



COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

Waste Minimization Plan

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Waste Minimization Plan
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Policy Statement

The Colorado School of Mines (“Mines” or “the School”) is dedicated to educating students and professionals in the applied sciences, engineering, and associated fields relating to

- the discovery and recovery of the Earth's resources,
- their conversion to materials and energy,
- their utilization in advanced processes and products, and
- the economic and social systems necessary to ensure their prudent and provident use in a sustainable global society.

This mission is achieved by the creation, integration and exchange of knowledge in engineering, the natural sciences, the social sciences, the humanities, business, and their union, to create processes and products to enhance the quality of life of the world's inhabitants. The Colorado School of Mines is consequently committed to serving the people of Colorado, the nation, and the global community by promoting stewardship of the Earth upon which all life and development depend. (*Mines Mission Statement*)

Introduction

Consistent with the School's overall mission, the Environmental Health and Safety (EHS) Department will maintain this Waste Minimization Plan for campus activities. This plan identifies established procedures and provides recommendations to the campus community to minimize or reduce the toxicity of waste generated on the Mines campus.

Mines is classified as a large quantity generator of hazardous waste by the Colorado Department of Public Health and Environment (CDPHE) and the U.S. Environmental Protection Agency (EPA). It is important that every member of the School be aware of the environmental and financial impacts related to the disposal of hazardous wastes. Areas on campus that generate hazardous wastes include research and teaching laboratories, Plant Facilities' maintenance shops and the truck shop, and Student Life maintenance shops. Waste minimization practices must be integrated into the operating procedures of these academic and maintenance departments.

Regulatory Background

1990 Federal Pollution Prevention Act – Requires the use of materials, processes, or practices that reduce the use of hazardous materials, energy, water, or other resources and practices that protect natural resources through conservation or more efficient use.

1992 – Colorado Pollution Prevention Act – Makes pollution prevention the “environmental management tool of choice.” It is the intent of the CDPHE to integrate and incorporate pollution prevention strategies into the agency's permitting, inspections, enforcement, rules development, remediation, assistance, and other functions.

Responsibilities

The Environmental Health and Safety Department (EHS) is responsible for the following:

- Develop and maintain the waste minimization program;
- Operate a centralized chemical procurement and distribution service;
- Maintain an accurate chemical inventory of chemicals stored on campus;
- Maintain a web site for campus personnel to search available chemicals in the inventory;
- Maintain a web page that allows campus personnel to adequately identify waste items generated on campus;
- Provide annual waste generator training that addresses the elements of this plan, and
- Identify new opportunities to minimize wastes generated during campus operations.

Laboratory supervisors, faculty and graduate level researchers are responsible for the following:

- Oversee activities to minimize waste generation in laboratories;
- Recommend waste minimizing techniques to limit hazardous waste generating processes;
- Substitute non-hazardous or less hazardous materials for research operations;
- Supervise chemical ordering practices;
- Follow chemical procurement practices that help reduce the quantity and hazard of wastes generated, and
- Identify new opportunities to minimize wastes generated during campus operations.

Students and Staff are responsible for the following:

- Follow established procedures to minimize waste generation;
- Participate in recycling programs on campus;
- Follow chemical procurement practices that help reduce the quantity and hazard of wastes generated, and
- Identify new opportunities to minimize wastes generated during campus operations.

Established Operating Procedures

Several waste minimization tools have been established in existing operating procedures at the School. These tools have been successful in fostering pollution prevention attitudes, and helping to reduce the volume and toxicity of waste generated at the School. The following identify established operating procedures that are incorporated into Mines operations to minimize waste generation.

1. Centralized Chemical Storage and Distribution Services

The Chemical Storage and Distribution Facility (CSDF) provides a centralized facility for chemical ordering and storage for reagent chemicals. The facility operation is supervised by the EHS Department's Chemical Hygiene Manager.

All requests for chemicals are submitted to the CSDF for processing. Chemical requisitions are filled from existing stocks whenever practical. New chemicals are ordered through EHS and received at the CSDF. All unused chemicals are returned to the CSDF for redistribution to other researchers on campus. Campus personnel must possess current Hazardous Waste Generator training to gain access to chemical procurement services.

The operation of the CSDF reduces the quantity of reagent chemicals that need to be ordered. Subsequently, the volume of chemical waste that requires disposal is reduced. The CSDF provides an important control to ensure initial chemical acquisition of reagents and raw materials is limited to amounts actually needed. Through the operation of the CSDF and the chemical return program, Mines minimizes the volume of chemicals purchased and reduces the potential for the generation of unused and expired chemicals that often require management as hazardous waste.

2. Web-Based Chemical Inventory and Database

An additional benefit of the CSDF operation is the maintenance of a campus-wide chemical inventory system and chemical database. Individual containers are affixed with a unique bar code identification number when received at the CSDF and entered into the database. The database is updated when a chemical is distributed to a laboratory to track the laboratory storage location. Upon disposal, the container or bar code number is returned to the CSDF and the database is revised to show the container is empty or managed as waste. The database also tracks the age of materials so reactive, peroxide-forming and phase sensitive chemicals can be tracked, removed and managed appropriately.

This inventory is made available to campus personnel on the EHS web site located at <https://www.is.mines.edu/ehs/SearchChem/searchlogin.asp>. Access to the inventory requires current waste generator training. Campus personnel without current training cannot gain access to search the database. Once logged in, campus personnel may search chemical inventories owned by their individual department, perform a campus wide search for a reagent stored in their building or another campus building, including a reagent stored in the CSDF.

The chemical database and searchable inventory are useful waste minimization tools. These tools provide campus personnel with the opportunity to identify available chemical stocks, the corresponding chemical storage locations, and check for available non-hazardous or less hazardous alternatives before placing an order for new reagents.

3. Centralized Waste Management Program

The centralized waste management program allows the EHS Department to evaluate each waste container for characterization and disposal. This program combines waste from all over campus to one facility for evaluation and consolidation prior to transportation to an off-site disposal facility. This program allows for more efficient waste disposal operations and minimizes the number of containers shipped for disposal. This program also reduces the number of waste haulers visiting campus and minimizes the haulers' need to visit multiple facilities in populated areas of campus.

4. Recycling Programs

The EHS Department and Facilities Management administers recycling programs for a variety of materials used on campus. In addition to the chemical recycling and redistribution program described previously, Mines employs recycling to divert many hazardous materials as well as commonly recycled materials from waste streams that would otherwise require disposal.

Facilities Management facilitates the following items for recycling:

- office paper;
- newspaper;
- aluminum cans;
- telephone books;
- cardboard;

The EHS Department facilitates the following items for recycling:

- used oil;
- antifreeze;
- scrap metals;
- batteries;
- computers and monitors;
- toner cartridges;
- cellular telephones;
- fluorescent lights; and
- elemental mercury.

The Student Life Department maintains a roll-off box for recycling number 1 and number 2 plastics, newspaper, glass and aluminum from student housing.

Purchasing gas cylinders and lecture bottles from vendors who accept unused or partially full bottles for recycling also helps reduce waste volumes. The School's personnel should try to work with General Air Products for gas cylinder services. General Air will accept full or partial cylinders from Matheson Gas Products, Phillips 66 and Alphagas for recycling.

5. Micro-scale Processes, Experiments, and Demonstrations

Campus personnel are encouraged to consider waste generation before the start of teaching and research activities. Researchers and instructors are encouraged to scale down chemical processes and experiments or consider alternative methods to reduce quantities or toxicity of wastes generated. In many cases, EHS will assist academic departments with both recommendations and finances to purchase equipment to achieve waste minimization goals.

6. Material Substitution

Campus personnel are encouraged to identify non-hazardous or less hazardous products to use in teaching and research laboratories as well as facility maintenance operations. Often EHS will assist with material substitution by recommending non-hazardous alternatives or offering to purchase replacement equipment that does not contain hazardous materials. Examples of material substitution strategies include:

- Use [Ultima Gold Scintillation Cocktail](#) in place of other solvent-based cocktails.
- Use ultrasonic baths, [Alconox](#) or similar detergents instead of acid-washing solutions.
- Replace mercury-containing devices such as thermometers and manometers with alcohol or digital systems.
- Use latex paints instead of oil based paints
- Use citrus degreasers instead of solvent based cleaners.
- Use non-halogenated solvents rather than halogenated solvents.
- Use [SYBR Safe](#) DNA gel stain instead of ethidium bromide, a known mutagen.
- Use digital photography to eliminate silver containing chemical fixers and developers.

7. Spill Team Response

The EHS Department oversees a spill response team responsible for responding to hazardous material spills on campus. Waste minimization techniques are implemented by the Spill Team whenever a spill response is initiated. Waste minimization techniques employed by the Spill Team include:

- Use of a mercury vacuum rather than mercury spill kit. These kits generate increased volumes of mercury contaminated solid waste.
- Use neutralization techniques to collect acid or basic spills.
- Use oil sorbent pads rather than paper towels or rags to clean up oil or nonpolar liquids.
- Reinforce waste minimization techniques during Spill Team training and spill response exercises.

8. Charge Back For Actual Waste Disposal Costs

In situations where waste generating departments or activities do not demonstrate good waste minimization practices, EHS will pass the actual waste

disposal costs back to the responsible department. Activities that generate large quantities of waste or do not follow the requirements of this plan are subject to the charge back policy. This policy is intended to make clear to responsible individuals of the monetary consequences of ignoring waste minimization practices. EHS pays a maximum of \$5,000.00 for annual waste disposal costs for research projects.

9. Waste Minimization Training

School policy requires all campus personnel who require chemical procurement services to receive Waste Generator Training. Annual refresher training is required to remain eligible. This training identifies the requirements of this Waste Minimization Plan and includes the strategies and tools available through EHS to improve waste minimization performance in research and facility maintenance operations.

Additional training topics include proper chemical storage and spill prevention to minimize or eliminate potential chemical accidents including spills, fires or explosions. Labeling requirements are identified to limit the generation of unknown materials. Waste disposal costs are also identified during this training class.

10. Safe Research Facilities

Procedures such as using secondary containment, storing chemicals by hazard class, limiting chemical purchases to only the volume needed for immediate research needs, and minimizing chemical storage in laboratory spaces all aid in promoting safety in laboratory settings. These procedures enhance laboratory safety and limit the volume and toxicity of wastes generated in the case of a spill, fire or explosion. Additionally, minimizing the amount of chemicals stored in laboratory spaces decreases the likelihood of chemicals expiring or deteriorating during storage.

11. Acid Base Neutralization

Using in-process acid or base neutralization as the final step before a waste product is generated helps reduce hazardous waste volumes and toxicity. If neutralization is not part of the research process, or is performed separately from the experiment, it is considered hazardous waste treatment. Waste treatment cannot be performed without a treatment permit from the CDPHE. Please contact EHS before initiating in-process neutralization procedures for additional information.

Green Chemistry Principals

With the implementation of the existing operating procedures, the School has established an effective and efficient waste minimization program. However, student enrollment has increased annually since the 2000-2001 academic year, and has reached its highest level in school history. Additionally, pollution prevention and waste minimization regulations require generators to evaluate the effectiveness of established

waste minimization procedures and submit a report of the evaluation with the generator's biennial hazardous waste report to the CDPHE. Further improvements to the overall performance of waste minimization program at Mines will need to include the use of green chemistry principals.

Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Green chemistry relies on a set of 12 principals that can be used to design or re-design molecules, materials and chemical transformations to be safer for human health and the environment.

The 12 principals identified by the [American Chemical Society](#) (ACS) Green Chemistry web site include:

1. **Prevent waste:** Design chemical syntheses to prevent waste, leaving no waste to treat or clean up.
2. **Design safer chemicals and products:** Design chemical products to be fully effective, yet have little or no toxicity.
3. **Design less hazardous chemical syntheses:** Design syntheses to use and generate substances with little or no toxicity to humans and the environment.
4. **Use renewable feedstocks:** Use raw materials and feedstocks that are renewable rather than depleting. Renewable feedstocks are often made from agricultural products or are the wastes of other processes; depleting feedstocks are made from fossil fuels (petroleum, natural gas, or coal) or are mined.
5. **Use catalysts, not stoichiometric reagents:** Minimize waste by using catalytic reactions. Catalysts are used in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and work only once.
6. **Avoid chemical derivatives:** Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.
7. **Maximize atom economy:** Design syntheses so that the final product contains the maximum proportion of the starting materials. There should be few, if any, wasted atoms.
8. **Use safer solvents and reaction conditions:** Avoid using solvents, separation agents, or other auxiliary chemicals. If these chemicals are necessary, use innocuous chemicals.
9. **Increase energy efficiency:** Run chemical reactions at ambient temperature and pressure whenever possible.
10. **Design chemicals and products to degrade after use:** Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.
11. **Analyze in real time to prevent pollution:** Include in-process real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts.
12. **Minimize the potential for accidents:** Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

Several of these green chemistry principals are already in use through the implementation of the standard operating procedures that were previously identified in this plan.

The Chemistry and Geochemistry Department has implemented green chemistry principals into teaching and research activities. The [Chemistry and Geochemistry Department](#) web page identifies a clear mission statement and identifies active research projects utilizing green chemistry principals.

In order to promote and implement green chemistry principals into teaching and research activities, EHS will take the following steps:

- Identify the advantages of green chemistry principals during Waste Generator Training classes;
- Advance green chemistry initiatives by funding Safety and Environmental Related Minor Capitol Improvement (SERMCI) proposals intended to implement green chemistry principals.
- Promote green chemistry programs through the EHS web page and chemical procurement program.

Program Assessment

An assessment of the waste minimization program should be made on an annual basis. Often this assessment can be used to update waste generator training programs so current waste volumes are passed on to campus personnel. A waste minimization assessment must be reported to the CDPHE with a biennial hazardous waste report.

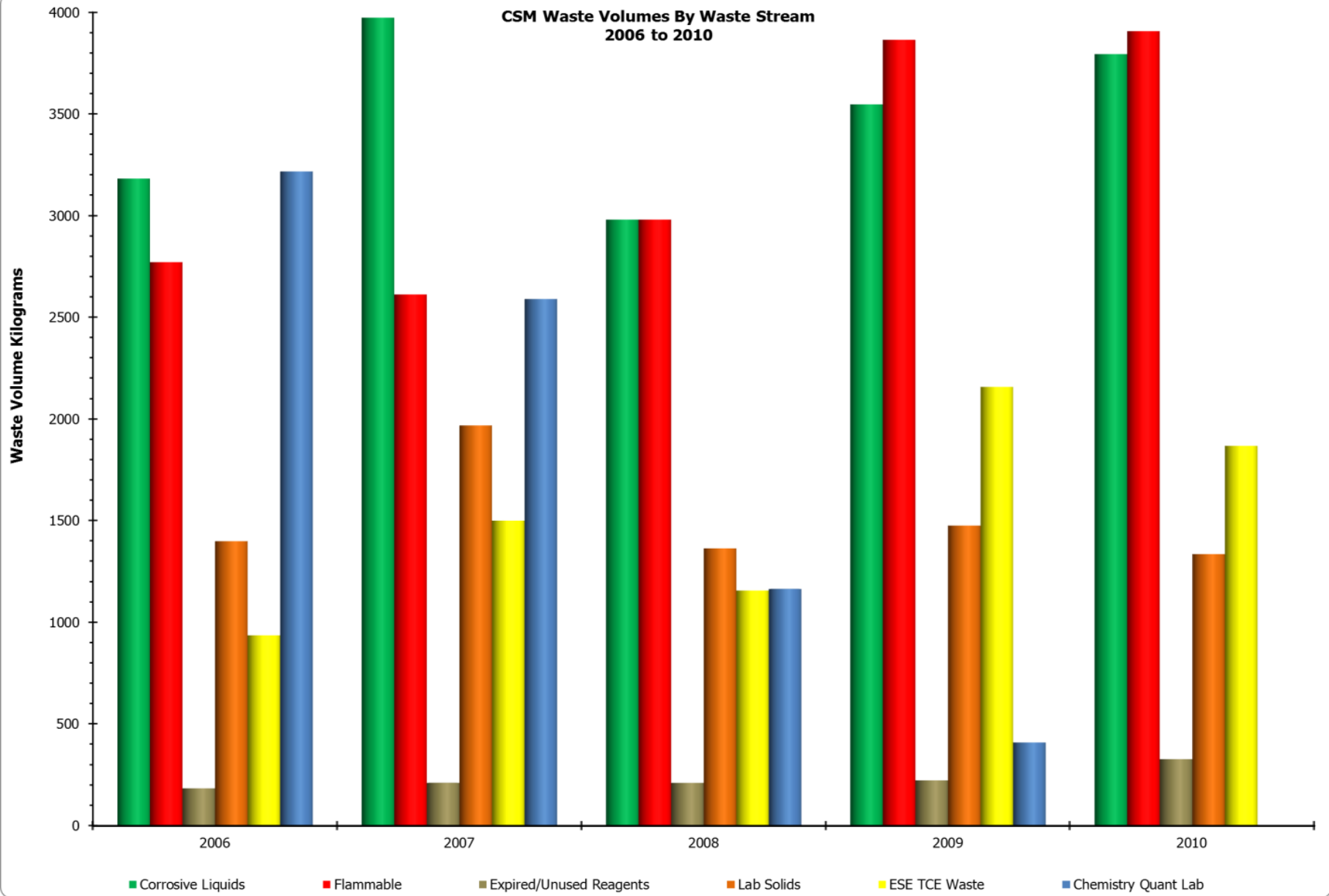
A summary of the volumes of waste generated in past years is included with this Plan in Appendix A. In order to accurately assess waste minimization efforts, total student population as well as the amount of research activities conducted on campus must be considered.

Appendix A – (2012 Revision)

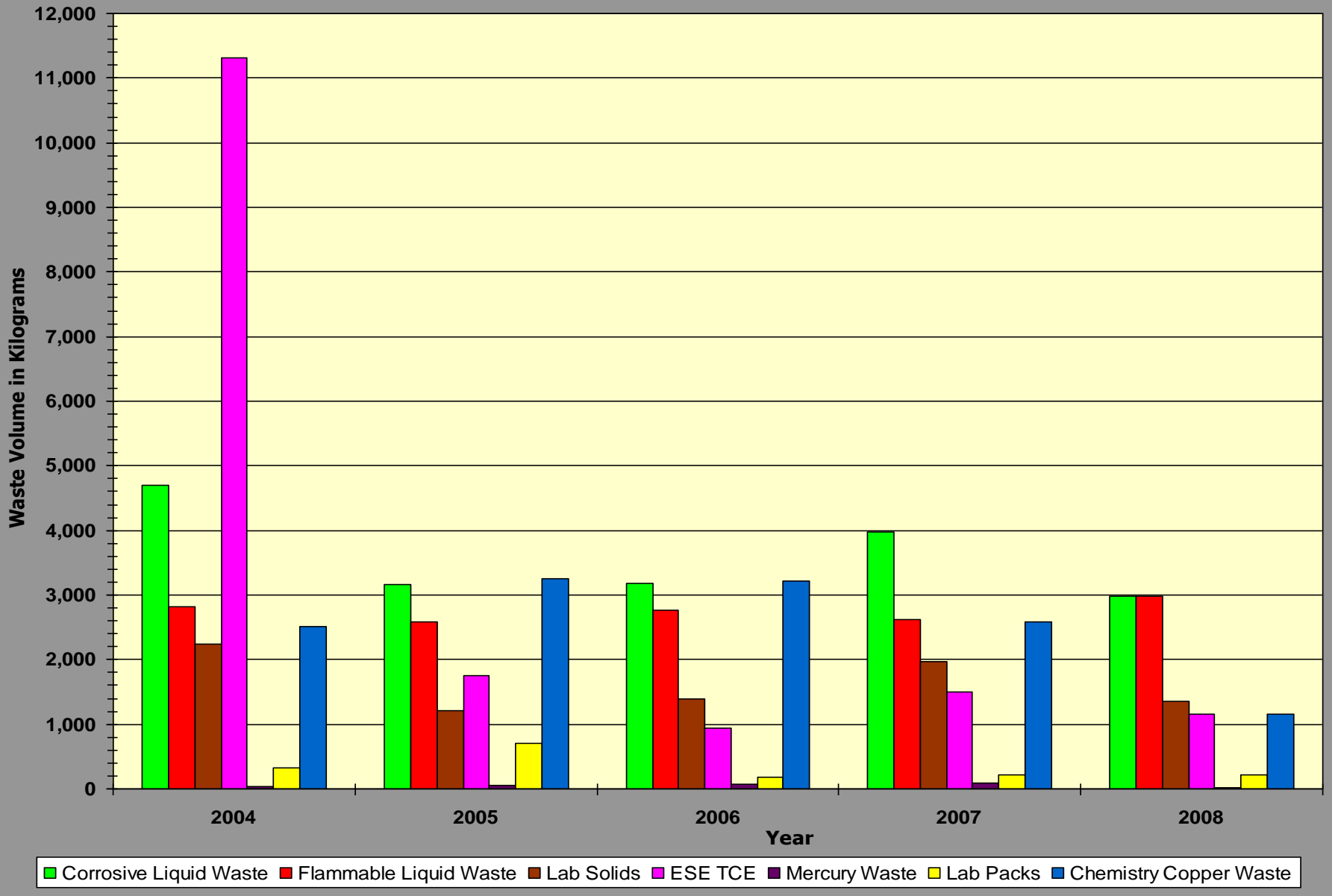
Waste Volume Summary

2004- 2010

CSM Waste Volumes By Waste Stream
2006 to 2010



Colorado School of Mines
Waste Volumes 2004-2008



CSM Hazardous Waste Generation Rate

