



Resource for Greening Medical Laboratories Pollution Prevention Information

**Version 1.0
December 2010**

DISCLAIMER: This guide is for educational and informational purposes only. The City of Toronto assumes no liability for the accuracy or completeness of these materials. Readers are responsible for ensuring compliance with Toronto's Environmental Reporting and Disclosure Bylaw (Municipal Code Chapter 423). These materials should not be relied upon as a substitute for legal or professional advice. Readers should seek their own legal or professional advice in regard to their use of the information contained in the guide.



Greening Medical Laboratories

Toronto's ChemTRAC program includes an Environmental Reporting and Disclosure Bylaw (Municipal Code Chapter 423) that requires local businesses to track and report their use and release of 25 priority substances. The ChemTRAC program provides an opportunity for you to identify strategies for improving your environmental performance. Strategies include those that reduce the use and release of the 25 priority substances. Strategies may also reduce the use and release of other chemicals that may have a health and/or an environmental impact. This Greening Resource for Medical laboratories will help you understand the chemicals that you are using and find ways to reduce or eliminate their use. For additional resources, including a Guide to Reporting visit <http://www.toronto.ca/chemtrac/>.

Medical Laboratories

This business sector is made up of establishments that conduct medically-related analytical or diagnostic services. These services are generally provided to the medical profession or the patient on referral from a health practitioner. Facilities may be independent or part of the larger medical system. Such facilities include bacteriological, biological, medical, medical pathology and x-ray laboratories.



Priority Substances and Other Chemicals of Concern

Toronto Public Health has identified 25 substances of priority health concern that are commonly used and released by businesses in the City of Toronto. As part of ChemTRAC, the Environmental Reporting and Disclosure Bylaw requires businesses and facilities to track and report on any of the listed priority substances that a facility manufactures, uses or releases to the environment if the amounts are equal to or above the reporting limits. In addition to the priority substances, industrial processes commonly use and release other chemicals of concern that may have a health and/or an environmental impact that are not subject to the by-law.

The Medical Laboratory sector may use and produce some of these priority substances and other chemicals of concern. Each of these chemicals may have an impact on human health and/or the environment. Below are the priority substances and other chemicals of concern that may be used or produced by your facility and its operation. This is not an exhaustive list.

Substances that may be used or produced by your medical laboratory and its general operations

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Preparing specimens may use or produce:	<ul style="list-style-type: none"> • Formaldehyde • Cadmium iodide (in staining) • Lead acetate • Lead citrate • Volatile Organic Compounds¹ (VOCs) (xylene) 	
Analyzing specimens may use or produce:	<ul style="list-style-type: none"> • VOCs <ul style="list-style-type: none"> - Xylene - Toluene - Ethanol - Methanol - Phenol • Formaldehyde • Chloroform • Mercuric chloride • Carbon tetrachloride • Trichloroethylene • Tetrachloroethylene • Methylene chloride • Benzene • Acrolein (Reagent) • Heavy metals: <ul style="list-style-type: none"> - Mercury (found in devices such as calibration manometer, water bath thermometer) - Chromium (in x-ray developer cleaners) - Nickel - Manganese 	<ul style="list-style-type: none"> • Selenium (in x-ray toners) • Acetone
Disposing specimens may use or produce:	<ul style="list-style-type: none"> • VOCs : <ul style="list-style-type: none"> - Xylene - Toluene • Formaldehyde 	<ul style="list-style-type: none"> • Mixed bio-hazardous wastes • Radioactive or mixed waste residues
Sanitizing equipment may use or produce:	<ul style="list-style-type: none"> • VOCs: <ul style="list-style-type: none"> - Xylene - Toluene • Formaldehyde <ul style="list-style-type: none"> - Glutaraldehyde² - Ortho-phthalaldehyde² 	<ul style="list-style-type: none"> • Ethylene oxide
Equipment cleaning and maintenance operations may use or produce:	<ul style="list-style-type: none"> • VOCs: <ul style="list-style-type: none"> - Xylene - Toluene 	

Notes:

* Chemicals that may have a health and/or an environmental impact.

1. VOCs are emitted as gases from certain solids or liquids. Smog forms when VOCs are combined with nitrous oxides (NO_x) in sunlight.
2. Glutaraldehyde and Ortho-phthalaldehyde are industry specific sub-forms of formaldehyde which are used in sterilization processes specific to medical facilities.

Understanding Your Company's Impacts: Medical Laboratories

In medical laboratories, there are several activities or processes that may contribute to the use and release of priority substances and other chemicals of concern. The use and release of chemicals depends on the type of process, as well as the equipment and chemicals that are used. Typically, medical laboratories are put into two categories: those that are independent and those that are part of a larger medical facility or hospital. Medical laboratories in either category perform a number of procedures in a variety of specialized fields, which include hematology, microbiology, chemistry, surgical pathology and histology. These facilities may also include x-ray laboratories and blood collection clinics.

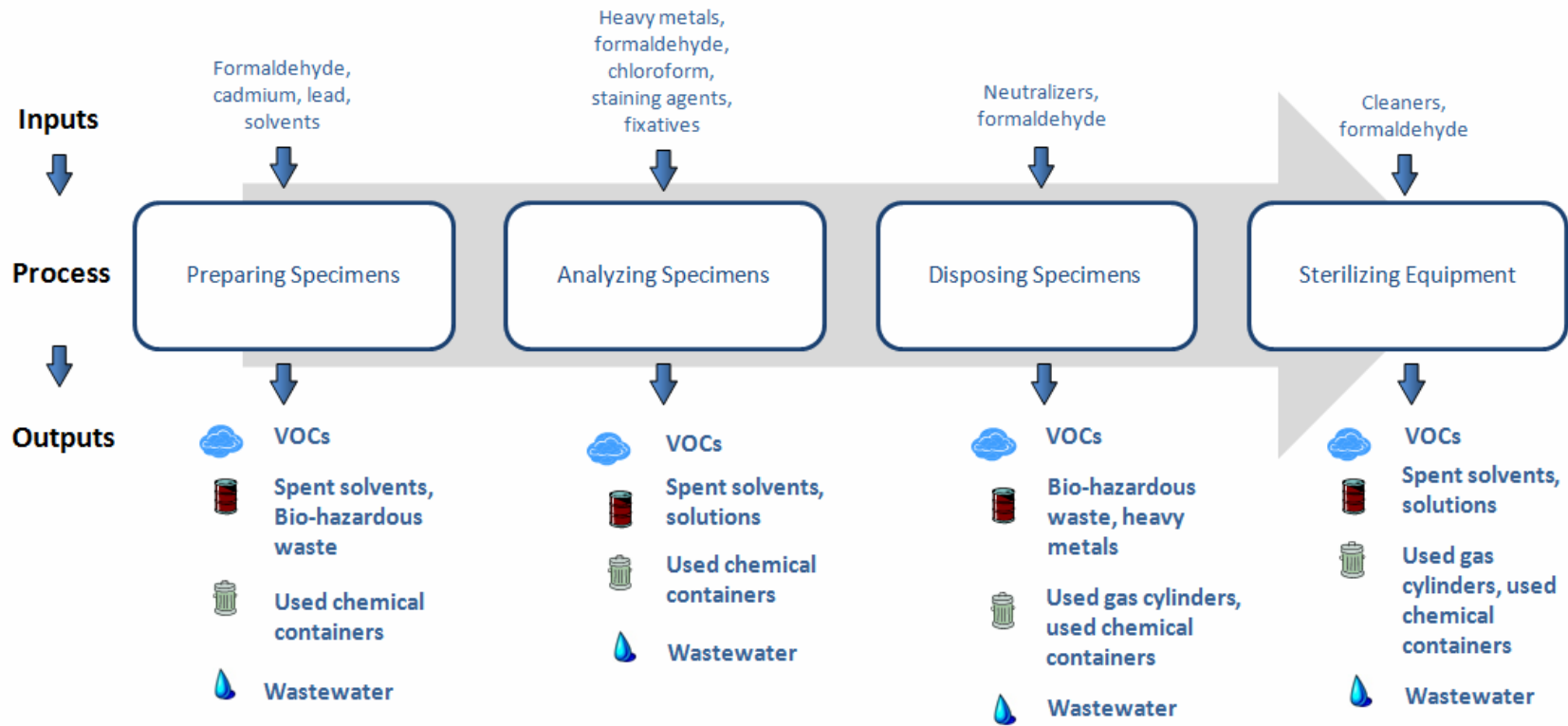
Given the variety of processes that are performed in medical laboratories, many different chemicals are used. By volume, xylene (a volatile organic compound or VOC) and formalin (an aqueous version of formaldehyde) are the most commonly-used chemicals in medical laboratories. Air emissions are a concern, since chemicals and VOCs evaporate during use. Water releases are another primary concern as chemicals are often diluted prior to sewer disposal.

The accuracy of lab functions is highly dependent on the cleanliness of the equipment used. Therefore, a secondary source of pollution occurs during the sterilization and cleaning of laboratory equipment. Both formaldehyde (including Glutaraldehyde and Ortho-phthalaldehyde) and ethylene oxide (also a VOC) are examples of common sterilizing agents, which are identified as priority substances. These are released during cleaning.





Some laboratory analysis can be performed by automated systems that reduce the volume of samples and reagents that are used. These systems are preferable to 'test tube scale' procedures, since they contribute to waste minimization and also promote increased productivity. If these systems are not available, laboratory employees should select the method that produces the least amount of waste product.

The following diagram shows the raw materials that may go into medical laboratory processes and the pollution that may come out of each process. This guide outlines the *general processes* for medical laboratories. Your facility may have more specialized processes or only engage in a subset of these processes; however, it is possible that these priority substances and chemicals of concern may still be present. Symbols show whether the wastes typically go to air, landfill, sewer systems and/or treatment facilities (as liquid or hazardous wastes).

Medical Laboratory Processes



Symbols used in the flow diagram

-  Air emissions
-  Landfill wastes
-  Wastewater (sewers)
-  Liquid or hazardous wastes

Pollution Prevention Steps You Can Take

This resource identifies steps you can take to reduce or eliminate your use of the priority substances and other chemicals that may have a health and/or an environmental impact, and to prevent pollution in the Medical Laboratories sector.

The pollution prevention measures identified in this information sheet can reduce costs and/or increase profits.



Pollution Prevention Assessments – A Good First Step

Before you go too far with any given measure, you may want to do a Pollution Prevention Assessment of your business. You may need an outside expert to help. A typical Pollution Prevention Assessment will include mapping process flows, reviewing equipment uses, evaluating the way you use and store chemicals, evaluating the way you use energy, as well as reviewing waste handling practices and discharges. This assessment helps you to identify many pollution prevention opportunities (and any regulatory compliance issues) and decide which steps to take first.

Pollution Prevention - A Key to Good Management

Good management of your chemical purchases, chemical use and waste disposal is very important. You can improve your environmental performance through Pollution Prevention by:




- identifying how you are using the priority substances and other chemicals of concern that may have a health and/or an environmental impact
- figuring out how much you are using of each chemical and estimating the related emissions (see the earlier description for more information on how to estimate chemical use and emissions)
- discussing the options to reduce or to eliminate these chemicals and, where feasible, taking action. Actions could include:
 - using a different product
 - changing how you apply or clean up the chemical product/waste
 - training staff on how best to apply and clean up the chemical product/waste, or
 - installing new technology
 - maintaining equipment to ensure that leaks and general efficiencies are managed
- tracking the amount of chemicals you use and see if it goes down over time, and
- reviewing progress and identifying whether or not you need to make changes to the company's practices and procedures.

Changes you could make in your medical laboratory















The following table lists many options to help you reduce or stop using the priority substances and other chemicals of concern in your facility. Some measures will cost more than others, and some will be easier to implement than others. Employees can implement certain measures by making minor changes in their day-to-day approaches; while others will require management to invest in new technologies.




The table provides a quick and simple way to take stock of what measures your business has already put into place and those measures that your business could apply. In completing the table, you are encouraged to prioritize the actions you would take. While it is not exhaustive, the table identifies many pollution prevention opportunities for medical laboratories. When assessing the options, please consider your facility-specific conditions and how each option might affect pollution releases to the air, land and water.














The table identifies three general types of options and distinguishes each with a symbol:




	Low-cost, good operating procedures – These measures involve operational and managerial changes that can reduce chemical use. They include simple changes to normal practices, process improvements, as well as training and good housekeeping opportunities. This measure does not need new technology purchases.
	Choosing an alternative chemical – These measures involve replacing traditional products (such as solvents and cleaning products) with products that have less harmful properties. The ease and cost of these measures depends on the product and the process used.
	New technology or system – These measures involve the installation of a new system, machine or process. The cost varies depending on the technology / system.















See **More Resources** for a list of additional resources related to pollution prevention in the medical laboratories sector.




Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place?			If 'No', indicate the level of priority for action (High, Medium or Low)		
		Yes	No	N/A	H	M	L
Preparing Specimens							
Stain slides with only a few drops of solution (rather than a dipping bath) to reduce waste and contaminated rinsate volume.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use hazardous waste containers when rinsing slides and containers, eliminating drain/sewer disposal.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use ion-selective electrode analysis of chloride samples instead of the calorimetric method, eliminating the use of mercury reagents.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Encourage lab managers and analysts to choose testing methods that produce the best results while limiting waste.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Minimize extraction sample sizes to reduce the volume of chemicals needed.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Store solutions remaining from tissue fixation (preservation) in hazardous waste containers.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Analyzing Specimens							
Replace thimerisol (mercury containing) with alternative chemicals, such as sodium azide, wherever possible.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Collect all solutions from the titrimetric method, commonly used for analysis of chloride in sweat, and dispose of as hazardous waste.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Reduce and/or eliminate the use of tissue fixatives that contain high levels of mercury (such as Zenker's solution, B5).		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use xylene substitutes wherever possible.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Collect waste from atomic absorption (AA) standards for heavy metals and dispose of as hazardous waste.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use the ion-selective electrode (ISE) method to analyze chloride instead of the calorimetric method.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Substitute sodium azide for thimerisol buffer solutions to avoid mercury pollution.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use formalin/formaldehyde substitutes wherever possible.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L











	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system
---	-------------------------------------	---	----------------------------------	---	--------------------------

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place?			If 'No', indicate the level of priority for action (High, Medium or Low)		
		Yes	No	N/A	H	M	L
Disposing of Specimens							
When possible, replace xylenes used for slide cleaning with terpene-based solvents.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Sanitizing Equipment							
Replace formaldehyde-based disinfectants with a solution of peracetic acid, acetic acid and hydrogen peroxide when possible.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Store formaldehyde-based cleaning solutions and specimens in secondary containment or on secured shelving and away from sinks.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Collect spent formaldehyde and its sub-forms for recovery.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Purchase formalin in a variety of bottle sizes, allowing the technician to select the most appropriate size and reducing the amount used and waste generated.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Laboratory Clean-Up							
Distill chemicals to separate xylene and formaldehyde from liquids so that they may be reused and/or recycled.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Equipment Containing Mercury							
Whenever possible, replace mercury-containing equipment with equipment that does not contain mercury (e.g., replacing mercury thermometers with alcohol (red) and/or digital thermometers).	 	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Maintenance, Management and Good Housekeeping							
Purchasing and Inventory							
Review suppliers' products regularly and select the most environmentally-responsible products when available.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Keep an accurate inventory of products used (including chemical name, manufacturer, and MSDS sheet).		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Order product containers sized for minimum storage time to reduce waste from expired products.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Work with suppliers to take back unused product.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Apply in-house procedures for the safe receipt and handling of chemicals used for cleaning and equipment repair and maintenance.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L




	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system
---	-------------------------------------	---	----------------------------------	---	--------------------------

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place?			If 'No', indicate the level of priority for action (High, Medium or Low)		
		Yes	No	N/A	H	M	L
Cleaning							
Substitute cleaning products for less harmful cleaning products such as water-based biodegradable cleaners (no-VOC or low-VOC) or use recyclable solvents.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Keep track of solvent use by process to identify sources of excessive use and waste.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Improve manual cleaning practices: <ul style="list-style-type: none"> Only use as much solvent/cleaning agent as needed; do not excessively soak rags or cloths in solvent. Use a spray bottle or plunger. 		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Either launder towels on-site to recover solvent, or collect and send to an industrial laundry facility off-site.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Do not allow rags to dry before being placed in collection cans. Keep lids on cans to stop the VOCs from going into the air.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Regularly maintain and clean equipment to reduce cleaning effort, to extend equipment life, and to reduce solvent use.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Solvent recovery							
Recover solvents on-site from towels using the following methods: <ul style="list-style-type: none"> gravity drain mechanical wringing centrifuge a solvent still 		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Reuse solvents or purchase solvents from a company that will pick up and recycle the spent solvent.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Storage							
Store chemicals according to need, with minimum inventory kept on hand.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Do not store hazardous material near floor drains.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Store chemicals according to manufacturer's recommendations.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Use secondary containment for liquid storage.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Keep solvent, chemicals, stain, etc. containers tightly covered at all times. Storing liquids properly reduces air emissions and waste products.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Eliminate all open buckets. Provide solutions in easily used, closed containers.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L

	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system
---	-------------------------------------	---	----------------------------------	---	--------------------------

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place?			If 'No', indicate the level of priority for action (High, Medium or Low)		
		Yes	No	N/A	H	M	L
Date containers when opened to ensure you use them before products expire. Recycle containers when empty.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Mark all containers to identify the contents to avoid improper handling or disposal.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Training							
Ensure employees are properly trained (WHMIS).		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Train workers to follow the standard work procedures (such as cleaning and set up), good housekeeping, and correct material handling methods to make sure all operators follow the same steps to reduce chemical use and waste.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Ensure that laboratory personnel know the constituents of each reagent used, as well as the proper disposal method.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Spills							
Use spigots and pumps when dispensing new materials and funnels when transferring wastes to storage containers to reduce possibilities of spills.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Develop a spill response plan and post it so that it is available for all employees.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Make spill kits available at the chemical storage rooms or racks for easy access.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Train workers in emergency spill response.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L
Other							
Ask employees for pollution prevention suggestions.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	H	M	L

Contact us to provide your feedback on this resource or to suggest any additional pollution prevention resources (email chemtrac@toronto.ca or call 416-338-7600).

	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system
---	-------------------------------------	---	----------------------------------	---	--------------------------

More Resources

Canadian Pollution Prevention Information Clearing House (CPPIC). 2010. Home Page.

<http://www.ec.gc.ca/cppic/En/index.cfm>

- The CPPIC provides a comprehensive list of pollution prevention resources for Canadian sectors and industries, such as best management practices, fact sheets and sector profiles. Conduct a 'Sector Search' to find resources most relevant to your industry (search the 'Health Care and Social Assistance' sector link for information related to Medical Laboratories).

Clinical and Laboratory Standards Institute. 2002. Clinical Laboratory Waste Management; Approved Guideline—Second Edition

<http://www.clsi.org/source/orders/free/gp5-a2.pdf>

- This guide was written for use by laboratory managers and is intended to provide approaches to controlling laboratory-generated hazardous and nonhazardous waste. The guide outlines:
 - Waste management program implementation
 - Purchasing with waste in mind
 - Elements of a waste management plan
 - Employee training and guidance
 - Waste types generated
 - Effective disposal methods

EPA Office of Compliance Sector Notebook Project. 2005. Profile of the Health Care Industry.

<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/healthsn2.pdf>

- The document lists pollution prevention strategies and suggested process changes. It includes a waste emissions profile for the health care industry.

Medical Industry Waste Prevention Roundtable. Managing Chemicals from Hospitals and Biomedical Labs – Common Disinfectants for Hospital Use.

<http://www.pprc.org/mirt/meetings/Disinfectants%20Handout.pdf>

- The document outlines common disinfectants used in medical facilities, their respective advantages and disadvantages along with disposal guidance.

North Carolina Department of Environment, Health and Natural Resources. 1990. Management Strategies and Technologies for the Minimization of Chemical Wastes from Laboratories.

<http://www.p2pays.org/ref/01/00373.pdf>

- A basic guideline that summarizes waste minimization technologies and strategies specific to individual materials.

Soil and Hazardous Waste Education Center – Waste Education Series.

<http://www3.uwm.edu/Dept/shwec/publications/cabinet/pdf/425-9602.pdf>

- This document provides a useful summary of priority substances generated by specific laboratory function (histology, chemistry, hematology, etc.) and the associated waste reduction activities.

The Regional Water Quality Control Plant – City of Palo Alto. Pollution Prevention for Hospitals and Medical Facilities. <http://www.p2pays.org/ref/04/03259.pdf>

- Detailed guidance surrounding a variety of laboratory types and the associated waste generated. Tools included in this document:
 - List of chemicals of concern generated
 - Laboratory best practices checklist

U.S. Army Center for Health Promotion and Preventive Medicine. 2004. Medical Treatment Facility Pollution Prevention Guide

<http://chppm-www.apgea.army.mil/hmwp/Document%20Library/MTF%20P2%20Guide%20Mar04.pdf>

- A document that details hazardous waste, air pollution and solid waste generation at medical facilities, including a section on laboratories. Specific guidance is offered on:

- Waste segregation
- Alternative waste disposal systems and treatment options
- Alternative sterilization methods
- Product substitution

U.S. Environmental Protection Agency. 2000. Environmental Management Guide for Small Laboratories. http://www.smallbiz-enviroweb.org/Resources/smallbizfiles/SmallLabGuide_500.pdf

- A guide summarizing environmental management best practices and processes for small laboratories. Specific tools in the publication include:
 - How to implement a pollution prevention program
 - Tips on managing waste onsite
 - How to implement an environmental management system (EMS) at a small lab (i.e., a lab that does not have a full-time EMS specialist on site)
 - Air emission calculator
 - Water discharge checklist

Western Memorial Regional Hospital, Canada. Pollution Prevention Strategies in Health Care Facilities. <http://www.c2p2online.com/documents/WMRH.pdf>

- This Canadian document gives a number of case study examples of modifications to processes that have resulted in better waste treatment and cost savings for the facility. More specifically the document covers:
 - Energy conservation in facilities
 - Water conservation in facilities
 - Waste reduction programs
 - Chemical waste generation and their sources