LAB XL PROGRESS REPORT FOR 2005

UNIVERSITY OF MASSACHUSETTS BOSTON

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2005 Lab-XL EPI Overview

Introduction

2005 was another challenging year for UMB EH&S. As a result of previous staffing cuts, the main focus of EH&S was to re-organize the office and add staff. In March, we were able to hire an additional technician for the EH&S program so we spent some time familiarizing our new staff to our programs. In spite of our staffing challenges, we continue to maintain a strong laboratory presence, hence our XL program remains strong. We anticipate that the remainder of 2006 and early 2007 will consist of EH&S reviving/renewing training programs, conducting re-inventory of all laboratory chemicals, and launching some new initiatives. We hope to launch a campus-wide effort with a rollout of the updated on-line bar coding program to departments through our intranet. We hope to have a minimum of one staff person per laboratory department participating in the inventory program.

EPI Overview

EPI #1: Annual Surveys of Hazardous Chemicals of Concern

Results to date:

The goal of the first EPI is to assure that outdated hazardous chemicals of concern are appropriately removed from laboratory shelves and disposed properly.

As stated previously, UMass Boston is required by the Boston Fire Department to maintain chemical inventories for all labs. Therefore, all laboratories (100%) have had a survey of Hazardous Chemicals of Concern (HCOCs) and are required to maintain this inventory.

Lessons learned:

The bar code system is currently operated by EH&S and provides only a snapshot in time of any single lab's inventory.

To date, we have not been able to update our bar coding of labs because of information technology/software issues that had to first be overcome. We hope to be up an running with the updated program by the Spring 2007 semester. The system will allow us to verify that our existing tracking measures (e.g., purchasing records, PI updates, waste disposal) can be relied upon to provide accurate snapshots of chemical inventories. A re-inventory will allow us to determine how "accurate" our inventories are at a given time and may give us some information about movement of materials from one lab to another. The re-inventory will also allow more careful evaluation of trends in HCOCs on the shelf.

We hope to transfer some of the responsibilities to the researchers in terms of adding new materials. We also hope that this will provide more opportunities for redistribution among laboratories.

EPI #2: Verification of HCOC Surveys

Results to date:

The second EPI measures the participation rate in the HCOC inventory effort. As stated above, with all HCOCs have been identified, and surveys have been conducted for all (100%) labs.

EPI #3: Pollution Prevention Opportunity Assessments

EH&S continues to emphasize pollution prevention concepts during training and researchers are encouraged, during both waste pickups and lab inspections, to incorporate pollution prevention ideas such as product substitution, limited purchasing and waste minimization into their everyday work. The EH&S Office encourages researchers to examine pollution prevention opportunities at the time of experimental design and when they are developing their Standard Operating Procedures. After the experimental design process is in place, we remind them to purchase only what they need. Finally, we suggest that they determine whether a treatment method can be incorporated at the end of the experiment. As a relatively small university, we are able to remind and reinforce the P2 message with faculty, staff and graduate students during our many informal EH&S/researcher interactions.

We believe this approach is quite effective. In 2002/2003 we conducted a P2 survey of all UMB PIs. Results of that survey showed that 73%, nearly ¾ of all PIs had already downsized their experiments, substituted chemicals or changed their

processes to use less toxic material in their experiments. The survey also showed that 25% of the PIs would look to another laboratory if they run out of a chemical.

For the years 2004, 2005 and 2006 we embedded several P2 statements into our Annual Environmental Awareness Survey and asked respondents to rank the statements from 1-5 with 1 being "strongly agree " to 5 being "strongly disagree". As seen in Table 1, the survey results are very encouraging and indicate that:

Table 1. Environmental Awareness Survey Results for P2

Statement	% of respondents that agree or strongly agree with statement		
	2004	**2005**	**2006**
Believe it is the lab workers responsibility to reduce their environmental impact.	100	96	93
Believe they can produce 10% less waste.	40	40	41
Believe scientists should find safer chemicals to use in experiments.	95	81	82
Believe that it is their responsibility to make changes in order to produce	92	77	78

EPI #4: Hazardous Materials Reuse and Redistribution

Results to date:

EH&S continues to evaluate laboratory wastes for reuse when these materials are collected from labs. EH&S maintains a list of excess chemicals and publishes it on the EH&S website. PIs or laboratory workers may request excess re-usable chemicals on the list and EH&S will deliver the material to their laboratory. If an excess chemical remains in the EH&S inventory for more than 2 years, the material will be disposed of. As in previous years, there have been few inquiries or requests for these excess stock materials. Chemicals were requested from EH&S and delivered to laboratories on only two or three occasions in 2004. Due to the minimal reuse requests and accumulation of chemicals, EH&S contracted Clean Harbors Environmental Services Co. Inc. to clean out our entire chemistry stockroom. The total cleanout cost slightly more than $25,000. Currently we have no centralized "stock" for redistribution. We plan on re-establishing some stock as we conduct cleanouts of laboratories that are no longer in use.

Lessons learned:

We learned from previous years' Pollution Prevention (P2) surveys that P2 is already occurring and that PIs often (i.e., 25%) look to another laboratory if they run out of a chemical. PIs report that they have downsized their experiments, substituted chemicals or changed processes to decrease their use of toxic chemicals. These changes have occurred independent of EH&S efforts promoting a central chemical waste reuse program and measuring its success.

Clearly, EH&S cannot dictate how researchers do their work and an EH&S implemented P2 program will not be effective. However, a communication from EH&S to labs on a frequent basis may be of value in reminding researchers to think about P2. EH&S can affect attitudes, but can't dictate strategies or mandate reuse of spent chemicals.

EPI #5: Laboratory Waste Generation Rates

Results to date:

EPI #5 concerns the amount of laboratory waste generated. The data are presented in Figure 1 and Table 2. UMB's hazardous waste generation increased just above 6% from the previous year. In total however, we have maintained an approximate 19% reduction of hazardous waste since the beginning of the XL Pilot Program. We have also seen the reduction of certain highly hazardous wastes (e.g., organic peroxides, pyrophorics and for the first time this year, EPA P-listed waste material). It is impossible to determine whether these reductions are attributable to a better-managed program or these reductions simply reflect changes in research activities.

Figure 1. UMass Boston Total Laboratory Waste Disposal 1999-2005.

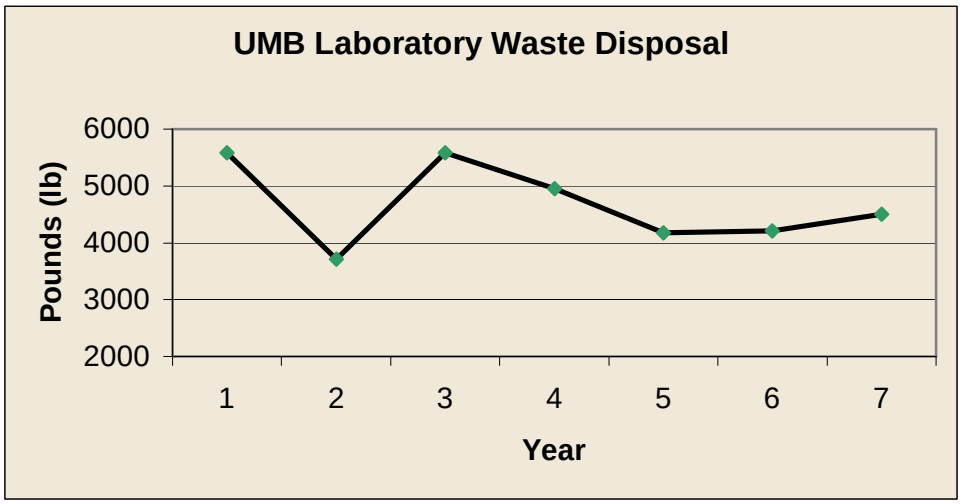

Table 2. UMass Boston Laboratory Waste Generation (in lbs)							
Waste Stream	*Calendar Year*						
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Labpack with poisons	192.83	335.57	1083.36	335.28	374.10	540.95	429.98
Labpack with corrosives	1161.46	959.94	2165.53	1497.22	919.95	1238.94	862.74
Labpack with acutely hazardous waste	31.48	2.00	16.78	8.39	18.78	8.85	0.00
Labpack with misc. hazardous waste	739.57	819.62	31.00	6.00	151.96	450.00	2.00
Labpack with organic peroxides	19.57	0.00	8.39	0.00	0.00	3.09	0.00
Labpack with spontaneous combustible material	11.68	0.00	1.00	14.00	2.00	3.25	30.0
Labpack with pyrophorics	21.34	10.00	28.39	9.00	2.00	3.00	1.00
Labpack with flammable liquids	2470.02	1168.39	1543.44	2010.64	1750.24	1393.06	775.73
Labpack with flammable solids	11.70	33.39	15.39	65.57	29.00	257.00	556.64
Labpack with oxidizers	148.48	121.75	225.10	303.42	52.39	153.64	238.00
Compressed gases and aerosols	264.27	20.00	156.39	15.57	40.39	62.00	9.00
Non-hazardous/non-regulated waste	512.07	240.00	310.00	690.00	830.00	100.00	1595.00
Total	**5584.47**	**3710.66**	**5584.77**	**4955.09**	**4170.81**	**4213.78**	**4500.09**
Total	**5584.47**	**3710.66**	**5584.77**	**4955.09**	**4170.81**	**4213.78**	**4500.09**
%Difference from previous year		**-33.75**	**+50.51**	**-11.27**	**-15.83**	**+1.03**	**+6.79**
Total % Difference from baseline							**-19.42**

Lessons learned:

Despite eight years of tracking hazardous waste generation at UMass Boston, it is still difficult to gain insight into any trends. While yearly totals continue to vary according to many factors, including type and amount of research, number of researchers and other factors, we have maintained for the third year an approximate 19% reduction from baseline in the annual generation of hazardous wastes from laboratories.

EPI #6: Environmental Awareness Survey

Results to date:

Summary results for six years of Environmental Awareness Survey data are shown in Table 3. We continue to use the modified survey developed last year. This newer survey contains questions were designed to elicit more feedback regarding pollution prevention and other attitudes/behaviors associated with a more mature management program. Many of the questions remain the same as in previous years to ensure year-to-year comparisons. A copy of the survey can be found in the Appendix. Only selected questions that were the same each year are included below in Table 3. The correct answer(s) is italicized.

Table 3. Environmental Awareness Survey Results

	2000	2001	2002	2003	2004	2005	2006
Number of Respondents	87	54	60	45	38	47	27
2. Ultimately, most chemical wastes generated in laboratories are:							
a. incinerated	*32%*	*17%*	*23%*	*18%*	*34%*	*21%*	*22%*
b. sent to a land-fill	15%	6%	10%	9%	18%	9%	11%
c. release to a sewer	23%	28%	12%	11%	16%	4%	4%
d. treated	*30%*	*49%*	*55%*	*53%*	*26%*	*72%*	*70%*
4. Which costs more, purchase or disposal of laboratory chemicals?							
a. disposal costs more	*51%*	*78%*	*77%*	*51%*	*71%*	*62%*	*70%*
b. purchase costs more	24%	4%	5%	17%	8%	28%	0%
c. costs are roughly the same	25%	18%	18%	15%	13%	13%	26%

Environmental Awareness Survey Results (cont)

	2000	2001	2002	2003	2004	2005	2006
9. What is the proper way to dispose of Strong mineral acids?							
a. Dilution with water	26%	13%	17%	9%	0%	13%	26%
b. Neutralization with lime	33%	24%	24%	24%	13%	28%	30%
c. Collection for pick-up by hazardous waste personnel	*8%*	*56%*	*53%*	*42%*	*76%*	*62%*	*59%*
d. Mixing with organic chemicals	8%	0%	3%	2%	0%	0%	0%
e. Other	25%	7%	3%	0%	6%	0%	0%
Number of Respondents	87	54	60	45	38	47	27
10. In general, how are fume hood emissions controlled in your laboratory?							
a. Filtration to remove particles	21%	17%	40%	13%	34%	43%	41%
b. Carbon filtration to remove gases	30%	20%	35%	40%	29%	32%	33%
c. Dilution with laboratory room air	*24%*	*63%*	*13%*	*20%*	*32%*	*6%*	*11%*
d. No hoods in lab		0%	7%	4%	0%	2%	4%
Unknown		0%	5%	22%	3%		

	2000	2001	2002	2003	22004	2005	2006
12. Typically, what is the largest environmental impact of laboratory work?							
a. release of toxic chemicals through the fume hood	15%	6%	2%	2%	23%	15%	22%
b. disposal of toxic chemicals with a hazardous waste disposal company	25%	19%	25%	22%	*63%**	*62%*	*70%*
c. release of chemicals to the sewer system	32%	48%	47%	29%	0%	0%	0%
d. energy use to cool or heat laboratory space	*15%*	*13%*	*23%*	*40%*	*23%**	*15%*	*19%*
Unknown	13%	14%	3%	7%	3%	0%	
	*most gave more than one answer						
Faculty	22%	28%	18%	18%	35%	11%	15%
Staff - Administrator	6%	2%	2%	0%	2%	11%	7%
Staff - Lab Tech	11%	17%	17%	20%	8%	21%	26%
Graduate Student	15%	30%	40%	45%	50%	32%	33%
Undergraduate Student	46%	23%	23%	18%	5%	23%	19%
16. How many years have you been working in college or university laboratories?							
Less than 1 year	40%	22%	16%	13%	13%	21%	19%
1-2 years	22%	20%	39%	18%	21%	27%	26%
3-5 years	10%	17%	20%	16%	18%	21%	33%
more than 5 years	28%	41%	25%	38%	47%	26%	22%
Respondents Trained in CH/EM Plan	0%	68%	47%	53%	71%	38%	67%

Lessons learned:

Respondents generally continue to score at levels recorded during the past three years, or slightly higher. The audience for the surveys has differed over time. This year's respondents were comprised of 50% faculty and staff and 50% students. The environmental awareness survey continues to provide important feedback with respect to the effectiveness of the EMP at UMB. The results of the survey continue to give us valuable information about the issues that require greater explanation during outreach efforts. Additionally, it gives us an objective measure of how effective our training efforts have been in reaching the laboratory population of interest and generating ideas about how to improve our training.

EPI #7: Environmental Awareness Training

Results to date:

EPI #7 measures the amount of training conducted for laboratory workers with regard to environmental compliance and awareness. EH&S has built an accurate training database. Each year, we send out forms to the PIs asking them to identify all laboratory personnel under their supervision that require training based on criteria for training listed in our Integrated Chemical Hygiene and Environmental Management Plan. Our criteria is: ALL laboratory faculty, staff, and graduate students must complete training in the Project XL laboratory regulations. Undergraduate students are included only if they are conducting independent study or work-study. EH&S has entered the information into a database and is able to generate the information on a yearly basis for the PI to update. This ensures that our training records are accurate and up-to-date. The last update to the training database occurred in the Fall of 2005. The number of laboratory workers trained in the CH/EM Program remains consistent with last two years at about 60% but is still lower than the high of 89% in 2002 when we were rolling out the full XL/Lab training program.. We have continued to train new staff and students at the beginning of each semester. We also make an effort to notify those who have not attended a training session that there are sessions available. As always, training also occurs on an informal basis during laboratory pickups and inspections. We anticipate updates to our training database in November 2006.

Lessons learned:

As long as we are flexible and available to provide training in a variety of settings, we should continue to have a high training rate. Additionally, the use of an accurate database, based on information from the PIs, is critical to insure that we are training the correct population. We continue to find that even though current formal training numbers are low, it is evident that informal training is highly effective based on improved laboratory audit scores and by the responses on our Environmental Awareness Survey. In fact, we believe that the training of key personnel (PIs and lab supervisors) early in the project and our strong management

system , with clear guidelines and standards, results in strong performance overall, even in years when few new individuals are trained.

EPI #8: Environmental Management Program Effectiveness

The following list summarizes progress toward the goals of the XL Program as set for in the Project XL FPA. The Project XL goals have acted as the de facto environmental "objectives" for the EH&S Department with respect to the management of laboratories

- 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 from the bar-coding system. All HCOCs have been identified and flagged on the inventories.

- EPI#3. P2 continues to be an area that we would like to improve. We anticipate trying to get more involvement from the Chemical Hygiene Committee and potentially the Dean of Sciences.

- EPI#4. We have currently cleaned out all of our stock available for redistribution. We hope to collect a small amount of material going forward.

- EPI #5. The amount of laboratory waste disposed of increased slightly (i.e., 6%) for 2005 compared to 2004, but is a 19% decrease from the project baseline year.

- EPI#6 The Environmental Awareness Survey was completed and the results are similar to survey results from 2004.

- EPI#7. The number of laboratory workers trained each year in the CH/EM Plan remains at approximately 60% of the lab worker population. All new workers receive training.

- EPI#8 Some EPIs are on-track (decrease in laboratory waste disposal, outdated chemicals, internal and external audits); while others like pollution prevention continue to need more attention.

- EPI#9. Audits continue to show significant compliance with the Minimum Performance Criteria of the XL Regulation. Overall results were similar to last year. It appears as though the only way that scores can increase in the future is to implement a large-scale

P2 program for all laboratories. It is not clear to us that such a large-scale effort is feasible or effective.

EPI #9: Environmental Management Plan Conformance

Results to date:

UMB EH&S staff conducted annual laboratory inspections in June and July 2006 to measure conformance with the Environmental Management Plan. For 2006, inspections were completed, and the results continue to show progress. See Figure 2.

Again, we utilized the C2E2 "audit grading" system that converts the results of the laboratory audit checklist used by the pilot schools into grades on the issues most important to the Lab-XL project:

- Chemical container management
- Laboratory housekeeping
- Pollution prevention
- Laboratory self inspections
- Training and awareness

This grading system was applied to UMB laboratory inspections previously conducted in 2000, 2001, and 2002. The range of the grading system was from 0 to 11 with 11 being the highest score. In applying scores to each laboratory for the categories listed above, certain assumptions were made. Since training in the Environmental Management Plan was not initiated until 2001, each laboratory was assigned a score of '0' for the 'Training and Awareness' category prior to 2001. In addition, the UMB pollution prevention program was not initiated until 2001, so each laboratory received a score of '0' for the Pollution Prevention' category prior to 2001.

Certain assumptions were made for the 2002 scores as well. In conducting laboratory inspections, it was often impossible to ascertain whether or not everyone who worked in in a laboratory was trained or not, since some labs were unoccupied at the time of inspection and our training database was incomplete. EH&S personnel relied instead upon the presence of the EMP in a laboratory to determine training status. If the EMP was present in a laboratory, it was assumed that some of its regular occupants had been trained in the new regulations, since the Plan was distributed only at training sessions. Thus, a laboratory was assigned a score of '1' for the 'Training and Awareness' category if the plan was present, and '0' if it was not. In both cases, self-inspection grades were based solely on the one page checklist that laboratories send to EH&S monthly, not on the container self-inspection checklists posted in each laboratory. In many cases, the posted checklists were filled out even if the monthly self-inspection sheets had not been sent to EH&S.

For 2003-2006 inspections, audit forms were completed during the inspection and the scores are based on actual observations for container management, housekeeping and self-

inspection. For training, EH&S records were examined. All laboratories were given a score of 1 for pollution prevention, which is consistent with previous years.

2006 results are presented in Table 4.

Figure 2. Average XL Audit Scores for 2000-2006.

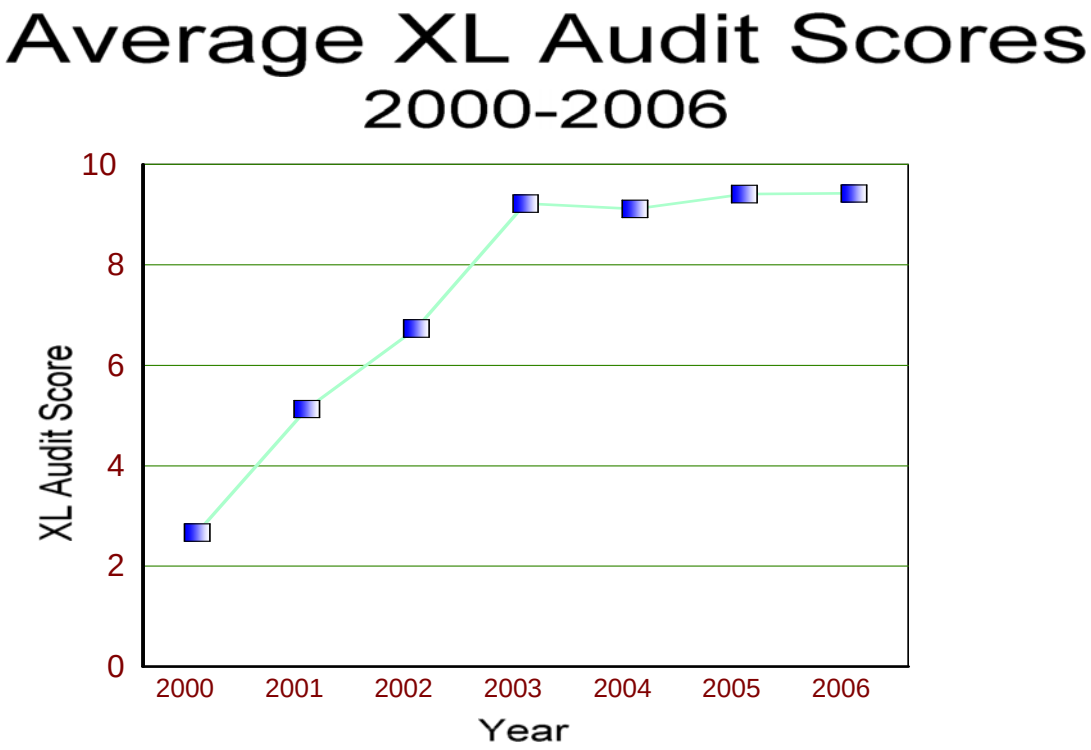

Table 4: 2006 Audit Grading Results at UMass Boston

Score	Container Management	House-keeping	Pollution Prevention	Self inspection	Training	Total Grade
NA						
0	0	0	0	0	0	
1	0	21	113	30	5	
2	9	92		83	108	
3	104					
4						
5						
6						
7						1
8						12
9						38
10						62
Total	113	113	113	113	113	113
Average Score						9.42

Lessons learned:

For laboratory inspections we continue to see good conformance with our EMP. Average audit scores have risen consistently. No lab scored below 7 which was an improvement from last year.

APPENDIX 1

Table 5: UMB Lab Worker Environmental Awareness Survey Spring 2006 (27 Responses)					
Question	**Response chosen (%)**				
1. When I need health/safety information about a chemical I consult (indicate the two most common sources):	*MSDS* 63 %	*Merck Manual* 26%	*Hazardous Chemical Desk Reference* 22%	*Supervisor* 26%	*A Lab Colleague 41%*
	Use of toxic chemicals	*Utility use (energy and water)*	*Hazardous waste production*	*Biomedical/sharps waste production*	*Animal waste production*
2. Which of these factors do you think is the largest overall environmental impact of laboratory work:	22%	19%	70%	11%	4%
3. Which of these factors do you think is the largest overall environmental impact of laboratory work:	19%	22%	56%	15%	4%
4. The purpose of a fume hood is to protect (pick the best answer as it applies to your work):	*The laboratory worker* 93%	*the laboratory* 15%	*The laboratory building and its occupants* 0%	*The outside environment* 4%	
	1 Strongly agree	**2**	**3**	**4**	**5 Strongly disagree**
5. It is the responsibility of every lab worker to minimize the environmental	78%	15%	7%	4%	0%

impact of their work.					
6. With careful planning, I would be able to produce 10% less laboratory waste without affecting my research.	26%	15%	11%	15%	4%
Question	**Response chosen (%)**				
7. Hazardous waste is a necessary byproduct of chemical research.	15%	22%	41%	11%	7%
8. It is important for scientists to find safer chemicals to use in their experiments.	67%	15%	7%	11%	0%
9. It is not my responsibility to make changes in the way my research is done in order to produce less hazardous waste.	4%	4%	15%	30%	48%
10. I have seen articles about pollution prevention in research in my discipline's journals.	11%	26%	26%	7%	15%
11. What is the proper way to dispose of strong mineral acids?	*Dilution with water* 26%	*Neutralization with lime* 30%	*Collection for pick-up by hazardous waste personnel* 59%	*Mixing with organic chemicals* 0%	
12. Ultimately, most chemical wastes generated in laboratories are:	*Incinerated* 22%	*Sent to a landfill* 11%	*Released to a sewer* 4%	*Treated* 70%	
13. In general, the	*Less than*	*Equal to*	*A little more (less than*	*A lot more (more than*	

cost of disposal of a chemical is _____ the cost of buying that chemical.	0%	26%	*twice as much)* 41%	*twice as much)* 33%	
14. In general, how are fume hood emissions treated before being released to the environment?	*Filtration to remove particles* 43%	*Carbon filtration to remove gases* 33%	*Dilution with laboratory room air* 11%	*Scrubbing to remove particulates, gases and toxics* 15%	No fume hood in laboratory 4%
15. Please check the types of laboratory worker training you have received at UMB.	*CH/EM Plan* 67%	*Radiation Safety* 33%	*Bio safety* 7%	*Laser safety* 0%	Other 11%
16. What is your current role in your laboratory?	*Faculty* 15%	*Staff-Technician* 26%	*Grad student* 33%	*Undergrad student* 19%	Staff 7%
17. How long have you been working in a university lab?	*less than 1 year* 19%	*1-2 years* 26%	*3-5 years* 33%	*more than 5 years* 22%	
18. Have you completed an XL Environmental Awareness Survey in the past?	*Yes* 37%	*No* 63%			