University of Vermont Lab XL Progress Report

INTRODUCTION

The University of Vermont Environmental Management Plan (EMP) was accepted by the State of Vermont's Department of Environmental Conservation on December 28, 2000. The UVM Environmental Safety Facility (ESF) staff has spent the last six months engaged in a variety of activities designed to support the implementation of the EMP in University laboratories. These activities include conducting training sessions for laboratory workers, performing internal and external lab compliance audits, managing clean-outs of excess stored chemicals, and decommissioning laboratories in preparation for moves or renovation. This report describes our progress during this implementation process June 28, 2001 using the nine Environmental Performance Indicators (EPIs) designatedby the Project XL Final Project Agreement (FPA).

We are proud of our progress to date; however, it will be observed that some of the performance results do not yet meet the goals suggested in the FPA. It should be remembered that the EMP is not yet fully implemented and that many of the goals are expected to be achieved over the four-year life of the project. This report describes the trends demonstrated by the EPI's over the first six months of implementation and some of the lessons learned in the process. UVM remains committed to continuous improvement and the achievement of the goals described in the FPA.

EPI #1: OUTDATED CHEMICALS ON SHELVES

UVM has a Hazardous Chemicals of Concern (HCOC) survey procedure in place, but has not yet determined how best to use the survey process to measure the number of outdated chemicals on laboratory shelves.

Our HCOC survey process includes lab workers identifying and disposing of outdated materials while completing the form on an annual basis. The success of this approach has been demonstrated by the increase in the amount of laboratory waste pick-up requests we receive within weeks of the survey being distributed. We do not, however, specifically track HCOC chemical disposals nor do we confirm the absence of outdated chemicals on shelves. This is partially because the concept of "outdated chemicals" is ambiguous in most cases and many laboratory workers find ways of reliably using chemicals that are beyond the manufacturer's expiration date. After the EMP is fully implemented, ESF staff will investigate ways of developing a more quantitative approach to this issue.

Despite this lack of a specific indicator about the size of this problem, ESF staff has been pursuing the issue of management of outdated HCOCs this year. Specifically, about 50 laboratories within the College of Medicine are being decommissioned, moved or renovated as a result of space reallocations. As these rooms are turned over, ESF staff provides clean-out assistance to the laboratory workers to make disposal of excess chemicals as easy as possible. Twenty-three laboratories from the College of Medicine have asked for this assistance.

In addition to the laboratory clean-outs in the College of Medicine, the internal and external audits described in EPI #9 have found two situations where a large number of excess chemicals were in storage: in the Chemistry Department stockrooms in the Cook Building and in the Agricultural Biochemistry stockrooms in the Hills Building. UVM has contracted with Heritage Environmental to conduct the work of inventorying, packaging and disposing of these chemicals. This work, estimated to cost more than $100,000 will be conducted this July. This issue is further discussed in the section on EPI #5 below.

EPI #2: HAZARDOUS CHEMICALS OF CONCERN INVENTORY

The 2001 UVM Hazardous Chemical of Concern survey took place between February 1, 2001 and March 31, 2001. This survey procedure was developed about 10 years ago in order to prepare a SARA Title III report for the Vermont Department of Emergency Management, and that continues to be its primary purpose. For a complete description of the process, refer to the Project XL Baseline Report. A copy of the most recent survey report (59 pages) is available upon request.

Participation in this year's HCOC survey was disappointing. HCOC forms were returned by 251 laboratories in time to be included in the SARA Title III submission. This number represents about 45% of the universe of UVM's laboratories. This return rate is below the historical response rate of between 60 and 80%. We attribute this decline to the fact that five new forms implementing the UVM Environmental Management Plan were distributed to the labs at the same time as the HCOC survey. This array of new information requests might have drawn attention away from the deadline associated with the HCOC survey. In addition, many laboratories in the College of Medicine did not complete the forms because they were planning to move within 3 months as part of the space reallocation and expected to conduct significant chemical clean-outs as part of that effort.

Our plan for improving this response rate next year will be to implement a web-based version of the form to facilitate data input by laboratories. In addition, the other forms in the EMP implementation packet will already have been distributed and implemented, so increased emphasis can be placed on the HCOC inventory requirement.

EPI #3: POLLUTION PREVENTION ASSESSMENTS

The third EPI tracks the number of laboratory pollution prevention assessments conducted on campus during the year. In 2000, there were three primary areas of concentration in this respect. Together, these three P2 initiatives reduced real off-site environmental impacts associated with discrete activities common to many labs. These initiatives were successful, in large measures, because they could be implemented without interfering with core activities or research. These efforts are described below in excerpts from UVM's annual Pollution Prevention Progress Report to the Vermont Department of Environmental Conservation.

Photographic Chemical Initiative

The University's Environmental Safety Staff have been working with staff responsible for photographic darkrooms in an effort to reduce the hazardous waste generated as spent photochemicals. The following options have been evaluated in various darkrooms:

1. Collecting photochemicals for management as hazardous waste;

2. Using commercial silver collection/filtration systems that reduce the silver content below 5.0 mg/L (0.029 mg/L in one instance);

3. Relying on tightly controlled processes that reduce the silver content below 5.0 mg/L (down to 0.117 mg/L in this instance);

4. Using digital image technology, which eliminates the chemical developing process completely.

The option selected for each darkroom will depend on specifics of that darkroom's operation. Environmental Safety personnel offer assistance with these efforts including education of users and collection of samples for analysis. This effort will continue in 2001.

Chemicals in the Art Department

Chemical wastes from Art Department studios are managed under UVM's Environmental Management Plan. The University's Art Department has a history of conscientiously reducing the

potential hazard to personnel health and safety as well as the environmental impact of creating and teaching art. Several years ago, water based inks replaced petroleum based inks in the print studio and oil paints were replaced with acrylic.

In 2000, Environmental Safety staff sampled the washings from students' paint brushes and arranged for lab analysis. The results showed significant concentrations of cadmium and selenium. As a result Art Department faculty discontinued the use of any paint, including water based paints, containing selenium and cadmium, in the teaching studio.

Mercury Thermometer Swap

In November 2000, UVM was presented with the "Governor's Award for Environmental Excellence in Pollution Prevention" in recognition of the mercury thermometer swap which was instituted in 1997 and continues still. The ESF maintains a stock of environmentally friendly thermometers in our chemical distribution program for voluntary replacement of mercury thermometers at no cost to University faculty and staff. Individuals in research laboratories continue to be active in our mercury thermometer exchange program. See EPI #4's discussion of the ChemSource program for statistical information about this effort.

EPI #4: AMOUNT OF LABORATORY WASTE REUSED

The most significant hurdle faced in instituting a laboratory waste reuse program is that most laboratory workers are reluctant to use materials of uncertain quality. If researchers receive a chemical from a known, trusted source, they are likely to use it. This process is too informal to be documented or tracked. However, if a chemicals comes from a lab they are not familiar with, most laboratory workers prefer to use chemicals directly purchased from chemical suppliers. For this reason, at UVM, we have combined our chemical recycling program with a chemical distribution program called ChemSource.

ChemSource, which has been operating for five years, involves the Environmental Safety Facility staff buying new chemicals in case lots and breaking down those case lots into individual containers so that laboratories can realize case pricing savings without buying excess chemicals. This aspect of ChemSource works in combination with the redistribution of chemicals discarded by laboratories.

The activity measures for this program over the last five years are given in Attachment 1. These numbers indicate that strong patterns or trends have not yet developed in laboratories' use of the program. We believe that this is because research activities are not managed based on the chemical processes involved in the research as much as the ongoing research interests and findings of the laboratory personnel.

The numbers given in Attachment 1 cover calendar years from 1996 to 2000. Therefore, they do not cover the period that the EMP has been in effect at UVM. Based on these figures, we believe that the best measure of the success of the program at preventing pollution will be a increasing use of both the amount of both new chemicals and reusable chemicals redistributed. In fact, the one of the purposes of the new chemical distribution program is minimize the amount of reusable chemicals generated by laboratories.

EPI #5: LABORATORY WASTE DISPOSAL

The UVM hazardous waste generation report for calendar year 2000 is attached (Attachment 2). Because UVM has a Part B storage facility at which laboratory waste is sorted and repackaged for more economical disposal, the amount of waste shipped from campus is reasonably steady. For example, the amount of laboratory hazardous waste disposed of in 2000 was 4% more than in 1999. However, this was well within the standard deviation around the average amount of laboratory waste generated during the 1990's (36,800 pounds +/- 13%). Additionally, this amount of laboratory waste is 4% less than the previous year if normalized with respect to UVM research dollar basis (about 90% of UVM's research funding is related to laboratory work).

We expect that the amount of laboratory hazardous waste generated in 2001 will be significantly higher than average because of the aforementioned cleanouts. In 1996, a clean-out of the Chemistry stock room, smaller than the one planned for this summer, generated about 11,000 extra pounds of waste chemicals (30% above the annual average for the whole University). This resulted in the largest chemical waste numbers of the decade. The ESF staff is working with the departments involved in this summer's clean-out to establish chemical management practices to avoid this problem in the future.

EPI #6: ENVIRONMENTAL AWARENESS SURVEY

The results of the 2001 Environmental Awareness Survey of UVM Laboratory Workers are attached (Attachment 3). Again this year, 100 randomly selected laboratory workers completed the survey. Significant improvements in the overall score were seen on most questions. This can be attributed to the large training push made by ESF staff this spring (see EPI #7).

The demographic trends found by the survey (a larger percentage of the people surveyed were students and had less lab experience than the 2000 population) were probably the result of the random process of selecting people to participate rather than a change in the laboratory population.

EPI #7: TRAINING EFFORTS

One of the primary features of the EMP implementation process has been a major effort at training laboratory workers in laboratory safety, environmental management, and regulatory compliance issues. Between March 1 and June 28, 529 laboratory workers have attended training sessions conducted by ESF. This level of participation has resulted primarily from commitments by laboratory departments to assure that their laboratory workers attend these sessions, as well as vocal support from the Provost and Deans.

The laboratory worker training process will continue to be a partnership between Environmental Safety Facility department staff and the laboratory supervisor. In the coming year, UVM will implement a personnel training documentation system that is tied to the Human Resources database. This database, driven by the increasing complexity of managing regulatorily-required trainings for health and safety issues, will make it significantly easier for both departments and ESF staff to track employees that are working in laboratories and the required training they receive. We expect that this capability will improve campus-wide participation in required training efforts.

EPI #8: PROGRAM EFFECTIVENESS

The effectiveness of the UVM EMP is determined by its ability to meet the University's goals for its laboratory waste management program, which, for the pilot program period, are those stated in the Project XL FPA. A review of these goals reveals:

EPI #1 The absence of outdated chemicals on laboratory shelves is not yet measurable

EPI #2 Participation in the HCOC inventory process has not yet met the goal of 80%

EPI #3 Campus wide laboratory pollution prevention programs and assessments were conducted.

EPI #4 The amount of laboratory waste reused has not yet increased 20% relative to pre-EMP levels, however, the infrastructure to support this program improvement is in place

EPI #5 The total amount of laboratory waste disposed of did not decrease in 2000 when unnormalized data are used.

EPI #6 The Environmental Awareness Survey showed significant improvements in laboratory workers' environmental knowledge.

EPI #7 The number of laboratory workers who received training significantly increased this year.

EPI #8 Overall the 9 EPI's show mixed success: laboratory worker environmental awareness and training has increased significantly with some disappointments (HCOC survey participation, and measurement of outdated chemicals on shelves).

EPI #9 The external environmental audit showed significant compliance with the Minimum Performance Criteria of the XL regulation.

EPI #9: CONFORMANCE WITH THE EMP

Tracking of the laboratory conformance with the EMP is conducted through two methods: an external audit by representatives of the Campus Consortium for Environmental Excellence and internal auditing by ESF staff. The results of the external audit, based strictly on the Minimum Performance Criteria of the XL are presented in Attachment 4.

The internal audits conducted by ESF staff are based on a variety of considerations, including the XL Minimum Performance Criteria, the UVM Chemical Hygiene Plan, OSHA regulations, fire codes, and recommendations in *Prudent Practices in the Laboratory* by the National Research Council. Thus, these internal audits take significantly longer to conduct and track than the external audit protocol.

To date, 291 (about 48%) of campus laboratories have been through the internal audit process. 115 of these laboratories (42% of those audited) have closed out the audit process by notifying the ESF staff of the corrective actions taken to satisfy identified deficiencies. Any audited laboratories with outstanding corrective actions will be referred to the Chemical and Biological Safety Committee for follow-up at its July, 2001 meeting.

Attachment 1:
UVM ChemSource Statistical History
1996 - 2000

Year	Number of orders	Sales (dollars)	Chemicals Distributed (liters)	Ethanol Sales (gallons)	Chemicals Distributed (liters)	Thermometers Swapped
1996	Not available	Not available	574.5	628	118	2
1997	314	$14,063	687	788	11.5	1150
1998	450	$14,911	1064	933	58	50
1999	644	$18,987	1240	896	31.7	102
2000	636	$19,271	1147	869	31.5	87
Statistics for year 1998-2000						
Average	577	$17,723	1150	899	40	80
Standard Deviation	110	$2,439	88	32	15	27
Relative Standard Deviation	19.04%	13.76%	7.65%	3.57%	37.73%	33.60%

Attachment 2:

Hazardous Waste Generation at UVM Calendar Year 1998 - 2000

EPA or VT Waste Code	Name of Hazardous Wastestream	Process Generating Wastestream	2000 pounds	Percent of total	1999 pounds	1998 pounds
LABP	Compressed gas/aerosol	Research and Teaching			1707	1705
LABP	w/acute toxic	Research and Teaching	1098	1.2	6590	6206
LABP	w/corrosive	Research and Teaching	7322	8.1	7596	5023
LABP	w/corrosive & toxic	Research and Teaching	13		1181	2173
LABP	w/flammable liquid	Research and Teaching	13836	15.4	5858	7874
LABP	w/flammable & corrosive	Research and Teaching	562	0.6	4780	2256
LABP	w/flammable & toxic	Research and Teaching			6760	8106
LABP	w/flammable solid	Research and Teaching	519	0.6	830	664
LABP	w/toxic	Research and Teaching	6218	6.9		
LABP	w/oxidizer	Research and Teaching	237	0.3		
LABP	w/reactive chemicals	Research and Teaching	476	0.5	784	1178
LABP	w/mercury	Research and Teaching	332	0.4	615	621
LABP	w/ethidium bromide	Research and Teaching	2367	2.6	1945	
D001	Flammable Liquid	paint related activities	2700	3.0	3005	1925
D001, U122	formaldehyde lp and soln	Research and Teaching	2139	2.4		
D002	Corrosive liquid	Photographic waste	2700	3.0		
D006, D010	Cadmium and Selenium soln	Art room paint washing	450	0.5		
D008	Lead debris	Paint and print activities	950	1.1	14150	16750
D008, D006	Batteries	Maint, Teaching & Resch	329	0.4	425	1955
D008, D002	Batteries for recycle	Maint, Teaching & Resch	4300	4.8		
V106	non RCRA pesticides	Research and Teaching				1392
V108	ethylene & propylene glycol	Maintenance	6750	7.5	14000	42
Total Pounds			**89994**		**84158**	**76205**
	Pounds from research and teaching		38269		36701	37198
% increase of total pound since 1998			**18.1**	**%**	**10.4**	

Attachment 3:
UVM Environmental Awareness Survey Results – 2000 and 2001

100 UVM laboratory workers responded to the Lab XL Environmental Awareness questionnaire in April, 2000. A second random survey was conducted in June 2001. This table compares the results.

1. Which federal agency regulates the disposal of chemical wastes:	**2000**	**2001**
a. Occupational Safety and Health Administration	30	16
b. Environmental Protection Agency	69	84
c. Department of Transportation	0	0
d. National Institutes of Health	1	0
2. Ultimately, most chemical wastes generated in laboratories are:		
a. incinerated	26	47
b. sent to a land-fill	27	12
c. release to a sewer	9	11
d. treated	38	30
3. What are the four main reasons researchers should keep containers of laboratory waste securely closed except when adding chemicals?		
1 reason	29	19
2 reasons	46	61
3 reasons	25	17
4. Which costs more, purchase or disposal of laboratory chemicals?		
a. disposal costs more	78	87
b. purchase costs more	7	5
c. costs are roughly the same	15	8
5. In the book, "Prudent Practices in the Laboratory", what is the preferred waste management hierarchy for pollution prevention? Use a scale of 1-4 with 1 being the preferred management method.		
Source Reduction	52	67
6. What is the proper way to dispose of strong mineral acids?		
a. Dilution with water	6	6
b. Neutralization with lime	17	12
c. Collection for pick-up by hazardous waste personnel	77	82
d. Mixing with organic chemicals	0	0
7. What is the maximum amount of acutely hazardous laboratory waste that your laboratory is allowed to accumulate ?	31 correct	57 correct

8. What emergency response equipment is available in your laboratory to respond to a hazardous chemical spill?		
0	8	2
1-3 items	73	81
4-6 items	18	17
7 items	1	
9. How is waste water from your laboratory buildings treated?		
a. Purification before release to the sewer	19	11
b. pH is controlled by acid neutralization, then released to the sewer	9	6
c. Diluted with the rest of the building's water, then goes to the sewer for municipal treatment by aerobic digestion	72	82
10. In general, how are fume hood emissions controlled in your laboratory?		
a. Filtration to remove particles	22	18
b. Carbon filtration to remove gases	38	27
c. Dilution with laboratory room air	38	51
11. The last time you needed health and safety information about a particular chemical, what resource(s) did you use?		
0 responses	8	4
1 response	57	55
2 responses	25	36
3 responses	10	5
12. Typically, what is the largest environmental impact of laboratory work?		
a. release of toxic chemicals through the fume hood	2	6
b. disposal of toxic chemicals with a hazardous waste disposal company	29	24
c. release of chemicals to the sewer system	49	38
d. energy use to cool or heat laboratory space	20	32
13. The last time you disposed of laboratory hazardous waste, what four pieces of information did you put on the label?		
0	21	8
1-3	27	37
4-6	17	39
7-9	17	14
10	4	3

14. What document(s) describes how to dispose of laboratory hazardous waste at your institution?	0 correct responses (The Environmental Management Plan had not yet been publicized in campus laboratories)	32 correct
15. What is your current role in your laboratory?		
Faculty	9	9
Staff - Administrator	4	2
Staff - Lab Tech	56	42
Graduate Student	23	33
Undergraduate Student	7	9
16. How many years have you been working in college or university laboratories?		
less than 1 year	14	22
1-2 years	14	25
3-5 years	22	25
more than 5 years	50	28
17. Distribution of respondents by college		
Agriculture and Life Sciences	14	7
Allied Health Sciences	0	3
Arts and Sciences	16	26
Engineering and Math	2	5
Medicine	63	57
Natural Resources	5	2
86% of respondents in 2001 report having attended an ESF training session on the EMP		

Attachment 4: External Auditor's Report on UVM Compliance with Project XL Minimum Performance Criteria

April 18, 2001

David Hemenway
Chair, Chemical and Biological Safety Committee
University of Vermont

Dear Dr. Hemenway:

This letter is a summary of the findings of the third party audit team who reviewed the performance of University of Vermont's (UVM) laboratory chemical waste management program on April 9, 2001. As you know, this audit is the first in a series to be conducted over the 4 year Project XL pilot program to assess UVM's overall compliance with the Minimum Performance Criteria (MPC) specified in the Lab XL regulation.

I have enclosed a copy of the checklist that was used by the audit team (Attachment 1). The audit team consisted of 4 members, recruited by the Campus Consortium for Environmental Excellence from the health and safety departments of other New England colleges and universities (see Attachment 2). The audit team members were assisted by UVM Environmental Safety Facility staff. Four teams, each comprised of one external auditor and one UVM staff member, visited randomly selected laboratories in each laboratory building on campus. The teams assessed compliance with the MPC in the laboratories, and, where appropriate, advised laboratory workers of any deficiencies and appropriate corrective actions.

Forty-eight laboratories were visited. As we discussed at the audit closing conference, in general, compliance with the MPC was high, especially considering that the Environmental Management Plan has only been in effect since its approval by the State of Vermont on December 28, 2000. Most laboratories had good housekeeping practices and interactions with laboratory staff were generally positive. Overall, laboratory staff appeared to be well-informed about the chemical waste management requirements.

Specifically, the majority of laboratories (29) visited had no more than one deficiency reported. The average number of deficiencies found for the whole group of 48 labs was 1.5 out of fifteen items on the checklist. The most common problem found concerned the proper labeling of laboratory waste; 50% of the laboratories visited had some deficiency in this respect. Other significant problems found include container closure issues (21% of laboratories visited); evidence of release of chemicals within the laboratory (12%); and over accumulation of laboratory waste (17%). All other deficiencies were found in less than 10% of the laboratories visited.

A summary of the deficiency rate of each survey item is enclosed as Attachment 3. We understand from the Environmental Safety Facility staff that UVM will follow up on the problems found and resolve them as soon as possible.

It should be noted that the number of laboratories visited represents just less than 10% of UVM's total. Thus, this is not necessarily a conclusive review of the effectiveness of UVM's Environmental Management Plan. In addition, we did not have time to review the EMP in detail as part of this audit visit. 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 UVM, but also for the national audience of laboratories in higher education struggling with complying with traditional hazardous waste (RCRA) regulations in laboratories. UVM has made a good start in demonstrating that the XL model is a reasonable alternative to RCRA in laboratory settings. 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, while some problems were found with chemical waste handling in UVM laboratories, these were not unusual in a laboratory setting in either quantity or severity; most are easily resolvable. Continued development and implementation of the University's Environmental Management Plan can be expected to prevent the recurrence of these problems. Please let me know if you have any questions about this report.

Congratulations on the University's performance!

Sincerely,

Thomas Balf
Nexus Environmental Partners

Attachment 2 to Audit Report

Third Party Audit Team
University of Vermont
April 9, 2001

Thomas Balf, Nexus Environmental Partners. Boston, Massachusetts
Zehra Schneider-Graham, University of Massachusetts Boston, Boston, Massachusetts
David Messier, Worchester Polytechnic Institute, Worcester, Massachusetts
Richard Battistoni, St. Michael's College, Winooski, Vermont

Attachment 3 to Audit Report

Item by Item Audit Results at UVM
April 9, 2001

	% of visited laboratories in compliance
Item 1 Waste Labelling	50
Item 2 Quantity	100
Item 3 Removal Times	92
Item 4 Excess accumulation	100
Item 5 Container closure	79
Item 6 Container condition	92
Item 7 Containers compatible	100
Item 8 Evidence of release	88
Item 9 Emergency response procedures	92
Item 10 Emergency equipment	96
Item 11 Worker emer response	96
Item 12 Release reporting	96
Item 13 Waste movement	100
Item 14 Waste transport	100
Item 15 Training	92