & King County at 206-296-4831. See http://www.metrokc.gov/health/hazard/solidwaste.htm#biomedical

Where does my solid waste go for disposal?
- Wastes generated within the Seattle city limits are disposed at Columbia Ridge Landfill, Oregon.
- Wastes generated in King County, outside the Seattle city limits, go to Cedar Hills Landfill near Issaquah

What process must I go through to get a clearance for questionable solid waste?
- Contact the Waste Characterization program at 206-296-4633 or e-mail wc@metrokc.gov, describe your waste and ask for instructions about the information needed to determine its acceptability.
- They will answer your questions and send you a two-page Waste Characterization Form. Download the form on-line at http://www.metrokc.gov/health/hazard/wcform.doc
- Complete the form and submit it with the appropriate data (typically material safety data sheets and/or results of laboratory analyses).
- If the waste is from Seattle, they'll review the information and, if it is acceptable, issue a permit.
- If the waste is from King County, outside Seattle, they'll review the information and issue a technical report. If the waste is acceptable, King County Solid Waste will issue a permit.

Can I dispose of "Special Wastes" at King County or Seattle solid waste facilities?

- Not at this time. Special Wastes are defined in WAC 173-303-040 as state-only dangerous waste that is solid only and is either:
  - A. Corrosive;
  - B. Category D toxic;
  - C. PCB Waste; or
  - D. Persistent waste that is not extremely hazardous.

Note: Some "special dangerous wastes" are allowed for local landfill disposal, generally only if they are toxic category D and a solid. Contact the Waste Characterization program at 206-296-4633 or e-mail wc@metrokc.gov for potential approval.

There are now some firms offering direct haul service for "special wastes." Call the Waste Characterization Program at 206-296-4633 or e-mail wc@metrokc.gov for more information.

What common solid wastes from labs may not be acceptable?

- Buffers consisting of more than 10% toxic category D substances (e.g., potassium hydroxide)
- Drier packages with over 10% potassium chloride, sodium chloride or copper chloride
- Soil samples with these characteristics:
  - A. Contains three percent (3%) or more total petroleum hydrocarbons;
  - B. Contains contaminants which occur at concentrations at or above a dangerous waste threshold in the toxicity characteristics list (see WAC 173-303-090 [8] [c])
- Many lab stains and dyes can designate because they are halogenated organic compounds (e.g., bromophenol blue).

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