Boston College Lab XL Progress Report
June 28, 2001

INTRODUCTION

The Environmental Management Plan (EMP) for laboratories at Boston College has been in effect since September 1, 2000. Over the past nine months, we have worked actively with the Biology, Chemistry, Physics, and Geology and Geophysics Departments to incorporate the EMP practices into the daily lives of laboratory workers. We have focused our efforts on training, a pollution prevention initiative and reviews of laboratory conformance with the EMP.

The following information summarizes BC's initial environmental performance as measureD by the nine Environmental Performance Indicators (EPIs) described in the Project XL Final Project Agreement (FPA).

EPI #1 & 2: OUTDATED CHEMICALS ON THE SHELVES AND ANNUAL SURVEY OF HAZARDOUS CHEMICALS OF CONCERN:

BC has always prepared an annual, comprehensive inventory of hazardous chemicals in labs to satisfy the Boston and Newton Fire Departments. This year, we requested that lab personnel examine their chemicals during the inventory and make quality or need-based decisions on keeping each chemical in stock. During training sessions, and in conversations with Principal Investigators (PIs) and Laboratory Coordinators, we emphasized the need to carefully evaluate containers of particularly hazardous chemicals, such as peroxide-forming chemicals and nitro compounds. A list of specific Hazardous Chemicals of Concern (HCOC) has not been issued to date as we have relied on the complete inventory. Furthermore, BC has not directly measured the absence of outdated chemicals on laboratory shelves per EPI #1.

After discussions with representatives of the EPA following our conformance review in April 2001, it is clear that we need to adjust our approach to the issue of HCOC's. In order to provide more specific information to labs about particular HCOC's, we will be preparing a list of chemicals that requires review at least annually. We will develop our list based on the criteria of degree of hazard and stability or quality over time. An excellent source is *Prudent Practices*. We will also consider lists of carcinogens and mutagens, the P-listed wastes, and other sources of information about particularly hazardous chemicals. This list is expected to be a subset of our current complete inventory.

The list of HCOC's will be developed by August 15, 2001, and will be specifically introduced in training starting in August. By May, 2002, the labs will have prepared an HCOC inventory and assessed whether any outdated chemicals remain on the laboratory shelves. (We are also hoping that our local fire departments will accept our HCOC inventories, rather than the full inventory.)

EPI #3. POLLUTION PREVENTION ASSESSMENTS

Two committees collaborated this past spring semester and have developed a list of Pollution Prevention (P2) activities in progress as well as those we plan to undertake for the 2001/2202

school year. We have been very successful at taking the energy and momentum created by Project XL and the lab EMP and applying it to the collection and reuse of computers and electronic equipment, a mercury thermometer swap initiative and the recovery of silver wastes from photographic operations. The Committee is currently focusing its activities on the potential recycling of silica gel, the reuse/redistribution of laboratory waste and the mercury thermometer swap program

The list of current and planned P2 activities is included as Appendix 1 at the end of this report.

EPI #4. RE-USE AND REDISTRIBUTION

A re-use and redistribution program was developed this winter. In the past, there was no formal reuse and redistribution program. We currently have a small inventory of chemicals that are available for redistribution. This information is summarized below in Table 1. These chemicals came from lab clean-outs and would have historically been managed as hazardous waste and disposed off-site.

Table 1. Chemicals available for redistribution, 6/15/2001.

	# items	**volume**
Organic Solvents, Flammables	45	42 L
Solids, non-flammable liquids, acids, bases	70	48 kg

The criteria for acceptance in the reuse program is articulated in BC's Waste Determination SOP's & Unknowns pick-up procedure found in Appendix 2 at the end of this report. To date, we have recycled propane, lighter fluid, ethanol, and cleaning materials. The inventory of chemicals has been updated recently and will be made available to lab workers during the summer. The program will not be able to reach a true operational level until the completion of renovations in Higgins Hall that prevent normal access to the Hazardous Waste Accumulation Room.

EPI #5. HAZARDOUS WASTE GENERATION

The table in Appendix 3 shows the amount of waste (in lbs.) generated by each laboratory within each department. In comparison to 1999, Boston College's laboratories increased by 55% the amount of waste produced. This increase is due almost entirely to an increase in waste generation by the Chemistry Department (which generates 96% of all laboratory waste). While we can make no firm conclusion about the cause for this dramatic increase, we offer the following insights:

- While the building hasn't grown, the Chemistry Department has undergone a continuous series of lab moves which has ultimately put the most productive researchers in the largest spaces.
- Two chemistry labs have started doing more wet chemistry.

- The overall population of waste generators has increased, including graduate students, post-doctoral fellows, and particularly the number of undergraduates who work in research labs.
- Finally, there may be variations in our calculations due to changes in personnel.

Interestingly, Boston College was able to realize cost savings in waste disposal in 2000 compared to 1999 ($2.62/lb in 1999, $1.31/lb in 2000 as summarized below in Table 2. Total waste management costs were 27% lower in 2000, which is likely due to different end disposal options provided by our contractor.

Table 2. Weight and cost comparisons, 1999 & 2000

	1999	**2000**
Weight (lb)	24862	38754
Cost (Fiscal year)	$103,800	$76,406

EPI #6. ENVIRONMENTAL AWARENESS SURVEY

This year we sent out 100 Environmental Awareness Surveys and received 18 responses to date. Two of the responses were from people who do not use chemicals in labs. The results from the 16 respondents are summarized in Appendix 4 at the end of this report. In spite of the small number of responses, the responses suggest the following :

- EH&S has done a good job in explaining proper container management.
- Laboratory workers do not have a strong understanding of laboratory environmental impacts and pollution prevention concepts
- We can improve the system for getting all lab workers to training.

EPI #7. TRAINING

Training is systematically managed to varying degrees in the different departments. The Office of EH&S coordinates and/or provides training and maintains a central record of who has been trained. The departments manage their own training lists.

From August 28, 2000 to June 1, 2001, the majority of laboratory workers received Environmental Management Plan training. All laboratory workers in Psychology (3 individuals) and Geology and Geophysics (approximately 10 individuals) were trained. During the academic year, the Chemistry Department had at least 95% compliance (potentially approximately 160 individuals) with the training requirements. The key to success in Chemistry is a department administrator who actively pursues people who need to be trained. Training of laboratory workers in the Biology Department was somewhat hindered by major renovations in the Biology Building. We will address outstanding training issues with the EH&S Oversight Panel in the fall semester. We also have the support of the academic deans in fully achieving the goal of training all laboratory workers.

EPI #8. PROGRAM EFFECTIVENESS

Our two primary goals for the past year were to implement the EMP and to institute a chemical redistribution system. The EMP has been successfully implemented and is followed in BC laboratories. We have all the elements of a chemical redistribution system with the exception of adequate marketing and promotion to give the program adequate visibility and momentum.

The following list represents a review of EPI performance as a measure of Lab XL program effectiveness.

EPI#1 It appears as though there is a sharp decline in outdated chemicals in laboratory--however, it has not been directly measured to date.

EPI#2 The EH&S Office has a complete chemical inventory on file; however, the complete list does not identify particularly hazardous chemicals of concern.

EPI#3 A pollution prevention initiative is underway and efforts to reduce silver waste and swap mercury thermometers for less toxic alternatives are proving effective.

EPI#4 The amount of laboratory waste collected for reuse has increased substantially, however the amount of laboratory waste reused or redistributed has not yet increased by 20%.

EPI#5 The amount of laboratory waste disposed increased substantially in 2000 due to a significant increase in chemistry research.

EPI#6 The Environmental Awareness Survey was completed and the partial results demonstrate that compliance knowledge is high, but understanding of pollution prevention and environmental impacts associated with lab activities is low.

EPI#7 The number of laboratory workers trained increased significantly from previous years.

EPI#8 Some EPIs are on-track (training, reuse/redistrbution program); others need more attention (outdated chemical tracking, environmental awareness surveys).

EPI#9 Both external and internal audits show significant compliance with the Minimum Performance Criteria of the XL Regulation.

EPI #9. CONFORMANCE WITH THE EMP

We have had three rounds of audits since January 1, 2001. Members of the EH&S staff conducted internal audits of most of the labs (some were omitted due to renovations and relocations). Members of the Campus Consortium for Environmental Excellence conducted a "mock audit" prior to our EPA inspection, which occurred on April 23 and 24.

The procedure for internal audits is as follows. After the audit is completed, the auditor sends two copies of the audit results to the PI or lab supervisor. In theory, they are to sign and return

one copy. We have not been successful in getting the signed forms returned to us, even after a reminder and another copy (approximately a 50% return rate in two months with reminder). We will be exploring another mechanism to ensure communication between EH&S and the PI's.

Internal Audits

The results of internal audits are summarized below in Table 3.

Table 3. Results from Internal Audits

	Yes	Needs work	No
Written copies		1	
Workers aware			
Waste bottles labeled		6	1
Labels properly filled out		5	1
Special containers?			
Secondary containment		3	4
55 gal			
P-list			
Full containers inventoried			
30 days			1
Container closed		6	1
Good condition, segregated		1	1
Compatible			
Weekly waste inspection sheet		3	8
No spills or releases			
In-line waste collection			
Managed?			2
Spill response equipment		3	1
Emergency contact info		2	2
Signs emergency eq.location			
Evacuation procedures			
PPE		1	1
Engineering controls			

We can find some clear direction for future training from the 25 internal audit records examined and tallied. At the time of these audits, (February and March 2001) labels were a big problem. Usually, labels were used, but we also observed that chemical names were abbreviated and hazards were not indicated. We conducted a campaign this semester and in our most recent audit found only one label with an abbreviation. (Hazard boxes still need work.)

Container management was also a problem that improved over the course of the semester. Secondary containment is used almost always. Containers are closed in most cases. During the EPA audit we were made aware that segregation of incompatibles is one shortfall in our program. We will be actively addressing this with training and facts sheets in the fall.

Our EMP requires that someone conduct an inspection on the laboratory waste storage area (LWSA) weekly. Conformance with this Boston College requirement has not been strong, and we will reconsider mechanisms for ensuring the condition of the LWSA's.

Emergency response awareness is the last area that needs attention in the labs. We do not have official evacuation route maps for Higgins Hall (still in renovation). We saw in our visits that lab workers need to be reminded to plan for potential emergencies, centralize their spill kits and have phone numbers posted. It is most effective to address this during audits, and we carry emergency information sheets with us when we are in labs.

The report from our external "mock audit" is in Appendix 5 at the end of this report.

Appendix 1
Boston College
Pollution Prevention Program
September, 2000 to June, 2001

Pollution Prevention Committees:
Laboratory: CHP/EMP Committee
Facilities: Dick Range, Recycling; Gerard Boyle, Housekeeping; Joe Ahern, Information Technology; Gail Hall, EH&S
Student groups will be invited to send representatives starting in Fall 2001.

Recycling Networks and Memberships
BC is a member of MassRecycles and The Institution Recycling Network (IRN).

Current Activities:
Computers and Electronic Equipment

Resale of computers directly by BC or through IRN: April 2001, BC sold approximately 75 used computers.

Electronic equipment: Since February 2001 IRN has been working on developing markets for electronic equipment, including discarded laboratory equipment, either for resale or for components.

Recyclable Wastes

Boston College has one silver recovery unit for the Photography Laboratories in Fine Arts (Devlin 009). A second unit is scheduled for installation in June 2001 in Higgins Waste Room. In addition, small photographic laboratories in the Biology Department have individual silver recovery units plumbed to automatic photoprocessors. When cartridges reach capacity, they are replaced and silver is extracted from used cartridge and sold by the vendor. The unit in Devlin is renewed approximately once a year with the generation of approximately two pounds of silver.

Silica gel is a laboratory waste that we are currently planning to recycle through Triumvirate Environmental or another vendor. (Status: Triumvirate has filed for permits in the US and Canada for shipment of waste to Silicycle in Quebec City, Canada.) We generate approximately 1000 lbs. of silica gel per year.

Laboratory Materials

Chemical Redistribution System: As part of the Project XL Agreement BC has developed a chemical redistribution system. A Standard Operating Procedure is available to explain the details of the system.

The Redistribution System began in March 2001 with an influx of chemicals from labs that were being relocated. In that time we have redistributed numerous cleaning supplies, 4 containers of lighter fluid, a Coleman fuel cylinder, a liter of hydrochloric acid, and some salts, acids, bases and ethanol that will be used in our own waste identification program.

By August 1 the inventory will be widely distributed to all the labs via email, our newsletter and our web site. We will track the movement of materials into the program and out for reuse rather than disposal.

Consumer Goods

Boston College has an ongoing program for recycling office paper, newspaper, cardboard, plastics, and soda containers. All dormitories and student dining areas have recycling containers, and the effort is moving into Administrative Buildings.

At the end of the year during "move out" BC has a program for collection of reusable materials (e.g. clothing, furniture, electronics) from students. This program is staffed by alumni/ae volunteers. Materials are redistributed to area charities.

Student Groups

BC has a couple of student activities groups that focus on environmental concerns. We will invite them to send representatives to the P2 Committee next year.

Proposed activities for 2001-2002:

Labs

- Complete administrative process for recycling of silica gel by September 1, 2001..
- Promote replacement of mercury thermometers in labs through training, email, web site, and personal communications (in progress).
- Investigate less toxic glassware cleaning alternatives to propose to users of chromic acid and nitric acid (Fall 2001).
- Analyze solvent generation; promote collection of certain organic solvents (e.g. acetone) as a "pure" waste stream which can be distilled and recycled. We have been in touch with CBG Biotech, a company which sells solvent recyclers. (Beginning Summer 2001)

Campus Initiatives

- Expand electronics recycling program through IRN.
- Expand recycling program into non-residential buildings.

Appendix 2
Waste Determination SOP for Higgins Waste Room

1. Laboratory waste may be brought into this room only by individuals who have received both EMP and RCRA training.

2. All laboratory waste will be placed into one of these categories:
   A. RCRA hazardous waste
   B. Material which may be considered for redistribution.
   C. Unknown (must have "unknown form" from lab). (Unknowns will be placed in fume hood to await analysis.) SOP for unknown identification follows.
   D. Non hazardous or "special" wastes. (e.g. Biohazards, sharps and pathological wastes)

3. Redistribution criteria
   A. Must have "laboratory waste" label or other source of information.
   B. Must know source of material.
   C. Material must be in very good condition.
   D. Label must be intact and readable.
   E. Storage must be according to label requirements.
   F. Container must be inspected by qualified individual, receive sticker and be entered in inventory.

4. Automatic exclusions
   A. Opened or expired unstable materials (e.g. peroxide formers).
   B. Materials altered from original physical state.
   C. Non-virgin material (see next)
   D. Exceptions for C.
      Materials like salts or sugars that may be used for teaching labs or non-critical applications.
      Solvents

5. If laboratory waste is excluded from redistribution either because it fails to qualify in section 3 or because it is excluded in section 4, it must be determined to be either RCRA hazardous waste, MA regulated waste or non hazardous waste and handled accordingly.

6. Waste not from laboratories will be handled according RCRA regulations.

7. RCRA hazardous waste must immediately be put in the appropriate Hazwaste storage room following RCRA regulations. Wastes to be considered for redistribution may remain in the "recycling room" until they have been assessed, at which time they will be designated for recycling or be managed according to RCRA.

Appendix 2 (Continued)
Waste Determination Procedure for Unknown from Lab Sources

1. Prior to pick-up from a lab, someone in the lab should fill out an "Unknown Waste for Pick-up" form.

2. Label container "Laboratory Waste" and "unknown."

3. Store unknowns in a safe place (generally a fume hood) and in secondary containment. On the regular waste pick-up form, give the location of the material so the chemist can remove it.

3. Identification procedure:
   >1 Liter, sample will be sent out for analysis.
   < 1 Liter, sample will be identified by in-house unknowns procedure. (We currently follow the procedure of Triumvirate Environmental.)

4. Unknowns from non-lab sources will be identified as above. Some containers (e.g. drums) may be left in place until analysis is completed.

5. All unknowns must be characterized or sampled within 30 days of removal from lab.

Resources: Merck Manual; DOT Guidebook; Prudent Practices; MSDS (available on web or from EH&S Office).

Appendix 2 (Continued)

Unknown Chemical Request for Pick-up

Fill out a new form for EACH unknown chemical you are submitting for disposal.

Unknown chemicals are potentially hazardous to all individuals in the lab, in transport and in waste handling. They also require costly analysis and disposal. Very often laboratory personnel may have some information that can be helpful in identifying the unknown or at least narrowing the possibilities. It is the responsibility of laboratory personnel to prevent the occurrence of unknowns, and to provide as much information as possible about any unknown materials that do arise.

Observe Standard Operating Procedures for Safe Handling of Chemicals. Use Personal Protective Equipment and work in a fume hood. **Do not handle a material that you suspect may be unstable. Call EH&S for assistance.**

Your Name _____ Phone _____
Date _____ Location of chemical _____

When and where was it first noticed? _____
_____

Chemical Description
State S / L / G / Mixture (describe) _____
Color _____ pH _____ Odor _____
Other significant characteristics _____
_____

Container
Original? _____
Glass / Plastic / other (describe) _____
Any label or identifying markings _____

Briefly describe activities in the lab and any other information that may be relevant to the source of this unknown. _____
_____
_____
_____

Best Estimate
When was it generated? _____
By whom? _____
What is it? _____

When this form is complete, request pick-up of a chemical as you normally do. This form should accompany the material when it is picked up. Label the container with a "**Laboratory Waste**" tag and write **UNKNOWN** on the label.

Date of pick-up _____ Container Identification _____

Appendix 4

New England Laboratories/XL - Awareness Survey (

 # incorrect responses in bold

1. Which federal agency regulates the disposal of chemical wastes: **2**
a. Occupational Safety and Health Administration
b. Environmental Protection Agency
c. Department of Transportation
d. National Institutes of Health

2. Ultimately, most chemical waste generated in laboratories is: **8**
a. incinerated
b. sent to a landfill
c. released to a sewer
d. recycled

3. What are the main reasons researchers should keep containers of laboratory waste securely closed except when adding chemicals? **2**

_____
_____
_____
_____

4. Which costs more, purchase or disposal of laboratory chemicals? **14**
a. disposal costs more
b. purchase costs more
c. costs are roughly the same

5. What is the preferred waste management hierarchy for pollution prevention? Use a scale of 1-4 with 1 being the preferred management method. **13**
___ Recycling
___ Disposal
___ Source Reduction
___ Treatment

6. What is the proper way to dispose of strong mineral acids? **7**
a. Dilution with water
b. Neutralization with lime
c. Collection for pick-up by hazardous waste personnel
d. Mixing with organic chemicals

7. What is the maximum amount of acutely hazardous (P-listed) laboratory waste that your laboratory is allowed to accumulate before you must request a pick-up? ____ liter(s) or . kg(s) **9**

8. What emergency response equipment is available in your laboratory to respond to a hazardous chemical spill?

_____ _____
_____ _____
_____ _____
_____ _____

9. How is wastewater from your laboratory buildings treated? **5**
a. Purification before release to the sewer
b. pH is controlled by acid neutralization, then released to the sewer
c. Diluted with the rest of the building's water, then goes to the sewer for municipal treatment by aerobic digestion
d. Which building: _____

10. In general, how are fume hood emissions controlled in your laboratory? **13**
a. Filtration to remove particles
b. Carbon filtration to remove gases
c. Dilution with laboratory room air
d. There are no fume hoods in my laboratory

11. The last time you needed health and safety information about a particular chemical, what resource(s) did you use?

_____

12. Typically, what is the largest environmental impact of laboratory work? **12**
a. release of toxic chemicals through the fume hood
b. disposal of toxic chemicals with a hazardous waste disposal company
c. release of chemicals to the sewer system
d. energy use to cool or heat laboratory space

13. The last time you disposed of laboratory hazardous waste, what pieces of information did you put on the label? **0**

_____
_____
_____
_____

14. What document(s) describes how to manage laboratory waste at your institution? **8**

_____

15. What is your current role in your laboratory? Department:

_____

6 Faculty
0 Staff - Administrator
1 Staff - Lab Tech
9 Graduate Student

0 Undergraduate Student

16. How many years have you been working in college or university laboratories?
0 less than 1 year
0 1-2 years
5 3-5 years
11 more than 5 years

17. Please check the types of training you've had in the last year.
12 Chemical Hygiene Plan
9 Environmental Management Plan
1 Radiation Safety Training
3 Biosafety training
3 none

Summary of Survey Results

	# incorrect	% correct
1. Agency	2	88
2. lab waste disposal	8	50
3. container closed	2	88
4. cost	14	12
5. P2 hierarchy	13	19
6. strong mineral acids	7	57
7. P-listed waste	9	44
8. emergency equipment		100
9. waste water	5	69
10. fume hoods	13	19
11. info		100
12. environmental impact	12	25
13. label info		100
14. documents	8	50
15. Role	6 Faculty, 1 stall, 9 grad student	
16. years at BC	5 @ 3-5; 11 @ >5	
17. Training	12 CHP; 9 EMP; 1 Radiation; 3 Biosafety; 3 none	75% CHP; 44% EMP; 19% none.

Appendix 5
Boston College Laboratory Audit Results
March 15, 2001

Conducted by: Tom Balf, Nexus Environmental Partners; Francis Churchill, University of Vermont; Dave Messier, Worcester Polytechnic Institute; Zehra Schneider-Graham, University of Massachusetts Boston.

Escorts: Gail Hall, Suzanne Howard, Boston College

This report is a summary of the findings of the third party audit team who reviewed Boston College's (BC) laboratory chemical waste management program on March 15, 2001. This audit is the first in a series to be conducted over the four-year Project XL pilot program to assess BC's overall compliance with the Minimum Performance Criteria (MPC) specified in the Lab XL regulation (40 CFR 262 Subpart J).

Scope of Laboratory Assessments

I have enclosed a copy of the checklist that was used by the audit team (Attachment 1). The audit team consisted of three members, recruited by the Campus Consortium for Environmental Excellence from the health and safety departments of other New England colleges and universities. Boston College Environmental Health and Safety staff accompanied the external auditors. Two teams were formed, each comprised of at least one independent, external auditor and one BC staff member. The teams each took a building (Higgins Hall or Merkert Chemistry Building) and visited two or more laboratories in each.

General Impressions

We observed that compliance with the MPC was high. Most laboratories had good housekeeping practices and interactions with laboratory staff were generally positive. It was clear that a system for managing laboratory wastes is in place at BC and that laboratory workers are familiar with the system and how it works. Most laboratory staff appeared to be well informed with respect to both the chemical waste management requirements and the location of laboratory waste accumulation areas, spill kits, postings and the inspection checklist.

There were only two items on the audit checklist where more than one "infraction" was recorded among the seven labs visited. The most frequent problems came up over labels (5/7), and most of the time it was the failure to check appropriate hazard boxes. Another common observation was that writing on labels was smudged and unreadable if the label had been wet.

The other checklist item for which a problem was noted was container condition and storage. In one case bottles were piled in a secondary container. In the other, waste storage was on the floor near a door in a high traffic area. In both cases recommendations were made and the problems fixed on-the-spot.

Relevance to the Regulatory Agency Inspection and Project XL Program Review

It should be noted that the number of laboratories visited represents less than 10% of BC's total. Thus, this is not meant to be an exhaustive review of the effectiveness of BC's Environmental Management Plan. However, based on this laboratory assessment, it is my opinion that the University's next action steps in preparing for a regulatory inspection should be based on the types of deficiencies we observed, and should focus on the labs in which multiple deficiencies were observed.

We did not have sufficient time to review the EMP in detail as part of this audit visit and therefore did not assess conformance of the BC EMP with the requirements described in the rulemaking. A regulatory inspection would include such a review. Therefore, the results of this audit may not be the same as one conducted by a government agency.

As you know, the success of the Lab XL project is important not only to BC, but also to the national audience of laboratories in higher education that continues to struggle to comply with traditional hazardous waste (RCRA) regulations in laboratories. BC has made a good start in demonstrating that the XL model is a reasonable alternative to RCRA in laboratory settings in that it grants compliance flexibility in certain areas and relies on the University to conform to certain standards developed by and for the University. We expect that the University will continue to work to improve its management of laboratory chemical waste in order to continue to demonstrate the value of this alternative regulation.

In summary, a system for managing laboratory wastes is operating effectively at Boston College. While some problems were found with chemical waste management, these were not unusual in a laboratory setting in either quantity or severity. These deficiencies can be corrected immediately and can be prevented through the continued development and implementation of the University's Environmental Management Plan, which is built on a continuous improvement system model.