



# Toxics Use Reduction Act Program Assessment

JUNE 2009

TURI Methods and Policy Report #26

**TURI**  
TOXICS USE REDUCTION INSTITUTE  
University of Massachusetts Lowell

*Making Massachusetts a Safer Place to Live and Work*

# **Massachusetts Toxics Use Reduction Act Program Assessment**

June 2009

## **Prepared by the Massachusetts Toxics Use Reduction Institute**

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### The Toxics Use Reduction Act (TURA) Program is implemented by the following state agencies:



Massachusetts  
Department  
of  
ENVIRONMENTAL  
PROTECTION

**Massachusetts Department of Environmental Protection (MassDEP)**  
One Winter Street, Boston, MA 02108-4746; 617-292-5500  
[www.mass.gov/dep/toxics/toxicsus.htm](http://www.mass.gov/dep/toxics/toxicsus.htm)

*Certifies Toxics Use Reduction (TUR) Planners, receives and reviews toxics use reports submitted by companies, provides guidance, takes enforcement actions, and collects chemical use data and makes it available to the public.*



**Office of Technical Assistance & Technology (OTA)**  
100 Cambridge Street, Suite 900, Boston, MA 02114; 617-626-1060  
[www.mass.gov/eea/ota](http://www.mass.gov/eea/ota)

*A non-regulatory agency within the Executive Office of Energy and Environmental Affairs that provides free, confidential, on-site technical and compliance consultations to Massachusetts businesses and institutions.*



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*Provides education, training, and grants for Massachusetts industry and communities; sponsors research and demonstration sites on cleaners, safer materials and technologies; provides policy analysis; and manages the TURA Science Advisory Board.*

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## Glossary of Acronyms

BRI	Byproduct Reduction Index
CMBEN	Central Massachusetts Business Environmental Network
DEHP	Di-(2-ethylhexyl) phthalate
EHS	Environmental Health and Safety
EMFACT	Energy and Materials Flow and Cost Tracker
EMS	Environmental Management System
ERP	Environmental Results Program
HAP	Hazardous air pollutant
HVLP	High volume, low pressure
LED	Light-emitting diode
MassDEP	Massachusetts Department of Environmental Protection
MDI	Methylene diphenyl diisocyanate
MEK	Methyl ethyl ketone
NEWMOA	Northeast Waste Management Officials Association
NBEN	Northeast Business Environmental Network
OPAC	Online Public Access Catalogue
OTA	Massachusetts Office of Technical Assistance and Technology
P2	Pollution Prevention
PBT	Persistent, Bioaccumulative, & Toxic
REACH	Registration, Evaluation, and Authorization of Chemicals
REC	Regional Environmental Council
RoHS	Restriction of Hazardous Substances
SPIN	Safe Products in Neighborhoods
TCE	Trichloroethylene
TDI	Toluene diisocyanate
TSCA	Toxic Substances Control Act
TUR	Toxics Use Reduction
TURA	Toxics Use Reduction Act
TURI	Toxics Use Reduction Institute
UL	Underwriter Laboratories
US EPA	United States Environmental Protection Agency
VietAID	Vietnamese American Initiative for Development
VOC	Volatile Organic Compound

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## **Executive Summary**

### **Toxics Use Reduction Act (TURA) Program Assessment**

#### ***1. Introduction***

Enacted in 1989, the Massachusetts Toxics Use Reduction Act (TURA) has been in effect for two decades. During this time, Massachusetts firms have achieved remarkable reductions in their use of toxic chemicals while achieving financial savings and maintaining their competitiveness in global markets.

In 2006, amendments were made to TURA. These changes were designed to update program elements, ensure continued relevance for Massachusetts facilities, and expand the program's focus on the chemicals of highest concern.

The experiences of the TURA program in its early years were assessed and documented in a comprehensive program assessment that was published in 1997. The adoption of the 2006 amendments, along with the approaching 20<sup>th</sup> anniversary of the TURA program, served as an occasion for the program once again to look back at its experiences, and identify opportunities and new directions going forward. Thus, in 2008 the Toxics Use Reduction Institute (TURI) undertook an assessment of the TURA program. This report presents the findings of this assessment.

The assessment presents a review of TURA program activities; a review of prior studies of the TURA program; the results of an online survey and telephone interviews with Massachusetts companies and consultants conducted by the consulting firm Abt Associates; and results from a survey and interviews conducted with organizations served by the Institute's Community program. Implications of the TURA program for the Massachusetts economy will be discussed in a separate report.

#### ***2. Program description***

TURA requires certain Massachusetts companies to report their use of toxic chemicals and examine ways to decrease their use of toxic chemicals and wastes generated, with the goal of protecting public health, the environment, and workers, while helping businesses become more competitive. TURA is implemented by three Partner agencies – the Massachusetts Department of Environmental Protection (MassDEP), the Office of Technical Assistance and Technology (OTA), and TURI. The program activities of these agencies can be grouped into eight broad categories.

- *Training programs.* A core means of ensuring that firms have access to TUR knowledge is to provide training for toxics use reduction (TUR) planners. These individuals work with facilities and certify their toxics use reduction plans. Every year, TURI provides a seven-week course to train individuals interested in becoming TUR planners. In addition, TURI, OTA and MassDEP offer continuing education workshops and conferences for TUR planners and others. Both the training course and the continuing education events provide regular opportunities for the program to convey useful new information on technical and policy issues to Massachusetts facilities.

- *Site visits.* OTA provides on-site assistance to facilities, helping them to identify and implement toxics use reduction options that are tailored to their particular needs. As of 2009, OTA has performed more than 3,300 on-site visits and provided an estimated 15,000 recommendations to Massachusetts facilities. The TURI Laboratory also provides site visits to individual facilities in association with laboratory testing activities.
- *Grant programs.* The TURA program uses a portion of its budget to invest in companies, academic researchers and communities that are implementing or investigating innovative TUR opportunities. Grants are provided for industry demonstration sites; environmental management system peer mentoring activities; university research; and projects carried out by municipalities, community organizations, and small businesses.
- *Information services.* TURI, OTA and MassDEP provide extensive information via library services, publications, and internet materials. The TURI Library provides access to over 5,000 books, reports and case studies and more than 50 journals and industry-specific magazines. TURI and OTA have published approximately 150 technical reports, policy reports, and detailed case studies. Other materials include demonstration site reports, brochures, tip sheets, and chemical fact sheets. The TURA program also provides a publicly searchable website showing detailed toxics use data reported by companies since 1990. This unique data set provides a rich source of information for industry, governments, academic researchers, and the public.
- *Compliance assistance and enforcement.* MassDEP implements the regulatory components of the TURA program, including ensuring that facilities comply with their TURA obligations and providing guidance on planning and reporting activities. OTA also provides extensive compliance assistance, helping facilities to comply with the full range of applicable state and federal regulations.
- *Laboratory activities.* The TURI Laboratory works with Massachusetts companies to identify safer alternatives for cleaning and degreasing applications. The Laboratory's activities include one-on-one assistance to individual companies, as well as research and development activities. The Laboratory's extensive online database assists companies in rapid evaluation of substitution opportunities. Since 1993, the Laboratory has helped hundreds of companies to identify and adopt safer alternatives to hazardous cleaning solvents. The Laboratory also works with community organizations and small business associations to identify, test, and implement safer alternatives.
- *Engagement with industry and communities.* In addition to the activities discussed above, the TURA program engages with industry and communities to facilitate specific efforts to reduce the use of toxics. Activities include convening work groups, sponsoring sector-specific training events, and providing technical information requested by small businesses or community organizations. Industry projects include supply chain activities with the electronics industry and the wire and cable industry; the creation of an innovative business environmental network; and facilitation of government and private sector dialogue around safer development of nanotechnology. Community engagement activities include projects to promote toxics use reduction in specific sectors such as cosmetology and dry cleaning, as well as extensive work with Massachusetts public schools.

- *Policy engagement.* Policy activities of the TURA program include educating Massachusetts companies about policies relevant for their businesses nationally and internationally; reviewing and acting upon scientific information relevant to the maintenance of the TURA list of toxic and hazardous substances; and developing and implementing alternatives assessment methodologies. The TURA Administrative Council, led by the Executive Office of Energy and Environmental Affairs, ensures coordination and consistency in state policy related to toxics. The TURA Science Advisory Board provides scientific analysis to inform policy decisions, and the TURA Advisory Committee, a stakeholder group, provides advice to the Administrative Council and the implementing agencies. Upon request, TURA program staff provide information to policy-makers and others working to replicate the TURA model outside Massachusetts.

### **3. Existing studies of the TURA program**

A number of analyses of the TURA program have been produced over the nearly two decades that the legislation has been in effect. The TURA program itself produces annual reports that present and analyze data submitted by companies using toxic chemicals. A program evaluation completed in 1997 looked at the first six years of the program, analyzed trends, and provided information on the cost savings achieved by companies participating in the program.

A 2006 study by OTA analyzed the TURA data for firms that received on-site technical assistance visits versus those that did not. The data analysis showed that visited companies reduced their toxics use by an average of 9% more after being visited by OTA, than before.

In addition to these analyses produced by the TURA program itself, scholars outside the program have provided analysis and commentary. In some cases, these studies have been motivated by interest in replicating the successes of the TURA model in other jurisdictions. For example, since 2006, the government of California has sponsored a series of reports and convened a high-level working group to consider options for chemicals policy reform in the state. The reports have featured detailed consideration of the TURA program as a key model for new initiatives in California. The government of the Canadian province of Ontario has studied the TURA program in detail as part of its effort to replicate the TURA model. Finally, the program has occasionally received letters from stakeholders providing detailed information on their experiences with the TURA program. These letters provide useful information to supplement the findings of formal studies of the program. The authors of the present report examined each of these sources to identify lessons learned and directions for further investigation.

The 1997 program evaluation found that the TURA program had been effective in reducing Massachusetts facilities' use of toxic substances while providing opportunities for facilities to achieve financial benefits. Recommendations and areas for improvement identified in the 1997 program evaluation included consolidation of chemical use reporting systems; identifying technological gaps that could be impeding progress in TUR, particularly related to product quality concerns and customer requirements; rewarding firms that have made progress in TUR and focusing assistance on those that have been less successful; working with smaller quantity toxics users to ensure they make progress in tandem with larger firms; applying the principles of TUR planning to areas other than use of toxic chemicals, such as water and energy use; and analyzing health and environmental effects of toxics in

consumer products during use and disposal. Studies produced independently of the TURA program highlighted many of the same themes.

Some of the recommended changes were adopted in the 2006 amendments to TURA. For example, the 2006 amendments have made it possible for the program to extend its reach to some, though not all, smaller toxics users. The 2006 amendments also implemented the recommendation that the TUR planning methodology be extended to encompass options for conserving energy, water, and other resources.

#### **4. Survey findings**

In 2008, TURI contracted with Abt Associates Inc. to conduct an online survey to assess the experience of facilities that are subject to TURA program requirements (hereafter referred to as TURA filers), as well as Toxics Use Reduction planners. Of the 561 facilities that filed in 2006, 196 responded to the survey (35 percent). In addition, 36 general practice TUR planners provided information on the range of their experiences working with multiple facilities. Abt Associates also conducted in-depth telephone interviews with a subset of 18 of the survey respondents. Both the online survey and the telephone interviews focused on facilities' experiences in the period 2000 to 2006.

##### *4.1 How facilities are reducing toxics*

The annual reports submitted by facilities on their use of toxic chemicals shows that facilities have steadily reduced their use of toxics. These reductions are documented and analyzed in the TURA program's annual information release. One goal of the survey was to learn more about *how* facilities are achieving reductions in their use of toxic chemicals.

The Toxics Use Reduction Act defines six Toxics Use Reduction techniques: input substitution; product reformulation; production unit redesign or modification; production unit modernization; improved operation and maintenance of production unit equipment and methods; and recycling, reuse, or extended use of toxics using equipment or methods which become an integral part of the production unit of concern.

The survey asked which of these techniques are being used most frequently at Massachusetts facilities. The survey results indicate that facilities are making use of all six of the techniques, although some are used more frequently than others. The largest number of respondents (63 percent) indicated that they have made use of improved operations and maintenance.

A number of additional themes emerged in the survey responses. These include a particular focus on reducing the use of toxic solvents; options for reducing toxics in wastewater treatment; facilities' efforts to reduce or eliminate the use of lead and other toxic substances targeted by the European Union's Restriction on Hazardous Substances; and integration between TUR activities and other management systems.

#### 4.2 Benefits of implementing toxics use reduction projects

Respondents indicated that the TURA program continues to provide significant benefits to Massachusetts facilities, ranging from organizational benefits to financial savings. The results also show clearly that TURA filers are continuing to identify and implement new TUR options. In both the quantitative portion of the survey and in open-ended responses, respondents described a variety of benefits from implementing TUR projects.

- *Organizational benefits.* More than half the survey respondents (55 percent) indicated that the TURA program led to increased management attention to environmental practices within the facility. As one respondent commented, “TURA is a great reason to make sure management and others are involved, and it facilitates routine business discussion.”
- *Health and environmental benefits.* More than half the respondents (51 percent) indicated that their facility has achieved improvements in worker health and safety as a result of implementing TUR projects. Respondents cited examples including automation of certain processes to reducing the possibility of spills and leaks; elimination of the use of carcinogenic solvents; and a range of other examples.
- *Financial benefits.* Just over 40 percent of respondents indicated that their facility achieved financial savings as a result of implementing TUR options in the period 2000-2006.
- *Compliance benefits.* One of the goals of the TURA program is to encourage the use of toxics use reduction techniques as a means to comply with existing regulatory requirements. A third of respondents (33 percent) indicated that their facility had experienced benefits related to compliance with other state or federal regulations as a result of implementing TUR projects. Many respondents also cited the assistance of the TURA program in their compliance with international requirements such as the European Union’s Restriction on Hazardous Substances.
- *Efficiency benefits.* Just under a third of respondents (29 percent) indicated that they achieved improvements in production efficiency as a result of implementing TUR projects.
- *Product-related benefits.* A number of respondents indicated that their facility experienced benefits related to product marketing (21 percent), product quality (17 percent), or retention of a product line (6 percent).
- *Extension of innovations to facilities outside Massachusetts.* Some respondents indicated that innovations developed within Massachusetts facilities subject to TURA program requirements subsequently propagate to facilities in other states.
- *Benefits from working with a TUR planner.* Some respondents placed particular emphasis on the benefits they experienced from working with a TUR planner. One respondent described the facility's relationship with the planner as “some of the best money we ever spent.”

- *Professional benefits for TUR planners.* Most general practice planners that responded to the survey indicated that they also work with facilities that are not TURA filers. Of these planners, 83 percent indicated that their knowledge of TUR is an asset for their work with non-TURA filers.
- *Other benefits.* Other benefits cited by smaller numbers of respondents were improvements in technology and physical infrastructure; compliance with international standards; improved worker-management relations; and improved community relations.

Benefits experienced as a result of implementing TUR projects in the period 2000-present		
Benefit	Responses	Percentage (of 196 Respondents)
Increased management attention to environmental practices	108	55%
Improved worker health and safety	99	51%
Financial savings	81	41%
Compliance with other state or federal regulations	64	33%
Improvements in production efficiency	57	29%
Improved product marketing	41	21%
Improvements in product quality	33	17%
Improvements in technology and physical infrastructure	30	15%
Compliance with international standards	22	11%
Improved worker-management relations	21	11%
Other	18	9%
Improved community relations	16	8%
Retention of a product line	12	6%

#### 4.3 TUR implementation challenges

The TURA program is designed to be flexible, making it possible for facilities to choose which projects make the most sense for them to implement. The survey gave respondents the opportunity to provide additional information on what challenges or barriers they face as they make decisions about what TUR projects to implement.

The challenges that respondents described can be divided into three broad categories: technical, financial, and institutional.

- *Technical challenges.* The most frequently cited barriers were technical feasibility problems; these were cited by 62 percent of facility respondents and 77 percent of general practice planners. These challenges include difficulty identifying a technically feasible alternative; customer specifications that dictate the use of a particular chemical; concerns about product quality; concerns about the environmental health and safety characteristics of alternatives; and, in some cases, difficulty in identifying new TUR options after the first few planning cycles.

- *Financial challenges.* The cost of implementing TUR projects was cited as a barrier by 55 percent of facility respondents and 68 percent of general practice planners. Specifically, respondents noted that safer alternatives may be more expensive in some cases, and some TUR options may involve an increase in operating costs or a significant capital expenditure.
- *Institutional challenges.* A variety of institutional challenges can affect facilities' ability to implement options. Some respondents cited management policies as a barrier, noting that management at their facility places greater emphasis on short-term costs than on long-term benefits, or simply considers TUR to be a low priority. For some facilities, plant policies and procedures are dictated by parent companies. Other respondents considered other management systems to be more useful than TUR in achieving environmental health and safety goals. Finally, a few respondents simply stated that they see toxics use reduction as antithetical to their company's goals.

The design of the TURA program, with its focus on voluntary implementation of TUR options, makes it possible for facilities to choose the most technically and financially viable options. Those options that are less viable from a technical or financial standpoint are set aside in favor of those that are most advantageous to the facility. Thus, even under ideal circumstances, there will always be some options that facilities reject due to technical or financial barriers. However, the TURA program endeavors to help facilities overcome as many barriers as possible, in order to achieve maximum TUR. Thus, the challenges that respondents have listed here provide a basis for identifying opportunities going forward.

Barriers to implementing TUR projects in the period 2000-present		
Barrier	Responses	Percentage (of 196 Respondents)
Technical feasibility problems	121	62%
Financial costs too high	107	55%
Concerns about product quality	97	49%
Customer requirements	88	45%
Lack of sufficient expected benefits	56	29%
Project considered too time consuming	37	19%
Project considered low priority for management	18	9%
Lack of support from supply chain partners	16	8%
Regulatory environment	14	7%
Other	13	7%
Lack of organizational support for implementation	13	7%

#### 4.4 Value of TURA program services and resources

TURA program services, ranging from trainings, conferences, and workshops to on-site technical assistance, are available to all Massachusetts facilities and communities, not just TURA filers and planners. The survey gathered information on the value of these services and resources for TURA filers and planners specifically. The goal of this section of the survey was to determine the extent to which facilities and planners are making use of program services, assess how useful those services are, and identify potential areas for improvement.

<b>Opinion of TURA Program Resources: Respondents on behalf of a facility</b>			
<i>Resource</i>	<i>How useful was [item] in helping your company implement TUR? (% of respondents that used each resource)</i>		
	<i>Very</i>	<i>Somewhat</i>	<i>Not useful</i>
TURA program trainings, conferences, and workshops (154)	33	56	10
TURA program websites (148)	26	66	8
TURA program written resources (120)	15	68	18
TUR planner course (101)	33	57	10
Compliance assistance (94)	28	55	17
Library and reference services (72)	18	63	19
Site visits to your facility (69)	16	58	26
Cleaner technology demonstration site events (64)	14	53	33
Laboratory services (42)	14	52	33
(#)= Number of respondents for specific resource			

The TURA program services used most frequently are the TURA program trainings, conferences, and workshops; TURA program websites; TURA program written resources; the TUR planner course; and compliance assistance. As shown in the table above, these services were considered very or somewhat useful by 89, 92, 83, 90, and 83 percent, respectively, of respondents whose facilities had made use of these services.

General practice planners' responses to this question were recorded separately. The over-all ranking of usefulness was the same. TURA program trainings, conferences, and workshops, websites, written resources, TUR planner course, and compliance assistance were ranked as very or somewhat useful by 96, 96, 94, 96, and 89 percent, respectively, of general practice planners who had made use of these services.

<b>Opinion of TURA Program Resources: General Practice Planner responses</b>			
<i>Resource</i>	<i>How useful was [item] in helping your company implement TUR? (% of respondents that used each resource)</i>		
	<i>Very</i>	<i>Somewhat</i>	<i>Not useful</i>
TURA program trainings, conferences, and workshops (45)	58	38	4
TURA program websites (45)	36	60	4
TURA program written resources (45)	27	67	7
TUR planner course (42)	29	67	5
Compliance assistance (34)	18	71	12
Library and reference services (32)	28	63	9
Site visits to your facility (30)	20	70	10
Cleaner technology demonstration site events (27)	7	67	26
Laboratory services (21)	5	67	29
(#)= Number of respondents for specific resource			

The survey also asked respondents about the usefulness of TUR plan elements. All the plan elements were ranked as “very” or “somewhat” useful by the majority of respondents.

Opinion of TUR Plan Elements: Respondents on behalf of a facility			
Plan element	How useful was [item] in helping your company’s TUR efforts? (% of respondents for each plan element)		
	Very	Somewhat	Not useful
Materials accounting and process characterization (190)	41	43	16
Environmental health and safety (EH&S) evaluation of potential TUR projects (186)	35	49	16
Identification and screening of TUR options (188)	34	52	14
Technical evaluation of potential TUR projects (186)	31	54	16
Financial evaluation of potential TUR projects (187)	27	55	18
Soliciting TUR ideas from employees (190)	26	46	27
Developing a management policy (188)	26	59	16
Developing chemical use and byproduct reduction goals (188)	26	52	22
(#)= Number of respondents for specific plan element			

#### 4.5 Changes in facilities’ experiences over time

One of the goals of the program assessment was to determine how facilities’ experiences in the program have changed over time. The early years of the program were characterized by facilities identifying “low hanging fruit” – opportunities to reduce toxics through simple changes in production systems. These changes were often associated with financial savings as well. The survey posed questions designed to determine how facilities’ experiences with TUR planning and other aspects of the program have changed over time.

One key question of interest is whether the TUR planning requirement continues to provide value to facilities over time. The survey asked respondents to indicate how often the first, second, and subsequent TUR planning cycles lead to the discovery of new TUR opportunities or options. Respondents were asked about planning years 2000 to 2006, which pre-date the alternative planning provisions of the 2006 amendments. Thus, responses to this question provide information about the baseline prior to the implementation of the 2006 amendments.

Some respondents indicated that they find that planning is no longer as useful as it was earlier in the program. Others indicated that they do continue to identify new options over time. Seventy percent of respondents “always” or “usually” found new TUR opportunities or options when doing a TUR plan the first time. While a facility’s first and second plans are most likely to produce significant insights into the production process, nearly all respondents indicated that they sometimes identify useful TUR options in subsequent planning cycles as well.

Frequency with which the planning process results in the discovery of new TUR opportunities or options						
Plan	Always	Usually	Sometimes	Not Often	Never	Don't Know
First TUR Plan	36%	34%	15%	6%	2%	6%
Second TUR Plan	2%	34%	34%	21%	2%	6%
Subsequent TUR Plans	0%	4%	23%	55%	9%	6%
Note: Totals may not add up to 100% due to rounding.						

Some respondents offered suggestions about how the TURA program could increase the effectiveness of planning and encourage facilities to learn from one another's experiences. One general practice planner recommended shifting the perspective of the planning periodically: "Usually, if we re-metric ... we can find other options that are not readily apparent." Another respondent noted that additional regulatory motivators become increasingly important after the first two planning cycles.

#### 4.6 Survey information on municipal, community, and small business projects

In addition to its work with large quantity toxics users, the TURA program is also charged with providing information and assistance to Massachusetts communities. This includes work with municipal agencies, community organizations, small business associations and others.

To supplement the survey of TURA filers and planners conducted by Abt Associates, TURI staff conducted a brief online survey for individuals and organizations that have worked with the TURI community program, as well as past recipients of TURI community grants. The survey posed questions about benefits gained from the TURA program, challenges in implementing toxics use reduction projects, and suggestions about how the TURA program can serve communities most effectively.

The online survey was sent to 350 individuals. Responses were received from 62 individuals (18 percent), of whom 18 were associated with an organization that had received a grant from TURI at some point in the period 1998-2007. TURI also hired a consultant to conduct interviews with representatives of organizations that had received a TURI community grant in fiscal year 2006, 2007, or 2008. The interviews included questions about the organization's experience working with TURI, the role of the TURI grant in the development of the organization's agenda and activities, the organization's ability to raise funds prior to and after receipt of a TURI grant, and media recognition of the organization's work.

*Grant recipients.* Of the eighteen online survey respondents that had received a TURI community grant, fourteen provided detailed information on their experience. Findings from this portion of the survey included the following.

- Many projects have continued after the grant period ended. Of the fourteen projects discussed in the online survey, eleven continued after the grant period ended. Only three had received funding prior to the TURI grant.
- In the telephone interviews, respondents indicated that they had been highly successful in leveraging TURI grant funding to gain additional funding from outside sources in subsequent years.

- Projects supported by TURI grants have yielded economic as well as health and environmental benefits. These include marketing benefits for small businesses, such as landscaping and janitorial services. Economic benefits for municipalities included the provision of training to municipal employees and boards, and potential long-term savings from reducing hazards to water supplies.
- The TURI community grant program has provided substantial resources beyond the grant funding itself. Respondents commented on ways in which the grant program provided them with access to scientists and professionals with specialized expertise, media outlets, and opportunities to leverage additional support. Unique resources offered through the grant program included technical support, training, and materials; education and hands on training that would have not been available otherwise; and assistance with media outreach.
- Most grant recipients did not describe major implementation challenges. The problems that were mentioned included difficulty in carrying out the project in the allotted time; difficulty coordinating all the partners and activities involved in the project; and in some cases, regulatory and institutional barriers.

*Other respondents.* The forty-four respondents not associated with an organization that received a TURI grant also provided information on a range of topics. Of forty-one respondents who answered questions about whether they had witnessed reductions in the use of toxics in their community, eighteen indicated that they had witnessed reductions in the use of toxics in their community, and five had witnessed improvements in worker health and safety related to TUR. Many of these community organizations do not target worker safety, but rather the health and safety of community members in general. Improvements that respondents described in detail included reductions in pesticide use; reduction in the use of toxic household products in homes; reduction of lead in fishing; and reduction in the use of perchlorate flares.

#### *4.7 Non-filers Study*

At the conclusion of the Abt survey for TURA filers, a small separate study by Pure Strategies, Inc., investigated the experience of non-TURA filers that had received assistance from OTA. Pure Strategies interviewed eleven companies. Of these, four provided quantitative information about recent cost savings. The net present value of the projects implemented at the four firms was \$870,000. In addition, seven companies provided qualitative information on benefits resulting from the technical assistance they received. Qualitative benefits cited most often were improved worker health and safety and improved environmental compliance. In addition, one interviewee credited OTA with the survival of the company.

### **5. Conclusions**

The survey results indicate that the TURA program elements and the TUR planning process continue to be useful for many Massachusetts facilities. Facilities continue to experience a range of benefits from implementation of TUR options, including improvements in efficiency and product quality, financial savings, and improved communication about environmental issues within the facility. Facilities also continue to make use of a variety of program elements, and cite both agency staff and TUR planners as useful resources.

The survey also provided insights on how the TURA program can improve its effectiveness through program enhancements or modifications, and how the benefits realized by some firms can be studied and

transferred to others. Survey findings identified areas in which program services can be improved. The findings also helped to identify barriers that TURA filers continue to face, and areas in which additional research may be necessary to develop feasible TUR solutions. Several important opportunities are summarized below:

- *Further leveraging of TUR for product quality improvements.* The survey results show that TUR planning and project implementation have led to improvements in product quality for some facilities, while product quality concerns have been a barrier to implementation for others. Demonstration sites, peer networking opportunities, and similar activities can ensure that facilities learn from one another about opportunities to improve product quality through TUR. In addition, there is continued scope for the TURA program to sponsor technical research to address specific product quality issues.
- *Expand the benefits of TUR program services by increasing awareness and use.* There are opportunities to increase facilities' awareness of TURA program services. For example, although companies have made significant progress as a result of site visits, there are many companies that have not received a site visit in recent years. Thus, there is an opportunity to conduct additional outreach to ensure that facilities are aware of the availability of these services.
- *Expand the benefits of the TUR planning process for organizational behavior.* The TURA program helps to shape internal dynamics within a facility. This includes affecting the level of management attention to environmental issues, as well as helping to ensure that employee ideas are solicited and valued. TURA provides a valuable opportunity to empower shop floor employees, resulting in new opportunities and better solutions. There may be an opportunity to encourage better use of this plan element by facilities.
  - There are opportunities to improve the quality and results of the planning process. Some of the general practice planners, in particular, offered suggestions about ways to maximize the benefits from the TUR planning process. For example, because firms that start the planning process early have been observed to get more benefit from it, the TURA program could send reminders to facilities encouraging them to start the planning process early and schedule training events in such a way as to encourage facilities to start their planning early. The program could also offer training for planners on ways to re-metric the planning process, and on other ways to ensure useful planning results after the first and second planning cycles. These opportunities are, of course, in addition to the changes that will result from the new planning options allowed under the 2006 amendments.
  - There are opportunities to increase TUR project implementation rates. Although many facilities were able to identify and implement TUR options, nearly a quarter (22%) of respondents stated that their facility did not do so in any of the 2000-2006 plan years. This finding indicates that there are opportunities to work further with these facilities. The alternative planning options created by the 2006 amendments to TURA can be expected to help improve the number of facilities that implement TUR and Resource Conservation options in future years.
  - There are opportunities to link TUR with other management systems. The TURA program has undertaken a variety of activities designed to integrate the TUR approach with other environmental quality management systems, such as Environmental Management Systems (EMS) and Lean Six Sigma. The 2006 amendments took this effort a step further by making it possible for facilities to develop an EMS in place of a standard TUR plan under some

circumstances. Comments from a number of respondents indicate that this type of integration of management systems is useful to facilities.

- There continue to be opportunities to help facilities learn from one another. For example, there are opportunities for multiple facilities to learn from an innovation initially pioneered at a single facility. There are opportunities to analyze the TUR data to determine sectors and facilities where there may be useful 'lessons learned.'
- *Process-specific opportunities.* Finally, there are many process-specific opportunities for Massachusetts facilities, including new options for reducing use of toxic solvents, options for adopting new energy- and water-saving techniques, options for reducing use of hazardous acids, and more.

The TURA program is currently working on a follow-up study that will consider the economic implications of the TURA program. This economic analysis will draw in part on information gathered through the online survey and telephone interviews with TURA filers, and with individuals and organizations associated with TURI's community program. In addition, the analysis will include information on the experience of non-filing facilities that receive services from the TURA program.

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## **Section 1: Introduction**

### **Toxics Use Reduction Act (TURA) Program Assessment**

Enacted in 1989, the Massachusetts Toxics Use Reduction Act (TURA) has been in effect for nearly two decades. During this time, Massachusetts firms have achieved remarkable reductions in their use of toxic chemicals, while achieving financial savings and maintaining their competitiveness in global markets.

The Toxics Use Reduction Act Program (“the Program”) collects and publishes data every year on companies’ progress in reducing toxic chemicals. In 2008 and 2009, the Toxics Use Reduction Institute (TURI) undertook a program assessment designed to gather additional information beyond what we are able to learn from annual data collection and analysis. This program assessment reviews the accomplishments of the program over time, and explores opportunities for improvements going forward.

In 2006, amendments were made to TURA. These amendments provide for new flexibility in the toxics use reduction (TUR) planning process for TURA filers. They also provide for greater focus on the chemicals of greatest concern by allowing for the designation of higher and lower hazard substances. The amendments were developed in response to feedback from TURA filers and others about the need to update certain program elements over time.

The 2006 amendments signal a new phase of the TURA program, making it particularly important to assess the strengths and weaknesses of the program at this juncture in order to be able to monitor changes going forward as the amendments are implemented.

The goals of the program assessment were to:

- Gather and analyze additional information to complement the program’s analyses of toxics use data submitted by firms each year;
- Identify areas of success and consider ways to extend these successes;
- Identify areas of difficulty and consider options for addressing those difficulties;
- Establish a new baseline from which to monitor changes associated with the 2006 amendments, going forward; and
- Formulate recommendations for how most effectively to measure program effectiveness in the future.

Components of the program assessment included:

- Review of existing literature on the TURA program;
- Review of existing TURA program activities;
- Online survey of 241 TURA filers and general practice TUR planners (conducted by Abt Associates of Cambridge, MA);
- In-depth telephone interviews with 18 TURA filers (conducted by Abt Associates);
- Online survey of 62 individuals or organizations served by the Toxics Use Reduction Institute’s Community program (conducted by TURI);

- Telephone interviews with representatives of fourteen community organizations (conducted by a consultant).

The survey results indicate that the TURA program elements and the TUR planning process continue to be useful for many Massachusetts facilities. Facilities continue to experience a range of benefits from implementation of TUR options, including improved communication about environmental issues within the facility; financial savings; and improvements in efficiency and product quality. Firms also continue to experience challenges in implementing TUR, noting barriers such as a lack of technical feasibility, and customer specifications. Facilities also continue to make use of a variety of program elements, and cite both agency staff and TUR planners as very useful resources.

Section 2 of this report provides a review of TURA program activities. Section 3 provides a brief review of prior studies of the TURA program. Section 4 presents the results of an online survey and telephone interviews with TURA filers and planners, conducted by the consulting firm Abt Associates. It also includes the results of an online survey of individuals and organizations served by the Institute's Community program. Finally, Section 5 summarizes lessons and opportunities drawn from the material presented here. Implications of the TURA program for the Massachusetts economy will be discussed in a separate report, also drawing upon survey results from TURA filers.

This program assessment does not include a consideration of the information that can be drawn from the chemical use data that are submitted annually by firms. These data are analyzed in detail in the annual information releases published by MassDEP, as well as in reports that focus on trends in specific categories of chemicals.

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## **Section 2: TURA Program Description**

### **Toxics Use Reduction Act (TURA) Program Assessment**

For two decades, Massachusetts has been a national leader in toxics use reduction. Over the period 1990 to 2005, the Program helped large quantity toxics users to reduce use of toxic chemicals by 40 percent, toxic byproducts by 71 percent, and on-site releases of toxic chemicals by 91 percent. These reductions are documented and analyzed in the TURA program's annual information release reports.<sup>1</sup>

TURA program activities are carried out by three implementing agencies: the Massachusetts Department of Environmental Protection (MassDEP); the Office of Technical Assistance and Technology (OTA) within the Executive Office of Energy and Environmental Affairs; and the Toxics Use Reduction Institute (TURI) at the University of Massachusetts Lowell.

These implementing agencies work in collaboration with three bodies. TURI maintains a Science Advisory Board that provides guidance on scientific questions. The TURA Advisory Committee provides stakeholder input on program decisions. The TURA Administrative Council makes program decisions based on input from the implementing agencies, the Science Advisory Board, and the Advisory Committee.

The implementing agencies work together to carry out a suite of services:

- Grant programs designed to assist companies and communities in implementing and disseminating TUR techniques;
- Training programs on tools and techniques for achieving TUR;
- Site visits to companies to provide technical assistance;
- Laboratory activities to identify high performing alternatives for cleaning and surface preparation processes;
- Information services providing access to current and emerging tools, technologies and research;
- Engagement with industry and communities to facilitate specific toxics use reduction efforts;
- Compliance assistance and enforcement; and
- Policy engagement activities that promote grounded yet visionary policies to continue and extend program successes.

Each of these broad categories of work is described below.

## 2.1 Grant Programs

The TURA program uses a portion of its budget to invest in companies, academic researchers and communities that are implementing or investigating innovative TUR opportunities. The grant funds are focused on moving the field of toxics use reduction toward more effective and efficient next generation techniques that can be implemented broadly throughout the Commonwealth. TURI administers four grant programs:

- Industry demonstration site grants;
- Environmental management systems peer mentoring grants;
- University research grants; and
- Grants to community organizations and municipalities.

The TURA program has provided grants to Massachusetts researchers, companies, and others since its inception. TURI began providing university research grants in 1991, grants to industry in 1992, and community grants in 1996. The following table shows the dollar value of grants awarded by TURI since 2000. Each of these programs is discussed in more detail in the sections that follow. All figures are shown in 2009 dollars.

<b>Fiscal Year</b>	<b>Industry Demonstration Sites</b>	<b>EMS Peer Mentoring</b>	<b>Academic Research</b>	<b>Community Projects</b>	<b>TOTAL</b>
<b>2000</b>	\$ 50,840	\$ 27,280	\$ 159,811*	\$ 52,799	\$ 290,730
<b>2001</b>	\$ -	\$ 48,000	\$ 117,168*	\$ 61,560	\$ 226,728
<b>2002</b>	\$ 23,800	\$ 47,600	\$ 94,022*	\$ 65,932	\$ 231,354
<b>2003</b>	\$ -	\$ 46,400	\$ 92,800*	\$ 64,786	\$ 203,986
<b>2004</b>	\$ -	\$ 16,950	\$ 22,600	\$ 56,500	\$ 96,050
<b>2005</b>	\$ -	\$ 16,350	\$ 21,800	\$ 54,500	\$ 92,650
<b>2006</b>	\$ 31,800	\$ -	\$ 42,400	\$ 40,280	\$ 114,480
<b>2007</b>	\$ -	\$ 10,300	\$ 41,200	\$ 59,132	\$ 110,632
<b>2008</b>	\$ 24,750	\$ 9,900	\$ 48,411	\$ 67,617	\$ 150,678
<b>2009</b>	\$ 4,000	\$ 10,000	\$ 60,000	\$ 63,000	\$ 137,000
<b>Total</b>	<b>\$ 135,190</b>	<b>\$ 232,780</b>	<b>\$ 700,212</b>	<b>\$ 586,106</b>	<b>\$ 1,654,289</b>
* Funds were provided in collaboration with the Massachusetts Strategic EnviroTechnology Program (STEP).					

### 2.1.1 Cleaner Technology Demonstration Site Grants

The Cleaner Technology Demonstration Site Matching Grant program provides matching funds and technical support for facilities that have implemented innovative toxics use reduction techniques and are interested in disseminating knowledge to their peers. Grantees provide opportunities for their industry peers to see the technology up close, learn about associated management methods, discuss challenges, and discover new opportunities to further reduce the use of toxic chemicals at their own facilities.

Companies receiving TURA program funds match the amount of the grant through labor allocated to the project, materials and supplies for the site visits, and/or hiring of experts to help develop materials and presentations.

Since the inception of the Cleaner Technology Demonstration Site program in 1996, TURI has provided over \$360,000 in matching grants to almost 40 companies in the Commonwealth. Table 2, below, shows the demonstration sites sponsored by TURI in the period 2000 to 2009.

<b>Table 2: Cleaner Technology Demonstration Grants, 2000 – 2009</b>			
<b>Fiscal Year</b>	<b>Company</b>	<b>Project Description</b>	<b>Attendance</b>
<b>2000</b>	Riverdale Mills	Elimination of Acid and Lead in Wire Strand Annealing and Galvanizing	20
	Barry Controls	VOC Reduction Using Innovative Spray Tumble Machine	40
	B&J Manufacturing	Replacement of Solvent Degreaser with Aqueous Cleaner	20
<b>2002</b>	Texas Instruments	Innovative Energy Conservation Techniques	40
	Institute for Plastics Innovations	Green Materials for Wire/Cable Coating Industry	40
	Rexam Image Products	Green Processing in Web Coating Applications	40
<b>2006</b>	M/A-COM	Compliance with European Union Restriction on Hazardous Substances (RoHS)	60
	Vicor Corporation	RoHS Compliance	40
<b>2008</b>	Rohm and Haas	Energy Conservation through Toxics Use Reduction	50
	Silver Hanger Cleaners	Conversion to Dedicated Wet Cleaning from Perchloroethylene Dry Cleaning	n/a*
<b>2009</b>	Bristol-Myers Squibb	Water Conservation during Construction and Facility Start-up	25
	Silver Hanger Cleaners	Demonstration of Dedicated Wet Cleaning	50
* Conversion was funded in FY08, demonstration in FY09.			

### **2.1.2 Environmental Management Systems Grants**

An Environmental Management System (EMS) is a systematic approach to integrating environmental considerations into an organization's day-to-day operations and management culture. The environmental and economic benefits of implementing an EMS can be augmented by incorporating toxics use reduction principles into the system.

Since 1999, TURI has provided over \$200,000 in matching grants to facilities that have implemented an EMS and are interested in providing peer mentoring to other companies. These EMS peer mentors have provided guidance and networking opportunities to over 120 other company representatives in the Commonwealth. They host EMS Peer Mentoring Work Groups; these structured meetings for

Massachusetts companies offer strategies to support implementation and improvement of companies' EMSs. Figure 1 shows the locations of facilities that have hosted EMS Peer Mentoring Work Groups.

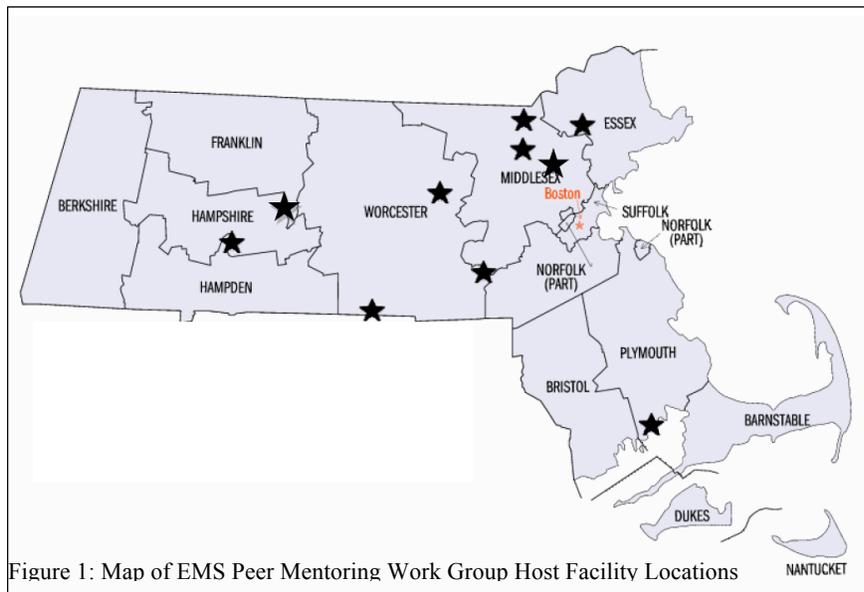


Figure 1: Map of EMS Peer Mentoring Work Group Host Facility Locations

The 2006 TURA amendments allow facilities to develop an appropriately targeted EMS as an alternative to TUR planning requirements. A TURA EMS offers the opportunity for a facility to integrate its chemical and product quality management and planning efforts into the system, so that the focus is not just on hazardous chemicals or waste, but on the prudent use of all materials and resources.

### 2.1.3 Academic Research Grants

TURI's University Sustainability Research Fellows program taps the research strengths of the University of Massachusetts system to investigate, develop and evaluate technologies that are environmentally, occupationally and economically sound. Since its inception in 1991, this program has provided over \$1,250,000 in funding to UMass researchers, supporting more than 80 graduate students. University research supported by TURI has contributed to the development and use of alternative formulations for PVC-based wire and cable coatings that do not use lead; lead-free materials for electronics; diffusion dialysis for in-process acid recycling; and use of naturally-derived dyes in textiles, among other areas.

### 2.1.4 Community Grants

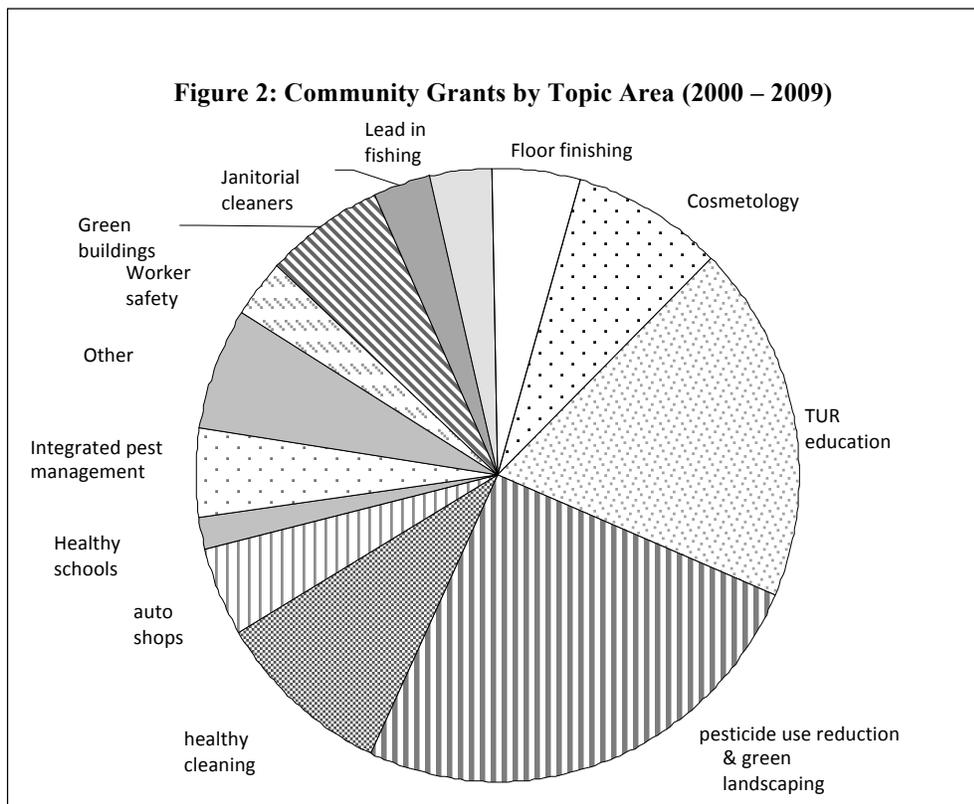
The success of the TURA program does not rest with industry alone. Many toxic exposures result from the products used and activities performed in schools, homes, town operations, and small businesses. Community residents and municipalities both have a critical role to play in raising awareness and reducing toxics use. With this in mind, the Toxics Use Reduction Act requires TURI to: "Provide toxics use reduction training and assistance to citizens, community groups, workers, labor representatives and local government boards and officials."

The TURI Community Grant Program, now in its fourteenth year, was established to provide support to community organizations and municipalities to conduct projects that raise awareness, understanding and implementation of toxics use reduction at the local level.

The Community Program has fostered the development of unique partnerships around TUR among many diverse groups. These collaborative efforts have addressed toxics in and around schools, municipal

buildings and operations, households, recreational activities, and small businesses such as auto body shops, and hair and nail salons.

Since the TURI Community Program initiated its grant program in 1996, it has awarded over \$700,000 to qualifying organizations, providing support for 95 projects. Organizations funded in this period include



environmental justice organizations, public interest groups, neighborhood associations, community development corporations, youth organizations, health centers, hospitals, civic organizations such as chambers of commerce, local unions and labor organizations. In addition, grants have been awarded to a wide range of municipal entities,

including schools, departments of public works, fire departments, police departments, local emergency response offices, boards of health, planning and zoning boards, town commissions, and libraries.

## 2.2 Training

The TURA program provides a variety of training programs. These programs are designed to provide the skills and knowledge necessary to implement TUR in organizations, especially those that are large quantity toxic users. They are also designed to encourage thinking and planning beyond current accepted standards of practice by exposing participants to state of the art practices in toxics use reduction.

Each year, TURI offers a 42-hour comprehensive training course for professionals seeking certification as TUR Planners. In addition, TURI typically hosts two day-long continuing education conferences for TUR planners each year.

<b>Training</b>	<b>Attendance</b>
TUR Planner Class	21
Fall TUR Planner Continuing Education Conference	91
Spring TUR Planner Continuing Education Conference	100
Resource Conservation Planning Basics (3 sessions)	110
TURA EMS Course	34
TUR Planning for EMS Professionals	15
Introduction to Tools for Risk Assessment and Control of Chemicals (online pilot course)	9

After the passage of the 2006 TURA Amendments, the TURA program developed new workshops on Resource Conservation and Environmental Management Systems (EMS). Completion of these courses qualifies TUR Planners to apply to MassDEP for authorization to certify alternative plans, or to certify that a company’s EMS meets the standards required by TURA. Workshops in energy efficiency, renewable energy for industry, water conservation, and reducing toxics in products and solid wastes are held frequently. In 2006, OTA held a major conference on water conservation.

OTA and TURI also offer industry-specific workshops. OTA works with companies to develop and demonstrate cleaner technologies. These efforts have included using plasma cleaning to substitute for hazardous chemical usage, digital printing (a technique that saves energy as well as reducing toxics use), and green chemistry.

**2.3 On-Site Assistance**

On-site assistance allows TURA program staff to assess the unique conditions and challenges associated with implementing TUR at Massachusetts companies and provide recommendations and assistance designed to address each company’s needs. This service is provided by the Office of Technical Assistance and Technology (OTA), and by the TURI Laboratory when companies need help specifically with cleaning issues.

One-on-one assistance addresses facilities' individual needs. Technical assistance staff members learn about the particular concerns of each facility and tailor advice to meet specific requirements. In addition, staff can build a valuable relationship and trust that is often absent from interactions between government agencies and the regulated community. Staff also learn from high-level performers about what has worked in their facilities, and within the bounds of confidentiality, have helped others to adopt successful practices.

**2.3.1 OTA Site Visits**

OTA’s on-site assistance is the core service through which the program helps Massachusetts businesses improve efficiency, ensure compliance with environmental regulations, conserve resources and reduce costs. Since its establishment in 1990, OTA has provided non-regulatory, confidential technical and compliance assistance services. These services are provided at no cost to facilities.

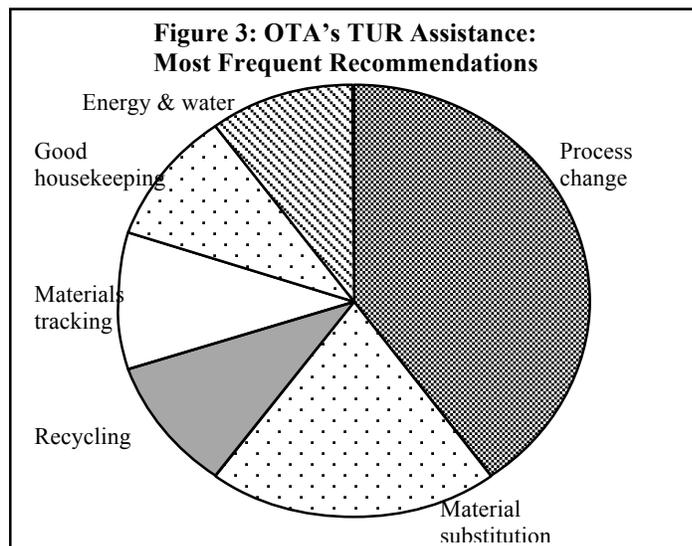
Since 1990, more than 1,300 facilities have invited OTA on-site, many asking for return visits. As of 2009, OTA has performed more than 3,300 on-site visits and provided an estimated 15,000 recommendations to Massachusetts facilities. From 2006 through 2008 OTA conducted approximately 240 site visits. In these visits, OTA staff members identify possible process improvements, pollution prevention, energy efficiency or water conservation opportunities, and address environmental compliance issues.

In addition to providing direct technical assistance services, OTA helps to make companies aware of other services available through public agencies, utilities and vendors. In recent years OTA has helped more than two dozen companies obtain subsidies for energy projects and training in energy software tools, and ten companies to receive extensive energy audits.

*As of 2009, OTA has performed more than 3,300 on-site visits and provided an estimated 15,000 recommendations to Massachusetts facilities.*

OTA has provided assistance in areas including regeneration of waste acids, elimination of hazardous solvent cleaners, recycling and continued use of coolants, efficient spray coating, use of coatings that minimize or eliminate volatile organic compounds (VOCs), improved rinsing, improved filtration, enclosing and capture of evaporatives, leak detection and prevention, chemical bath life extension, use of sensors and controls to optimize production, and upgrading of motors, air compression systems, and refrigeration, among other areas.

As part of the site visit, OTA staff members provide specific recommendations as well as referrals to



public agencies, nonprofits, and other businesses that offer relevant additional resources. In 2001, an analysis was performed of OTA recommendations made in the period 1996 to 2000. The analysis found that 58 percent of OTA's recommendations to facilities pertained to pollution prevention and 42 percent pertained to compliance. The recommendations included about 400 sets of referrals, about half of which (51 percent) were to private sector vendors, while the others (49 percent) were to public agencies or nonprofits (including trade or professional associations).

Through its work with the regulated community, OTA has developed a special expertise concerning the capacity of companies to implement more sustainable practices and to comply with regulations. By sharing its unique perspective, OTA has helped Massachusetts policy-makers to develop innovative programs and initiatives, including the Environmental Results Program and the state's Environmentally

Preferable Purchasing program, and to incorporate pollution prevention into regulations and enforcement practices.

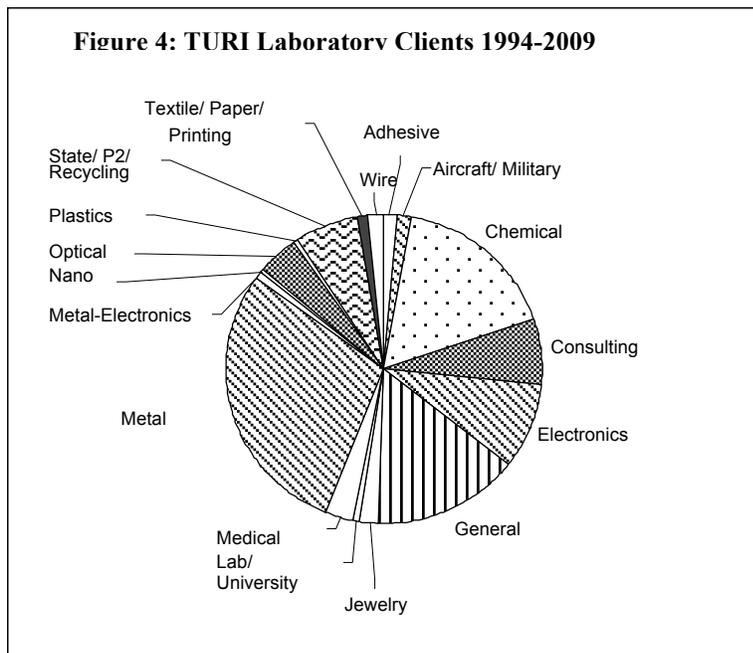
## 2.4 Laboratory Services

TURI's Laboratory assists in the development and promotion of safer alternatives to hazardous cleaning chemicals. The Laboratory tests and evaluates environmentally friendlier cleaners and provides free assistance for Massachusetts companies, helping them to select process-specific cleaning systems.

In operation since 1993, the Laboratory has helped over 250 companies identify safer alternatives to hazardous cleaning solvents. A 2001 study found that one-third of the companies that had worked with the TURI Laboratory had fully adopted its recommendations. More recently, the Laboratory has intensified its implementation assistance efforts, resulting in a nearly 80 percent adoption rate since 2007.

The Laboratory evaluates safer alternative cleaning processes for industrial applications using aqueous, semi-aqueous and media blasting, as well as various types of soak, ultrasonic and other equipment. For janitorial applications, the Laboratory has tested many commercial formulations, as well as "do-it-yourself" home recipes, and assists the Massachusetts state Environmentally Preferable Purchasing program by testing the effectiveness of greener cleaners.

Figure 4 shows the types of industries and organizations for which the Laboratory conducts testing.



*CleanerSolutions Database.* All Laboratory test results are recorded in a database called *CleanerSolutions*, which is designed to assist companies in rapidly evaluating solvent substitution opportunities for their individual needs. It generates a list of chemical alternatives, based on similar process conditions from other client testing.

*Laboratory Field Services.* The TURI Laboratory works with Massachusetts companies to identify safer alternatives to their existing cleaning and/or degreasing methods.

In recent years, the Laboratory has achieved a high level of implementation by conducting site visits.

A laboratory field specialist visits the client company, sometimes in conjunction with OTA, or as a result of an OTA referral, to observe the process that is being evaluated and to talk to the managers and operators of the process. The unique challenges and performance requirements of the process can thus be better

understood and taken into consideration as the Laboratory evaluates possible alternatives. Once a safer alternative has been identified by the Laboratory, the field specialist works with the company to pilot test the new chemistry and/or process. The Laboratory provides troubleshooting advice for any issues that arise.

## **2.5 Information Services**

The body of knowledge that supports the TURA program and the professionals, researchers and citizens of the Commonwealth has been assembled in a staffed library and made available in a family of websites. It includes reports from TURA Program agencies, practical and sector specific guidance, research articles, and searchable databases.

*TURI Library, outreach, and publications.* The unique TURI Library provides access to over 5,000 books, reports and case studies and more than 50 journals and industry-specific magazines. Its web-based library catalog provides abstracts of those resources, as well as summaries of more than 7,000 journal and news articles relevant to toxics use reduction.

The Library maintains relationships with other pollution prevention and green chemistry libraries, as well as public libraries, in the U.S. and internationally. In FY08, there were over 8,100 off-site (remote) search sessions of the online TURI Library catalog. A specialized reference librarian is available to respond to questions from researchers, green designers, program strategists and community groups. The TURI Library's free weekly update, Greenlist, addresses innovative technologies, chemicals policy, pollution prevention, environmental health, toxics alternatives and other topics.

TURI has published over 60 technical and policy reports. In addition, TURI publishes outreach materials including program reports, demonstration site reports, brochures, tip sheets, and chemical fact sheets. TURI chemical fact sheets offer concise information on chemistry, toxicity, quantities used and user facilities in Massachusetts, and the national and international policy environment affecting each chemical.

Online resources and tools created by the program offer searchable databases and guidance on safer alternatives. These include the CleanerSolutions Database, in which results of safer cleaning alternatives are archived from trials in the TURI Laboratory (see Section 2.4); the TURAdata, providing annual data collected under TURA about facilities' use of listed chemicals, searchable by facility name, chemical or by community; the TURI Library's online public access catalog (OPAC) with over 14,000 abstracts of environmental books, articles, videos and websites; P2Gems, a database of hundreds of selected resources on the internet for pollution prevention; and a summary database of TUR Case Studies published by program agencies.

*OTA publications.* OTA publishes fact sheets, case histories and sector reports based on its applied research and on-site experience. Sectors and processes of focus have included coatings, paper, lighting fixtures, plating, specialty chemicals, wastewater, precision instruments, marine science and technology, electronics, medical device, wire and cable, and food processing. OTA reports provide analysis and guidance on topics including energy, barriers to change, and economic and technological evaluation.

Since 2000, OTA has published numerous written materials designed to encourage the understanding and adoption of TUR technologies and methods. All OTA conference information and publications are available online at [www.mass.gov/eea/ota](http://www.mass.gov/eea/ota).

*MassDEP publications related to TURA.* The Massachusetts Department of Environmental Protection (MassDEP) publishes regulations, guidance, filing forms, and fact sheets to assist companies in complying with TURA. MassDEP also provides guidance, instructions and forms for TUR planners, and publishes an annual Toxics Use Reduction Information Release that measures progress in TUR reported by filer companies.<sup>2</sup>

## 2.6 Engagement with industry and communities

In addition to the activities discussed above, the TURA program engages with both industry and communities to facilitate specific efforts to reduce the use of toxics. In the area of industry engagement, examples include supply chain activities with the electronics industry and the wire and cable industry; the creation of an innovative business environmental network; and facilitation of government and private sector dialogue around safer development of nanotechnology. Community engagement activities include projects to promote toxics use reduction in specific sectors such as cosmetology and dry cleaning, as well

**Helping Companies Work Together:  
Central Massachusetts Business Environmental  
Network**

Created by OTA in the 1990s, the Central Massachusetts Business Environmental Network (CMBEN) provides a forum for businesses to work together to improve their environmental performance. CMBEN members have worked jointly to produce a matrix summarizing environmental regulatory requirements, which OTA and MassDEP update periodically. CMBEN's matrix can be downloaded from MassDEP's website, and has been widely distributed. The matrix was designed in particular to be useful to small and medium-sized businesses, but can be used by large facilities as well. No membership dues are required for CMBEN, and all meetings are free of charge. CMBEN's most recent meeting was on stormwater, with more than 60 attendees.

as extensive work with Massachusetts public schools. Activities include convening work groups, sponsoring sector-specific training events, and providing technical information requested by small businesses or community organizations.

- *Electronics.* TURI staff members have worked over a number of years to help electronics manufacturers to develop lead-free electronic products.
  - *Wire and cable.* TURI staff members have worked with wire and cable manufacturers to facilitate information sharing as these manufacturers work to develop products based on safer materials.
- *Safer development of nanotechnology.* TURI, OTA and MassDEP staff members have worked over the past several years to help facilitate the safer development of nanotechnologies.
  - *Small business sectors.* TURI and OTA work with a variety of small business sectors, including small metal finishers, dry cleaners, and others.
  - *Public schools.* Until fiscal year 2009, OTA worked with public schools to identify and remove hazardous substances from school laboratories.
  - *Business Networks.* In the 1990's OTA created two organizations, the Northeast Business Environmental Network (NBEN), and the Central Massachusetts Business Environmental

Network (CMBEN), to help businesses improve their environmental performance. CMBEN remains active, having quarterly meetings.

- **Software development.** OTA has provided many companies with software tools to assist them in measuring their use of materials, in order to better detect losses and identify opportunities to improve efficiency. In 2006, OTA and the Northeast Waste Management Officials Association (NEWMOA) won a competitive grant to develop a software tool to better track resource use. In 2008 they unveiled EMFACT, the Energy and Materials Flow and Cost Tracker, a sophisticated tool for measuring energy, water and materials use in a facility, and associated costs. EMFACT is provided free of charge and will become open source software in 2011.

### Lead-Free Electronics: Industry, Academia, and Government Working Together

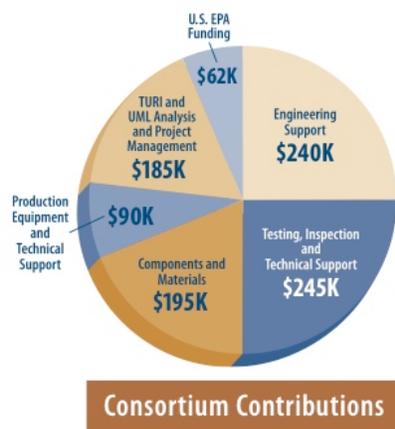
To help the electronics industry find alternatives to lead, TURI and the University of Massachusetts Lowell launched the New England Lead-Free Electronics Consortium – a collaboration of industry, academia, and government.

*The need to replace lead in electronics.* Although lead is highly hazardous to human health and the environment, it is still used in many products. In electronics, lead has remained the selection of choice on printed circuit boards for the past 60 years.

Manufacturers are now moving away from using lead in electronics for two main reasons: regulatory and market drivers. In particular, since 2006 the European Union’s RoHS Directive has restricted the use of lead in consumer electronic products.

Switching from lead to safer alternatives presented a colossal challenge for the entire electronics supply chain – from small assembly shops to large original equipment manufacturers. Lead-free solder materials require higher melting temperatures and have a narrower “processing window,” with a greater risk of mistakes that could be amplified throughout the supply chain.

*How the Consortium works.* Consortium members designed and executed comprehensive research experiments to evaluate various lead-free materials and manufacturing processes. To measure and analyze the performance of the lead-free materials during the experiments, the Consortium employed Six Sigma tools, a methodology used to address quality problems in a manufacturing environment.



With careful selection of materials and manufacturing parameters, the first four phases of the Consortium’s research have proven to its members that lead-free electronics assembly and rework not only is possible, but actually produces results that are equal to or better than what is achieved with lead. The Consortium is now conducting research to investigate the long-term reliability of lead-free materials for critical applications such as medical, defense, aerospace, and IT infrastructure.

*“Getting the toxics out of electronics is no easy task. But this Consortium’s groundbreaking model of mining the depth of technical knowledge from industry and academia with support from TURI and EPA was very successful.” – Linda Darveau, Environmental Scientist, U.S. Environmental Protection Agency.*

*“We are extremely fortunate to have the Six Sigma skills of Sammy Shina of UMass Lowell and Greg Morose of TURI to design the lead-free electronics experiments. Since the balanced experiments evaluated many different factors at*

*once, we were able to realize our goal of speed to market. We learned a great deal in a short period of time. A lot of businesses don’t have this type of expertise.” – Karen Ebner, Senior Quality Engineer, Raytheon.*

*Contributions over \$1 million.* Consortium members contributed their resources to find lead-free alternatives. TURI estimates the cost for materials, equipment usage, engineering time and technical expertise provided by the companies and organizations to total more than \$1 million.

*“If you added up all the components, materials and testing costs, the dollar amount would be enormous, probably more than any one company could manage. And even then, you wouldn’t have gained the depth of knowledge that has been so valuable throughout this process.” – Helena Pasquito, Manufacturing Skills Instructor, Cobham Defense Electronic Systems, Lowell, MA.*

**Source: Toxics Use Reduction Institute Fact Sheet “Get the Lead Out of Electronics.”**

## 2.7 Compliance, Enforcement and Policy Engagement

*Compliance and enforcement.* MassDEP implements the regulatory components of the TURA program. This includes developing and implementing regulations governing toxics use reporting and planning; developing reporting and planning forms and guidance documents; promoting compliance with reporting and planning requirements; and taking enforcement action when necessary. MassDEP also maintains the TURA information management system and reports toxics use information to the public; coordinates with the U.S. Environmental Protection Agency (EPA) on federal Toxics Release Inventory reporting; and implements multi-media compliance and enforcement programs that promote pollution prevention.

*Policy engagement.* TURI is the principal policy arm of the TURA program; OTA and MassDEP also engage with policy issues in a variety of ways. Policy activities include development of alternatives assessment methodologies; engagement with chemicals policy development at the state, federal, and international levels; and assessing, developing, and evaluating specific initiatives to reduce use of toxic substances industry and communities. In addition, TURA program implementation requires decision-making on listing and de-listing of substances, designation of higher and lower hazard substances, and other activities related to managing and updating the TURA list of toxic and hazardous substances. This process requires analyzing both scientific information and policy implications.

The increasingly global economy demands that Massachusetts companies understand not only Massachusetts regulations, but also regulations and restrictions in other parts of the world. As part of on-going TUR planner continuing education conferences, TURA program policy experts provide information on policies of global relevance, such as the European Union's Registration, Evaluation, and Authorization of Chemicals regulation (REACH) and the Restriction of Hazardous Substances<sup>3</sup> (RoHS) directive, as well as new chemicals policy developments in other states within the US.

The non-regulatory arms of the TURA program (OTA and TURI) provide input to regulatory agencies to improve regulations and incorporate pollution prevention. All three agencies (OTA, MassDEP and TURI) have worked together to identify opportunities to improve regulations to better encourage sustainable practices by Massachusetts companies. For example, OTA has helped federal and state regulatory agencies to modify enforcement practices for facilities with zero wastewater discharge. OTA has also helped to identify options for developing good faith settlements, such as Supplemental Environmental Projects and other structured negotiations.

Information gathered by OTA helped in the formation of MassDEP's Environmental Results Program and the development of federal and state efforts to develop responses to environmental issues in the autobody, marine, biotech, hospital, schools, municipal and medical devices sectors. OTA also served as the lead agency for an interagency effort to open a dialogue with nanotech companies. OTA's unique position in each of these cases helped to enlist the participation of key industry parties and helped the agencies to understand the capacity of the regulated entities to address environmental issues.

*Alternatives assessment methodology and other methods development.* Implementation of toxics use reduction often depends on the availability of safer alternatives. The TURA program works with technical

assistance providers, policy makers, industry representatives and public health advocates to develop and disseminate methodologies for alternatives assessment. This includes assessing the availability and relative safety of a range of alternatives to chemicals of concern.

TURI's *Five Chemicals Alternatives Assessment Study*, published in 2006, established the Commonwealth's leadership in the methodology of Alternatives Assessment, and provides detailed information about five chemicals for policy makers, industry, public health and environmental professionals, advocates and other stakeholders.<sup>4</sup>

Currently, TURI is working with representatives from a number of states, including Maine, Washington, Oregon, Connecticut, California, Illinois, Vermont, Michigan, and Minnesota, as well as with the U.S. Environmental Protection Agency's Design for Environment (DfE) program, to develop a common language and protocol for assessing alternatives to chemicals of concern. When completed, this collaborative work will be available to all policy makers interested in assessing the availability and viability of safer alternatives, and will be fully adaptable to the user's specific needs and goals.

In related work, TURI has held workshops focusing on green chemistry, alternatives to toxic solvents, and methodologies for assessing alternatives to toxic chemicals. In 2001, OTA held the first of several events on Green Chemistry, an approach that has now received national attention.

*Engagement with Chemicals Policy Development in the U.S. and Internationally.* The TURA program is known nationally and internationally as a model of innovative and effective chemicals policy. TURA staff provide detailed information to policy makers and others working to replicate the model in other jurisdictions. Projects with a focus outside Massachusetts are supported by external funding.

Several states have used, either indirectly or directly, the TURA program as a model when developing their own chemicals policies. TURA program staff members have been available to assist policy makers and advocates from other states, such as California, Washington and Maine, in developing new approaches to chemicals policy. International activities have included providing assistance and information to other jurisdictions working to develop TURA-type programs, including the Baltic States, Brazil, Canada, Chile, the Philippines, Scotland, and the Organisation of Economic Co-operation and Development (OECD), and meeting with delegations from the Mideast, Ireland, Eastern Europe, Japan, Korea and Russia.

TURI staff members have also received outside funding to collaborate with international organizations on a variety of activities related to reducing or eliminating exposures to toxic chemicals. For example, TURI staff members wrote a report for the Swedish Chemicals Agency (KemI) on chemicals in products. The resulting report was used as the background document for a United Nations Environment Programme conference on this topic. TURI staff members also coordinated an international process to develop a Preliminary Global Outlook for Chemicals for the United Nations Environment Programme. This is an overview document considering a wide range of scientific, policy, and economic factors related to use of toxic chemicals worldwide, with a particular focus on developing countries.

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## **Section 3: Existing Studies of the TURA Program**

### **Toxics Use Reduction Act (TURA) Program Assessment**

A number of analyses of the TURA program have been produced over the nearly two decades that the legislation has been in effect. The TURA program itself produces annual reports based on toxics data submitted by companies. A program evaluation completed in 1997 analyzed the results of the first six years of the program and provided information on the cost savings achieved by participating companies.

In addition, scholars outside the program have provided analysis and commentary. In some cases, these studies have been motivated by interest in replicating TURA's successes in other jurisdictions. For example, a report on options for chemicals policy reform in California featured a detailed consideration of the TURA program; and the government of the Canadian province of Ontario studied the TURA program in detail as part of its effort to build a similar program.

#### **3.1 Analyses produced by the TURA program**

*Analysis of Further Chemical Restriction Policies (1993).*<sup>5</sup> In 1993, TURI published a study that examined the options available to the Commonwealth for additional legislative action on chemicals. The authors argued that existing authorities formed a patchwork of programs without a clear, comprehensive authority for the restriction of toxic chemicals. They outlined options for a more comprehensive approach, including a four-step "toxic chemical transition process" intended to identify safer materials and encourage companies to make the transition from more hazardous to less hazardous materials.

Some of the ideas proposed in the study have been undertaken within the TURA program, while others remain outside its scope. In particular, a process for distinguishing between more and less hazardous substances was formalized in the 2006 amendments to TURA.

*1997 Program Evaluation.* A detailed evaluation of the TURA program was completed in 1997. The evaluation examined the success of both companies and Massachusetts government agencies in implementing the law; analyzed trends in toxics use data; discussed the value of each program element; and assessed costs and benefits of the TURA program. The study found that the TURA program has been effective in reducing Massachusetts facilities' use of toxic substances, and has provided opportunities for facilities to achieve financial benefits. Key findings included:

- Massachusetts firms were making significant efforts to implement the law by changing their practices and processes to reduce their dependence on toxic chemicals.
- Barriers to TUR included company concerns about product quality, and customer concerns about changes in products.
- The survey showed a clear connection between TUR implementation and actual reductions in toxic chemical use; the reductions in use and byproduct occurred primarily among those facilities that implemented TUR options.
- The most frequently reported benefits of TUR implementation were cost savings and worker health and safety improvements.

- Almost all of the respondents that had some exposure to TURA program services found that they were very or somewhat useful.
- The program has produced net benefits for the Massachusetts economy.

The evaluation produced a number of recommendations and areas for further attention. The evaluation proposed examining existing barriers further, in particular with a view to identifying technological gaps that might be impeding progress. The evaluation also emphasized the importance of rewarding firms that have made good progress in toxics use reduction and focusing assistance on those firms that have been less successful. While firms subject to TURA were making good progress in toxics use reduction, the authors noted that smaller quantity toxics users were not necessarily making similar progress. Finally, the evaluation suggested that it could be valuable to apply the principles of TUR planning to additional areas, such as water and energy use, and chemicals in consumer products.

Some of the recommended changes were adopted in the 2006 amendments to TURA. For example, the 2006 amendments made it possible for the program to extend its reach to some smaller toxics users. The 2006 amendments also implemented the recommendation that the TUR planning methodology be extended to encompass options for conserving energy, water, and other resources.

*Effectiveness of Providing On-site Technical Assistance for TUR (2006).* OTA undertook a study to determine the extent to which site visits to firms are associated with improvements in toxics use reduction. Using data reported under TURA, OTA found that on-site visits do improve facilities' TUR performance. Visited companies reduced their toxics use by an average of 9% more after being visited by OTA, than before. Visited companies also had approximately half the waste byproduct per pound of chemical use than those not visited. More companies in the visited group made progress than companies not visited, and had greater reductions than those not visited by nearly all measures.

### **3.2 Studies produced outside the TURA program**

*Innovations in American Government Award (1999).*<sup>6</sup> The TURA program was a 1999 Winner of the Kennedy School of Government's Innovations in American Government Award. The award announcement recognized the TURA program as a national leader, noting that the U.S. EPA "and other agencies in New England have replicated various components of the program. Moreover, the program has attracted international attention, with Brazil, Chile, and Canada remodeling their toxic use programs on the Massachusetts approach."

*MassPIRG Report (2001).* A report published in 2001 by the advocacy organization Massachusetts Public Interest Research Group (MassPIRG) examined trends in the use of chemicals categorized as "More Hazardous Chemicals" by the TURA program's Science Advisory Board. The authors argued that Massachusetts was not making sufficiently rapid progress in reducing the use of highly toxic chemicals. The report examined trends in four categories: persistent and/or bioaccumulative toxics (PBTs); organochlorines and chlorine; "low hanging fruit"; and intermediates. The authors found that use of PBTs and organochlorines and chlorine actually increased between 1991 and 1999, while use of "low hanging fruit" chemicals declined during this time period.

The authors proposed a series of steps to adjust the priorities of the TURA program and ensure continued progress in reducing use of high priority toxics. They recommended lowering the reporting thresholds for the most hazardous chemicals; requiring all facilities that meet this threshold to report on their use, rather than exempting firms with fewer than 10 employees; increasing fees for the most hazardous chemicals; setting voluntary reduction goals for these chemicals by chemical class; and concentrating program resources on the chemicals of greatest concern. Many, though not all, of these recommendations were addressed by the 2006 amendments to TURA.

*Environmental League of Massachusetts (2001).*<sup>7</sup> In 2001, the Environmental League of Massachusetts published a report on use and releases of carcinogens in Massachusetts, using TURA data. The authors emphasize the importance of the publicly available data provided under TURA. They argue that the trends in carcinogens indicate that TURA is producing the desired effects, citing a 6 percent decrease in the use of carcinogens from 1994 to 1998, and a 76 percent decrease in releases of carcinogens to the environment in the same period. The report notes that these reductions occurred during a period of economic expansion, indicating that “companies are, in fact, becoming more careful and efficient in their use of toxics and are not simply curtailing their operations.”

The authors make some suggestions about areas for improvement, including conducting more analysis of the data in order to identify priority focus areas; identifying toxic chemicals that are increasing, rather than decreasing, in total use or releases; determining why those increases are occurring; and identifying differences between companies that have reduced use and those that have increased use.

*“Pollution Prevention and the Work Environment” (2000).*<sup>8</sup> One study investigated the relationship between toxics use reduction activities and the broader goal of improving worker health and safety. The authors reviewed published case studies of toxics use reduction by Massachusetts companies, and interviewed TURA program staff.

The authors found that “in almost 50 percent of the cases analyzed, improved worker health and safety was cited as a benefit of the toxic use reduction projects.” Projects included work to eliminate or reduce use of solvents; adopt safer, water-based alternatives to toxic chemicals; and reduce the use of acids and caustics. However, the authors found that worker health and safety was usually not an explicit focus of the TUR efforts, creating the possibility that new hazards could be created or opportunities to protect workers could be missed. They recommend increased efforts to integrate worker protection with pollution prevention efforts.

*O’Rourke and Lee (2004).*<sup>9</sup> A 2004 study by researchers at UC Berkeley and MIT notes that TURA is of particular interest for policy analysts because it combines ambitious toxics use reduction goals with an innovative approach to achieving those goals.<sup>10</sup> TURA embodies several principles that have been proposed as best practice for environmental regulation. According to these principles, regulations should: focus on performance outcomes; require firms to carry out self-evaluation and planning processes; make use of market incentives; “promote ‘preventive’ and proactive approaches to solving environmental problems;” and “support firm innovations through technical assistance and polling of learning among

firms.” TURA also embodies additional principles that have not been developed in the literature on environmental regulation, and which deserve further study.

The authors draw attention to areas in which the TURA program could be strengthened. In particular: the program does not work with small users of toxic chemicals; the program is “limited in its ability to motivate firms to implement their toxics use reduction plans”; and the program is “limited in its facilitation of public participation in environmental protection efforts.”

They also suggest that in the absence of public pressure for more progress, the TURA program “will likely face a plateau of effectiveness.” Such a plateau could result when all firms that are willing to innovate have done so, and less-motivated firms simply continue to submit TUR plans without acting on them. They offer several suggestions for ways to move beyond a possible plateau of this kind:

- Empower the public to bring pressure to bear on firms that have not made good progress in TUR: “Greater public disclosure of TUR data and a list of ‘worst performers’ might be an effective means to draw public concern into the universe of TURA.”
- Compare companies with one another: “TURA data could also easily be used to ‘benchmark’ firms in similar industries to publicly identify leaders and laggards. Benchmarking with TURA-like data could help firms better assess their current performance relative to their competitors, and help them identify possibilities for future improvements.”
- Use TURA processes to identify opportunities for effective regulation: “When several firms show it is possible to reduce a specific chemical, that chemical could be targeted for stricter regulation, thus leveling the playing field for all firms and benefiting leading firms.”

*Framework for Chemicals Policy Reform in California (2006)*. In 2006, University of California researchers wrote a report urging a “modern, comprehensive chemicals policy” be put in place in California.<sup>11</sup> The report documents the deficiencies in the federal Toxic Substances Control Act (TSCA) and discusses how omissions in federal legislation have become a liability for the state. The report evaluates several state chemicals policies, including TURA.<sup>12</sup>

The report suggests that the TURA program is a useful model to draw upon in developing a comprehensive chemicals policy for California. The authors note that:

“TURA is unique among U.S. environmental statutes in that it requires firms to report their *use* of hazardous chemicals rather than their releases of chemical pollutants, and it requires firms to evaluate their operations and plan for process improvements. It is the only statute that includes an institute – to provide ongoing technical assistance, training, and research for Massachusetts businesses in toxics use reduction strategies. Together, these approaches have motivated continual innovation by firms in strategies to reduce their use of hazardous chemicals. ... We believe that California can learn from (and build on) the 16 years of experience by government and industry in Massachusetts under TURA.”<sup>13</sup>

According to the report, TURA’s limitations include the following:

- The exclusion of smaller firms could be problematic. Collectively, firms that do not meet TURA requirements could be responsible for significant amounts of chemical use. In addition, some chemicals are hazardous in minute quantities.
- Companies are not required to implement TUR plans, and the state has only a limited ability to motivate implementation.
- The law does not require companies to evaluate toxicity of chemicals used or shipped in product. Nor does it require disclosure to workers or consumers of the toxicity of chemicals in processes or products.

Subsequently, the government of California sponsored a series of reports and convened a high-level working group to consider options for chemicals policy reform in the state. The reports featured detailed consideration of the TURA program as a key model for new initiatives in California.<sup>14</sup>

*Ontario provincial government study (2008).*<sup>15</sup> The government of the Canadian province of Ontario has studied the TURA program in detail as part of its effort to replicate the TURA model, including extensive consultation between Ontario government employees and TURA program staff. Among other activities, the Ontario government produced a detailed report on the Massachusetts model.

*Other publications.* A variety of scholarly and advocacy publications related to reforming chemicals policy at the state, national, or international level make reference to the TURA program as a useful model for protecting public health while promoting economic development.<sup>16</sup> For example, physician Samuel Epstein discusses the TURA program as part of a broader exploration of legislative options for reversing the cancer epidemic;<sup>17</sup> and a 2007 publication on “solutions to cancer” showcases the TURA program as a positive example of how policy changes can reduce public exposure to carcinogens.<sup>18</sup>

### **3.3 Summary**

Recurring themes in the existing literature include the need to address persistent barriers to toxics use reduction; opportunities to target resources to the highest priority chemicals; opportunities to work with smaller companies; options to expand the TURA model beyond toxics; options to provide additional motivation to companies; options to mobilize public participation; and the need to maximize coordination among state programs on toxics.

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## Section 4: Survey Findings

### Toxics Use Reduction Act (TURA) Program Assessment

In 2008, TURI contracted with Abt Associates Inc. to conduct an online survey to assess the experiences of facilities and planners in the TURA Program. The survey was designed to gather information on questions including:

- What techniques are most useful in helping facilities achieve TUR?
- What benefits are facilities experiencing as a result of their participation in the TURA program, or as a result of specific TUR projects they have implemented?
- What challenges or difficulties are facilities facing as they work to reduce their use of toxics?
- How have facilities' experiences in the program changed over time?

*Survey population.* Abt Associates distributed an online survey to all 561 facilities that filed under TURA in 2006. Of these facilities, 196 responded to the survey (35 percent). An analysis of the respondent and non-respondent populations indicated that the survey respondents were representative of the overall TURA filing population. Thus, results can be extrapolated to the TURA filing population as a whole.

The survey was also distributed to all TUR planners who were registered with the program as of January 2008. Those who identified themselves as general practice planners had the option to respond to the survey on behalf of a specific facility they worked with, or on their own behalf without reference to a specific facility. Some questions were targeted to general practice planners only and requested information based on the range of the planners' professional experience, without reference to a specific facility. Thirty-six general practice planners answered these questions, providing information based on their experiences working with multiple facilities.

The survey was also distributed to facilities that last filed under TURA in earlier years, going back to 2000. Only a small number of these facilities responded to the survey, so these responses cannot be considered representative of the larger population of facilities that filed in earlier years. Specifically, the survey received responses from three facilities that last filed in 2005; four that last filed in 2004; one that last filed in 2003; and one that last filed in 2000. These facilities' responses are not included in any of the statistical analyses, but this report does reflect some of these facilities' responses to the survey's open-ended questions.

Finally, Abt conducted in-depth telephone interviews with a subset of 18 of the survey respondents. These interviews provided additional detail to supplement the information provided by respondents in the online survey.

#### 4.1 How Facilities are Reducing Toxics

The TURA data allow us to determine the rate at which Massachusetts facilities are reducing their use of toxic chemicals. The survey allowed respondents to augment this information by providing detailed information on how facilities are achieving these reductions.

#### 4.1.1 TUR Techniques

TURA defines six toxics use reduction techniques: improved operations and maintenance; input substitution; recycling, reuse, or extended use of toxics integral to the production process; product reformulation; production unit modernization; and production unit redesign or modification. The quantitative portion of the survey asked respondents which of these techniques their facility commonly employed. In addition, respondents had the opportunity to provide open-ended responses describing their toxics use reduction efforts in more detail.

The technique selected by the largest number of respondents (63 percent) was improved operations and maintenance. The next most commonly selected techniques (each selected by 46 percent of respondents) were input substitution and recycling, reuse or extended use of toxics. Product reformulation, production unit modernization, and production unit redesign or modification were selected by 34 percent, 29 percent, and 28 percent of respondents respectively. These results indicate that facilities are making use of all six of the techniques, although some are used more frequently than others.

Technique	Responses	Percentage (of 196 Respondents)
Improved operation and maintenance	123	63%
Input substitution	91	46%
Recycling, reuse, or extended use of toxics	90	46%
Product reformulation	67	34%
Production unit modernization	56	29%
Production unit redesign or modification	55	28%
Don't know	13	7%

*Improved operations and maintenance.* Improved operations and maintenance was the TUR technique reported as being commonly used by the largest number of respondents (63 percent).

- For example, one facility installed a temperature controlled storage room to extend the shelf life of raw materials.

*Input substitution.* Just under half (46 percent) of respondents indicated that their facility made use of the technique of input substitution. Some examples of input substitution are discussed below, in the section on reduction or elimination of toxic solvents.

*Recycling, reuse, or extended use of toxics.* Under TURA, recycling qualifies as toxics use reduction only if it is in-process recycling (also known as integral or hard-piped recycling). A number of facilities described ways in which they reduced toxics via in-process recycling, reuse, or extended use of toxics.

- One facility reduced its use of acids through integral recycling, and was able to reduce its hazardous waste generation by over 50 percent as a result. Other facilities undertook projects including the implementation of a zero-discharge nickel/chrome recycling system; installation of a solvents recycler, making it possible to reuse solvents in-house; and implementation of integral recycling of methanol.
- A respondent for a facility in the coated fabrics sector explained that the facility cleans its resin tanks with acetone. As a result of the TUR planning process, the facility now continues to reuse the acetone until it is spent. When the facility can no longer use the acetone, it is recycled via an outside agency.

*Product reformulation.* Just over a third of respondents indicated that their facility used the technique of product reformulation.

- For example, one facility reduced solvent use by developing low- or no-VOC products. The respondent noted that this change led to a range of benefits. In addition to reducing the need to purchase solvents, the change "provided a marketing advantage as a more 'green product.'" The facility also "gained regulatory recognition for VOC reduction."
- Another facility reduced the phenol in its resins from 17 percent to 6 percent through reformulation. This facility also used product reformulation to reduce its use of formaldehyde. As a result, the facility dropped below the TURA reporting threshold for formaldehyde. Both of these projects were included in the facility's TUR plan, although the respondent noted that the reformulation to reduce phenol use would have been carried out regardless of TURA.

For more examples of the role of product reformulation in facilities' toxics use reduction efforts, see the discussion of solvents, below.

*Production unit modernization, redesign or modification.* Just under a third of respondents indicated that their facility made use of the techniques of production unit modernization (29 percent) and/or production unit redesign or modification (28 percent). In addition, the information that respondents provided on capital investments (discussed in section 4.1.3., below) show that production equipment was the area in which facilities invested most frequently. A number of respondents mentioned production equipment upgrades specifically in their open ended responses.

- For example, one facility "created a new vapor etch machine that cut chemical use by 80 percent."

#### 4.1.2 Focus areas for TUR efforts

Several themes emerged in the open-ended responses. These include a particular focus on reducing the use of toxic solvents; options for reducing toxics in waste and water treatment; facilities' efforts to reduce or eliminate the use of lead and other toxic substances targeted by the European Union's Restriction of Hazardous Substances (RoHS); and integration between TUR activities and other management systems. The TURA program has active, on-going projects in each of these areas. In addition, potential new opportunities emerge from the experiences of individual facilities.

*Reducing use of solvents.* Many respondents described work to reduce solvent use in cleaning applications, indicating that facilities are continuing to make progress in this area. Respondents described examples related to solvent use in cleaning applications, as well as solvent use in formulations.

*Solvents in cleaning applications.* Table 5, below, shows selected examples of TUR related to solvent use in cleaning applications. As shown in the table, some of the facilities that have reported reductions in solvent use in the period 2000 to 2006 have been in the program for many years.

For example, two facilities that have been in the program since its inception have implemented new TUR options to reduce solvent use in recent years. One facility eliminated its use of the solvent methylene chloride even though its use was already below TURA reporting thresholds.

The other reduced solvent use by purchasing a closed-loop vapor degreasing system.

This purchase is an interesting example of the value of repeated cycles of TUR planning. Closed-loop vapor degreasing systems were not available in 1990, when the facility first entered the TURA program. The technology became available in the late 1990s, and this facility adopted the technology in 2001. This is one example of how continued examination of toxics use reduction options over time makes it possible to identify new and emerging TUR options that may not have been available previously.

#### Development of new TUR options: the case of solvents

The survey results indicate that facilities are continuing to find new ways to reduce their use of toxic substances over time. In some instances, this occurs because the options available to facilities change over time, with the development of new materials and technologies. With repeated planning cycles, facilities have an opportunity to re-visit their use of toxic substances regularly and to take advantage of new alternatives that have become available.

In the case of solvents, a number of changes have occurred over the past several decades. Initially, industry made extensive use of hydrocarbon formulations, which posed a significant fire hazard. Hydrocarbon technologies eventually gave way to a variety of substances, including trichloroethane (TCA) and chlorofluorocarbons (CFCs), which were non-flammable but were later discovered to be ozone depleters. These ozone depleters, in turn, have been replaced in some cases by chlorinated solvents such as trichloroethylene (TCE) and perchloroethylene (PCE), and terpenes (a family of hydrocarbons produced by plants); these also pose environmental health and safety concerns. Some facilities began adopting safer aqueous systems in the mid-1990s, while others still find it difficult to make this shift. For these facilities, an alternative solution is to move to a closed loop system that minimizes potential exposures.

Table 5: Reduction or elimination of toxic solvents in cleaning applications: Selected examples		
Sector*	Years in TURA	Approach to reducing solvent use
Electronic & electrical equipment & components (36) <sup>19</sup>	5	<i>Elimination of a cleaning step:</i> Facility eliminated the washing of circuit boards, thus eliminating the use of solvents.
Electrical & electronic equipment & components (36)	8	<i>Process change:</i> Facility switched from parts washing using a manual, solvent-based system to a mechanized, water-based process.
Fabricated metal products (34)	16	<i>Equipment upgrade:</i> A facility that has been in the TURA program since 1990 purchased new closed-loop vapor degreasers in 2001. The purchase allowed the facility to reduce its consumption of trichloroethylene from more than 10 tons to less than 1 ton per year.
Fabricated metal products (34)	8	<i>Process change:</i> Facility eliminated vapor degreasing entirely.
Fabricated metal products (34)	16	<i>Reduction of a substance used below TURA threshold:</i> Facility replaced methylene chloride with a safer cleaning chemical. The respondent noted that this reduction was not reflected in the facility's annual reporting because methylene chloride use was already below reportable levels.
* SIC code is shown in parentheses.		

*Solvents in products.* Other facilities are working to reduce the use of solvents in products via reformulation. In some cases, this task requires coordination up and down the supply chain. For example, a facility wishing to reduce its use of a solvent in a purchased product may need to communicate with upstream suppliers in order to obtain a reformulated product. In other cases, a formulator may need to communicate with customers downstream in order to ensure that a reformulated product meets their specifications.

- One respondent noted that "as of November 2007, all use of n-hexane has been replaced by other less toxic chemicals. It took a long time to find and approve all the new formulations, but the replacement is now complete." The facility was able to stop reporting under TURA as a result.
- In another example of replacing or reducing a toxic solvent within a formulation, one respondent described implementation of a high volume, low pressure (HVLP) spray system, along with low hazardous air pollutant (HAP) coatings, as a source of toxics use reduction.
- Another respondent explained that the facility develops aqueous coatings instead of solvent-based coatings wherever possible. One challenge that arises in this effort is that "many customers have a specific coating already formulated ... which may prevent this from happening."

*Improving water and wastewater treatment.* Toxics use reduction can be a particular challenge when a toxic chemical is required for water treatment. Simply eliminating the treatment step is not an option. Once a facility has done all it can to reduce waste generation, the facility must treat the remaining waste.

However, several respondents described successful efforts to reduce the use of water and wastewater treatment chemicals.

- One facility changed the chemistry that it used for converting hexavalent chromium to the less toxic trivalent chromium in its waste stream. The new chemistry allowed for chrome reduction at a higher pH, making it possible to reduce the facility's use of sulfuric acid.
- Another facility made changes to its wastewater treatment that included reducing its use of sodium hydroxide and eliminating ferric chloride as a treatment chemical. These changes improved efficiency by reducing the facility's cycle time for treatment of wastewater. It also produced occupational health benefits by reducing the likelihood of workers' exposure to ferric chloride and sodium hydroxide.
- Another facility installed an ion exchange system for treatment of boiler feed water, thus reducing the need for water treatment chemicals.

*Energy and water conservation.* The toxics use reduction planning process can also be used to identify opportunities for conservation of other resources, such as energy and water. The 2006 amendments to TURA make it possible for facilities to conduct alternative resource conservation planning as an alternative to toxics use reduction planning under some circumstances.

The survey focused on facilities' activities prior to these amendments going into effect. However, the survey responses indicate that even prior to the 2006 amendments, some facilities were using the TUR planning process to identify options for energy and water conservation, in addition to reducing toxics.

- A facility that has been in the TURA program for 16 years installed a steam generator in 2006 in order to reduce natural gas use. This project was included in the facility's 2006 TUR Plan, and the respondent pointed to it as "feeding into our system from the TURA process."
- Another facility that has been in the TURA program for 16 years, and has eliminated or significantly reduced several TURA listed substances, is also working now to reduce its use of water. The facility uses 140 million gallons of cooling water annually. The facility has hired a fluid management contractor to examine options for reducing toxics and cutting costs in general. Any savings achieved through water use reductions are divided with the contractor.
- Another facility implemented options to conserve both water and energy. The facility installed a system for direct reuse of wastewater, and installed a non-contact heat exchanger to reduce heat input and fuel use.

Going forward, with the implementation of the 2006 amendments, the TURA program has the opportunity to encourage and facilitate adoption of new energy- and water-saving techniques. The experiences of facilities that have already undertaken some activities of this kind indicate opportunities for progress by other facilities. For example, other facilities could benefit from adopting heat exchangers, similar to the facility mentioned above.

*Reduction in lead use.* A number of respondents noted that they have used TUR techniques to reduce their use of lead and other hazardous substances, in order to comply with the European Union's

Restriction of Hazardous Substances (RoHS). This is an area that has been a focus of TURA program activities at both TURI and OTA. For example, as described in Section 2 above, TURI has worked with Massachusetts businesses to create a consortium of facilities working to build and test prototypes of lead-free electronic circuit boards.

- A facility that manufactures audio and video equipment began a lead reduction program in 2001. The program was motivated by the need to comply with RoHS requirements, and used TUR planning as a tool to achieve this goal. Among other changes, the facility eliminated a wave soldering line that used lead solder, and purchased new wave soldering equipment to replace the lead line. The facility planned to eliminate lead-containing products at the end of product life cycles (usually about five years). The respondent commented that an advantage of TURA is that it encourages businesses to make environmental improvements according to their own business plan and schedule.

Efforts to reduce use of lead also go beyond compliance with RoHS. Facilities whose products are exempt from RoHS or are not sold in the European Union also see the need to reduce their use of lead and other hazardous substances.

- One facility replaced a wave solder machine with a more efficient selective solder machine. This change enabled the facility to reduce lead use steadily from nearly 400 pounds in 2003 to just 30 pounds in 2007.

Some respondents also noted barriers related to the effort to reduce use of lead. For example, one respondent noted that "input substitution is the only real solution" for reduction of lead used in soldering processes, but noted that customer specifications make this impossible in some cases.

As noted above, the TURA program works to facilitate communication up and down the supply chain as a means of facilitating toxics use reduction for specific industry sectors. Supply chain communication has been particularly important for the work by manufacturers of electrical and electronic equipment to comply with RoHS requirements. This is discussed further in the section below on benefits of implementing TUR options.

*Integration of TUR activities with other management systems.* Some respondents emphasized the relationship between their TUR activities and activities under other management systems such as an EMS or Six Sigma.

- One respondent explained, "This facility employs Lean Six Sigma techniques in an attempt to continually improve our process safety, quality, energy efficiency, reduced waste generation and to limit the use, handling and exposure to toxic chemicals. We use the TURA process to feed potential projects into this existing process. Several projects are completed annually that reduce chemical usage, reduce chemical exposure, reduce waste generation, improve product quality, improve energy efficiency or improve the overall safety of the facility. Generally the barriers faced in the implementation of these projects are minimal due to the fact that the Lean

Six Sigma process and Continuous Improvement is supported at the highest levels within the organization."

In the process of implementing the 2006 amendments, the TURA program has worked to integrate TUR principles into the broader EMS methodology. Going forward, it may also be useful to work toward the integration of TURA principles into Lean Six Sigma processes and other, similar management systems.

#### 4.1.3 Capital investments

Another window into how facilities are reducing toxics is the capital investments they are making. The survey results indicate that facilities are continuing to make capital investments in toxics use reduction techniques. Note that in all cases, facilities made a business decision in favor of these capital investments; the TURA program does not require facilities to make these investments.

The survey asked respondents whether their facility had made capital expenditures (i.e. investments in equipment, buildings, or other fixed assets) as a result of implementing TUR projects in the period 2000-2006. There were 196 responses to this question for facilities that reported in 2006. Of these, 77 respondents, or 39 percent, indicated that their facility had made one or more TUR-related capital expenditure.

The 77 respondents provided detailed information on a total of 125 capital expenditures. As shown in Table 6, the largest number of these investments (78 percent) was for production equipment. Other capital expenditures selected by a number of respondents were for facility modification; emission control; instruments and controls; and ancillary process equipment.

Type of Expenditure	Responses	Percentage (of 77 respondents)*	Example
Production equipment	60	78%	Installation of high volume, low pressure (HVLP) spray system
Facility modification	16	21%	Creating a hard piped reuse system
Emission control**	12	16%	Redesign of exhaust system
Instruments and controls	12	16%	Improved wastewater control
Ancillary process equipment	11	14%	Automated mixing equipment
Other	7	9%	Investment in piping and pumps
Product testing equipment	6	8%	R & D test equipment
Don't know	1	1%	n/a
Total responses	125	n/a	
* Note: Some respondents provided information on multiple expenditures.			
** Note: Some responses in this category do not meet the definition of TUR.			

Some facilities provided additional details on these capital investments. For example, in the category of production equipment, respondents listed a wide range of specific investments. These included: purchase or modification of mixing tanks, chemical bath tanks, and acid tanks; replacement of mixer equipment; modifications such as enclosing a mixer or adding a furnace exit curtain; installation of a high volume, low pressure (HVLP) spray system; installation of diameter control equipment; purchase of a new boiler or other new equipment; purchase of a pointing machine; adoption of a reverse osmosis skid system for water purification; and adoption of closed-loop vacuum vapor degreasers.

It is worth noting that the activities reported under the category of emissions control are not necessarily toxics use reduction. However, these items indicate that the facility has used the TUR process to consider all the facility's operations. Although the TURA program encourages facilities to focus their attention upstream, on the factors that drive use of toxics, it is also crucial that facilities consider how they are managing end-of-pipe emissions.

Most of the capital investments (74 percent) were under \$100,000. A third of them were under \$10,000. These results indicate that facilities continue to identify toxics use reduction options that can be implemented with a relatively small up-front capital investment.

#### 4.2 Benefits of implementing toxics use reduction projects

In both the quantitative portion of the survey and in open-ended responses, respondents described a wide variety of benefits from implementing TUR projects. These benefits can be grouped in the following categories: health and environmental benefits; financial benefits; institutional benefits; compliance benefits; efficiency benefits; product quality and marketing benefits; and retention of a product line.

The benefits cited by the largest number of respondents were “increased management attention to environmental practices” (55 percent), “improved worker health and safety” (51 percent), and financial savings (41 percent). The full set of responses to this question is shown in Table 7.

<b>Benefit</b>	<b>Responses</b>	<b>Percentage (of 196 Respondents)</b>
Increased management attention to environmental practices	108	55%
Improved worker health and safety	99	51%
Financial savings	81	41%
Compliance with other state or federal regulations	64	33%
Improvements in production efficiency	57	29%
Improved product marketing	41	21%
Improvements in product quality	33	17%
Improvements in technology and physical infrastructure	30	15%
Compliance with international standards	22	11%
Improved worker-management relations	21	11%
Other	18	9%
Improved community relations	16	8%
Retention of a product line	12	6%

#### **4.2.1 Organizational benefits**

*Increased management attention to environmental practices.* The TURA planning requirements are designed to ensure buy-in from every staffing level, including management. By requiring management involvement, the planning requirements can help to amplify the voices of those employees who wish to make production improvements to protect the environment or human health and safety. More than half of the respondents selected "increased management attention to environmental benefits" as a benefit of the program. As one respondent commented in the telephone interview,

"TURA is a great reason to make sure management and others are involved, and it facilitates routine business discussion."

One respondent indicated that toxics use reduction had led to improvements in morale.

"Modifications to fixturing or facility to reduce amount of clean-up materials used (that become contaminated with the TURA chemical in the process). Great morale booster -- cleaning is not a desired task."

An additional, related benefit of TURA compliance is increased attention to ideas that are generated by employees. TURA requires that the planning process include consultation with employees. This requirement helps to ensure that employees have an opportunity to express concerns and provide suggestions, an opportunity that is not guaranteed by other regulations. An example is provided in the discussion of production efficiency benefits, below.

#### **4.2.2 Health and environmental benefits**

*Improved worker health and safety.* Improved worker health and safety is another central goal of the TURA program. More than half the respondents indicated that their facility has achieved improvements in worker health and safety as a result of implementing TUR projects.

- One facility recently switched to hard piping of the facility's wash-water reuse system. TUR, worker safety, and productivity were all cited as incentives for implementing the project. The facility had always reused wash water, but had accomplished this by pumping the water into drums, moving it back to the front of the line, and putting it back into the system. Hard piping and automating the system has saved time and labor, and reduced exposures for shop floor workers by reducing the possibility of spills or leaks from the drums.
- Another facility has eliminated or reduced a range of toxic chemicals. It has eliminated cyanide and PCBs, reduced TCE use by 100,000 pounds, reduced methylene chloride use by 25,000 pounds, reduced anhydrous ammonia use by 130,000 pounds, and reduced use of a VOC lacquer. The respondent noted that eliminating cyanide alone has greatly improved worker health and safety.

#### **4.2.3 Financial benefits**

*Financial savings.* TURA program requirements are designed to allow facilities maximum possible flexibility in achieving their TUR goals. While facilities are required to complete a TUR plan and to conduct a financial analysis of their TUR options, they are not required to implement any specific TUR option. Thus, when facilities do implement TUR options, they frequently select options that offer direct financial savings as well as health, environmental and other benefits. Eighty-one respondents (41 percent) indicated that their facility achieved financial savings as a result of implementing TUR options in the period 2000-2006.

- A facility that has been in the TURA program for four years installed new cutting presses that allow for tighter patterns, reducing the quantity of scrap fiberglass that is sent out for disposal by about one ton per week. This approach reduced operating costs by reducing both the quantity of raw material needed and the cost of disposal, while improving productivity. Through this and other TUR projects, as well as changes in energy use, the facility has reduced annual operating costs in the range of \$25,000-\$100,000.

#### **4.2.4 Compliance benefits**

*Compliance with other state or federal regulations.* One of the goals of the TURA program is to encourage the use of toxics use reduction techniques as a means to comply with existing regulatory requirements. Sixty-four respondents (33 percent) indicated that their facility had experienced benefits related to compliance with other state or federal regulations as a result of implementing TUR projects. A number of facilities indicated in open-ended comments that they had benefited from toxics use reduction techniques and TURA program services in their efforts to comply with RoHS (see Section 4.1).

- One facility began a multi-year process to move to lead-free manufacturing in 2004. The decision to switch to lead-free manufacturing came in direct response to the RoHS Directive. The facility chose to eliminate one product line entirely, as the equipment and formulation changes were too expensive to make the re-design worthwhile. The facility considered the changes a cost of doing business, because the changes were necessary to ensure the products could be sold in the European market. The respondent indicated that the TUR planning process and TURA program services had helped the facility's lead reduction efforts.

#### **4.2.5 Efficiency benefits**

*Improvements in production efficiency.* Fifty-seven respondents (29 percent) indicated that they achieved improvements in production efficiency as a result of implementing TUR projects.

- One facility that has been in the TURA program since 1990 installed a bulk caustic solution tank in 2007. The idea was generated by shop floor employees who worked directly with the caustic solution. Prior to the toxics use reduction project, employees worked directly with 30-gallon drums of caustic solutions. The process was labor intensive and involved exposure of workers to toxic chemicals. Now the entire process is automated. By eliminating the need to handle 2500 or more drums per year, the facility has saved \$70,000 in raw materials annually.

- Another facility, also in the program since 1990, used a single large tank that was difficult to cover and resulted in the loss of large amounts of methanol through evaporation. The facility decided to introduce three smaller machines that were more efficient and had better seals. The replacement was driven partly by interest in reducing chemical losses, and partly by an effort to reduce the risk of down-time. As long as the facility relied on a single tank, there was a risk that in case of a problem with the tank, production would need to be shut down entirely until it was repaired. With three machines, there is less risk of down-time.

#### **4.2.6 Product-related benefits**

A number of respondents indicated that their facility experienced benefits related to product quality, product marketing, or retention of a product line. Forty-one respondents (21 percent) indicated that their facility benefited from improved product marketing as a result of implementing TUR projects. Thirty-three respondents (17 percent) indicated that their facility benefited from improvements in product quality as a result of implementing TUR projects.

Twelve facilities cited retention of a product line as a benefit. Although this benefit was cited by a relatively small number of respondents, this is a potentially significant benefit from an economic perspective. Facilities that cited this benefit are in the following industry sectors: chemicals and allied products (1); petroleum refining and related industries (1); leather and leather products (2); fabricated metal products, except machinery and transportation equipment (3); and industrial and commercial machinery and computer equipment (2). Some of these respondents provided additional information in open-ended responses; several mentioned activities related to lead reduction and RoHS compliance.

- One facility that indicated “retention of a product line” as a benefit noted that the facility selected a reformulated alloy to lower lead content. In addition to reducing use of lead, this change had the added benefit that the alloy had a lower cost per unit and decreased the need for lead management planning. The respondent noted that the change resulted in a slight increase in annual operating costs for two reasons. First, the new alloy had a higher reject rate than the alloy with higher lead content. Second, because the new alloy had a higher melting point, it required greater energy use. “However, the move was a customer requirement and has been reflected in pricing.”

Other activities described in the open-ended responses included the reduction of the use of a toxic chemical in the manufacture of aluminum tubing; a change in hexavalent chrome treatment chemistry; and reformulations that addressed the facility’s problem of rising waste disposal costs.

Two facilities that cited retention of a product line as a benefit were also contacted in telephone interviews. One respondent explained that lead reduction has allowed the facility to retain parts of its product line. The respondent stated that TURA has helped the facility to stay in business over time.

*Facilitating product recertification.* The need to re-apply for certification can be an obstacle to product redesign or reformulation. In some instances, the TURA program has promoted the transition to safer alternatives by facilitating communication between manufacturers and certifiers. For example, wire and

cable products require certification on several metrics, including flammability and electrical insulation. Manufacturers were concerned that shifting to safer materials for hundreds of products would require a lengthy and complex recertification process for each product.

The TURA program spearheaded an effort to streamline the approval process for redesigned wire and cable products. Underwriter Laboratories (UL), one of the principal entities responsible for certifying wire and cable products, participated in TURI's Wire and Cable Supply Chain workshops. The issue of recertification was raised as a major barrier to substitution of safer stabilizers, colorants and other plastic insulation additives. OTA then worked with UL to develop a fact sheet outlining strategies for streamlining the recertification process and testing requirements. This process facilitated the wire and cable industry's reformulation efforts, and minimized the delay between development of a greener product and marketing of that product to customers.

For example, one respondent described a facility's experience in reducing its use of lead compounds through a collaborative effort with raw material suppliers, customers, and a third party (Underwriter Labs). The facility receives third-party inspections and certifications from UL, which is preferred by the facility's largest customer. Any time a product is reformulated, UL performs tests and issues re-approval.

The respondent noted that the facility made a significant investment in R&D to evaluate reformulated products and demonstrate that they meet all requirements. The cooperative work with UL and the customer, facilitated by the TURA program, helped to streamline the facility's investment of time and resources to achieve approval of reformulated products for customer end use. The respondent noted that "by involving the customer in TUR efforts, TURA helps us maintain communication with our preferred customer."

#### **4.2.7 Other benefits**

Other benefits cited by smaller numbers of respondents were improvements in technology and physical infrastructure (15 percent); compliance with international standards (11 percent); improved worker-management relations (11 percent); and improved community relations (8 percent).

In addition to the benefits that were identified in the quantitative portion of the survey, some additional themes emerged from the open-ended responses. For example, some respondents drew attention to the fact that the TURA planning process can lead to eliminating or reducing chemicals that are used below TURA threshold levels. These reductions are not reflected in the annual TURA data.

#### **4.2.8 Innovations extend to facilities outside Massachusetts**

Of the 196 facilities that reported in 2006 and responded to this question, just over half indicated that their company has one or more facilities outside Massachusetts. Just under a third of the respondents whose company has a facility outside Massachusetts indicated that the company has employed TUR techniques and planning at facilities outside Massachusetts.

This response may be interpreted to indicate that innovations resulting from participation in the TURA program sometimes propagate to facilities in other states. Some of the responses obtained in the follow-up telephone interviews support this interpretation. Respondents indicated that TUR techniques and policies had propagated from Massachusetts facilities to facilities in other states, including Maine, New Hampshire, and North Carolina.

- A respondent on behalf of a facility in the household audio and video equipment sector explained that the Massachusetts facility is small compared to other facilities owned by the same company in the South, so it serves as a manufacturing pilot. Improvements the Massachusetts facility has made through TUR have been shared with other facilities.
- A respondent on behalf of a facility in the aircraft engines sector noted that a Tennessee facility owned by the same company has taken advantage of some TUR ideas to reduce its hazardous waste from 36,000 to 1,000 pounds per year.
- A respondent on behalf of a facility in the small arms sector noted that the facility has been filing with TURA since the beginning of the program. The facility has made significant progress in reducing its use of toxics. Facilities in Maine and New Hampshire have adopted some of the Massachusetts facility's TUR practices.

#### **4.2.9 Benefits from working with a TUR planner**

Some respondents placed particular emphasis on the benefits they experienced from working with a TUR planner.

- One respondent explained that the facility provides information to a planner, who does the reporting and completes the TUR plan on behalf of the facility. The TUR planner comes in to meet with the respondent and the plant manager well before they begin the TURA filing process in order to look over the previous TUR Plan, see what has worked and what additional adjustments could be made. Bringing in an outside specialist has resulted in more effective plans and more ideas than he would have been able to generate alone. The respondent also repeated that with all of his duties, being able to trust in the TUR planner's help had been a boon. The same planner had been working with the facility for at least a dozen years. She made contact with the plant throughout the year, not just at filing time, and was intimately involved in the operations of the facility. The respondent described the facility's relationship with the planner as "some of the best money we ever spent."

#### **4.2.10 Dissemination of innovation through TUR planners**

In addition to the benefits it creates for TURA filers, the TURA program can create benefits for TUR planners and the non-TURA facilities they work with. The training that TUR planners receive creates skills that are broadly applicable.

Three-quarters of general practice planners that responded to the survey indicated that they also work with facilities that are not TURA filers. Of these planners, 83 percent indicated that their knowledge of TUR is an asset for their work with non-filers.

### 4.3 TUR implementation: Challenges and opportunities

The TURA program is designed to be flexible, making it possible for facilities to choose which projects make most sense for them to implement. In the planning process, facilities must identify and examine options, identify those that make sense for them to implement, and make a good faith effort at implementation. A built-in element of this system is the recognition that some options identified in a TUR plan will not be implemented, due to technical feasibility, financial constraints, or other factors. As facilities revisit their plans over time, an item that was passed over in an early implementation cycle may be selected in a later cycle. The survey gave respondents the opportunity to provide additional information on what challenges or barriers they encounter as they make decisions about TUR project implementation.

In the quantitative portion of the survey, the challenges cited by the largest number of respondents were technical feasibility problems (62 percent); financial costs (55 percent); concerns about product quality (49 percent) and customer requirements (45 percent). The full set of responses to this question is shown in Table 8. The challenges that respondents described can be divided into three broad categories: technical, financial, and institutional challenges. Each of these themes is discussed in more detail below.

<b>Barrier</b>	<b>Responses</b>	<b>Percentage (of 196 Respondents)</b>
Technical feasibility problems	121	62%
Financial costs too high	107	55%
Concerns about product quality	97	49%
Customer requirements	88	45%
Lack of sufficient expected benefits	56	29%
Project considered too time consuming	37	19%
Project considered low priority for management	18	9%
Lack of support from supply chain partners	16	8%
Regulatory environment	14	7%
Other	13	7%
Lack of organizational support for implementation	13	7%

#### 4.3.1 Technical Challenges

The most frequently cited barriers were technical feasibility problems – 62 percent of facility respondents and 77 percent of general practice planners mentioned these as a general category of concern. Comments from respondents provided more detail on the nature of the technical challenges.

*Difficulty identifying or implementing technically feasible alternatives.* Implementing TUR depends on the availability of alternatives that work for both the facility and its clients. In some industries and for some chemicals much research has been done on safer alternatives; in some cases, however, there are knowledge gaps.

For many products and processes there may be technically feasible alternatives available, but they may not be simple “drop-in” substitutes that are well-known and documented. If research and testing are needed before a TUR project can be adopted, the project may be seen as consuming too much time.

Nineteen percent of facility respondents and 23 percent of general practice planners cited the amount of time required for a TUR project as a barrier. One respondent stated,

- “Lead reduction has been time-consuming. It took our facility a few years of R & D to replace lead in its product and also learn how to correctly process the new formulations.”

*Customer requirements/specifications dictate use of a particular chemical.* Forty-five percent of facility respondents and 55 percent of general practice planners cited customer requirements as a barrier to TUR projects. Such requirements may be due to hard-to-change specifications (e.g. military specifications), unique functional requirements, or simply a preference for something that is ‘tried and true.’ Comments included the following:

- “The medical industry has a lot of product requirements and exemptions, and getting changes approved is difficult.”
- “Our facility does custom formulations or required formulations for clients; customer decisions often veto substitution options.”
- “Customer demand has been the biggest barrier to phase out lead. Leaded glazes are superior in quality and performance, and customers still want the leaded glaze, although recent stories about lead in toys and paints has helped dull demand.”

*Product quality concerns.* Concerns about product quality were mentioned by 49 percent of facility respondents and 62 percent of general practice planners. One respondent explained:

- “We tried to use high grade zinc with low lead content instead of prime western zinc with about 1% lead content in our galvanizing process. The zinc coating quality is not as good using the high grade zinc. As a matter of fact, the quality was so poor that management decided to go back to the prime western zinc until we can come up with another solution.”

*Alternatives may have their own safety and operational problems.* In some cases, the available alternatives considered for implementation reduced the use of toxics, but were more difficult to handle or control, or posed physical hazards.

- One respondent discussed the facility's decision to replace the carcinogenic solvent methylene chloride with acetone, a TURA listed substance with lower toxicity. Because acetone is flammable, this change required a significant capital investment to create a separate storage room and air filtering equipment. Now the facility is working to reduce total acetone use by distilling the acetone for reuse blending.

*Difficult to find new TUR options after first few plans.* Many respondents found it difficult to find new opportunities for TUR after the first few planning cycles. While 68 percent of facilities implemented at least one TUR project in the 2000-2006 planning years, approximately one quarter of those (26 percent) completed only one project. As one respondent stated,

- “The more iterations of TUR planning a facility goes through, the harder it becomes to find alternatives.”

#### **4.3.2 Financial Challenges**

The cost of implementing TUR projects was cited as a barrier by 55 percent of facility respondents and 68 percent of general practice planners. Cost-effectiveness was mentioned repeatedly as an issue – the benefits of some projects were seen to be less than the costs incurred.

*Alternatives can be more expensive, and finding inexpensive alternatives can be difficult.* Some chemicals with toxic properties are used, at least in part, because they are relatively inexpensive. Safer alternatives may have higher up-front costs, so in the short-term the implementation of TUR appears to increase expenses. Also, there may be a relatively small number of suppliers carrying a limited selection of substitutes, so negotiating a good price may be difficult.

*TUR projects can increase operating costs.* Thirty-one percent of facility respondents and 39 percent of general practice planners said that implementing TUR projects between 2000 and 2006 had increased their operating expenses.

*TUR projects may require significant capital expenditures.* Thirty-nine percent of facility respondents said that their facility had made a capital investment related to TUR.

- “Switching to ribbon printing reduced MEK by 95%, but involved a big capital investment.”

*Implementing TUR puts the facility at a competitive disadvantage with those in other states or countries.* Some respondents felt that having a requirement in Massachusetts that companies in other countries or states did not have to comply with put the Massachusetts facility at a competitive disadvantage. Consequently, some expressed the belief that going beyond the minimum to comply with TURA was counter-productive for their facility. Others, however, felt that the qualitative or long-term benefits of TUR outweighed the potential short-term costs.

- “The objectives of TUR are worthwhile. Unfortunately, other states around us do not have similar programs. This puts us at a competitive disadvantage.”

#### **4.3.3 Institutional Challenges**

The barriers in this category relate to management issues and corporate philosophy and policies.

Management issues:

- *Management puts greater emphasis on short-term costs of TUR projects as opposed to long-term benefits.* Perceived lack of sufficient benefits (which often are realized in the long-term and are difficult to quantify) was cited as a barrier by 29 percent of facility respondents and 28 percent of general practice planners.
- *TUR is given a low priority by management.* Nine percent of facility respondents and 28 percent of general practice planners felt that TUR projects were given a low priority by management.

Those companies were not necessarily opposed to implementing TUR, but most likely felt that other activities were more important in light of scarce resources.

- *Some facilities have parent companies that dictate plant policies and procedures.* Massachusetts facilities that have a parent company located in another state or country sometimes find implementing TUR is difficult if the parent company is unfamiliar with the program and its principles, or is slow to move to less toxic chemicals in general.

Corporate philosophy:

*The company does not see value of TUR, or considers it antithetical to company mission.* Managers of some companies are unconvinced of the value of TUR, and have no interest in implementing TUR projects. In such cases, it is seen as an empty compliance exercise imposed by the state, and no effort is made to go beyond the minimum required by law. As stated by one respondent,

- “No notable benefits achieved from toxic use reduction programs.”

Some companies go beyond being unconvinced of the value of TUR, and are philosophically opposed to the TURA program. For example chemical sales and distribution businesses may believe that reducing the use of some chemicals (even if other chemicals are used as substitutes) also will reduce their potential sales. One respondent explained:

- “Our company is in the business of selling chemicals. The TURA program essentially reduces our business. A company that survives by selling both toxic and non-toxic chemicals should not have to provide a TURA plan. We can call it a business reduction plan.”

Other factors:

*Other systems are seen as more useful than TUR.* Some respondents mentioned strong corporate support for the goal of TUR, but said that the company reached those goals in other ways, such as implementing Lean Six Sigma or an ISO 14000 environmental management system. Doing TUR planning in some of those cases was seen as redundant (although some respondents felt that TUR planning complemented the other systems.)

- “TURA [filing] is required because of one production process. We will be moving to ISO 14000 as a broader health, environment and safety platform that will have more value as a management tool. TURA has had limited benefit for us.”

#### **4.3.4 Discussion**

The design of the TURA program, with its focus on voluntary implementation of TUR options, makes it possible for facilities to choose the most technically and financially viable options. Those options that are less viable from a technical or financial standpoint are set aside in favor of those that are most advantageous to the facility. Thus, even under ideal circumstances, there will always be some options that facilities reject due to technical or financial barriers. However, the TURA program endeavors to help facilities overcome as many barriers as possible, in order to achieve maximum TUR. Thus, the challenges

that respondents have listed here provide a basis for identifying opportunities going forward. These opportunities are discussed further in Section 5.

#### 4.4 Value of TURA Program Services, Resources, and Plan Elements

TURA program services and resources include trainings, conferences, and workshops; compliance assistance; on-site visits; written and on-line materials; laboratory services; library services; and more. These services are available to all Massachusetts businesses and individuals, regardless of whether they are subject to TURA program requirements. In this section, we summarize survey results on the value of these services and resources to TURA filers and to general practice TURA planners.

##### 4.4.1 Use of TURA program services

As shown in Table 9, below, the services used most frequently by TURA filers and planners are the TURA program trainings, conferences, and workshops; TURA program websites; TURA program written resources; the TUR planner course; and compliance assistance. General practice planners reporting on their own experience used each program service at higher rates than respondents on behalf of individual facilities, consistent with the fact that general practice planners work with multiple facilities and develop expertise in a wide variety of TUR topics.<sup>20</sup>

Note that where a respondent indicated that a facility did not use a given service, the facility may have used the service in earlier years. The survey text for this question did not specify that respondents should consider only the period 2000 to 2006. However, other portions of the survey did ask respondents to limit their answers to this period, and some respondents may have interpreted this question to be similarly limited. Thus, for example, if a facility received a site visit from OTA staff in the 1990s, that may not be reflected in these responses.

	Respondents on behalf of TURA filers (196 respondents)		General practice planners (51 respondents)	
	Used	Have not used	Used	Have not used <sup>21</sup>
TURA program trainings, conferences, and workshops	79%	21%	96%	4%
TURA program websites	76%	24%	96%	4%
TURA program written resources	61%	39%	96%	4%
TUR Planner Course	52%	48%	90%	10%
Compliance assistance	48%	52%	73%	27%
Library and reference services	37%	63%	67%	33%
Site visits to your facility	35%	65%	63%	37%
Cleaner technology demonstration site events	33%	67%	59%	41%
Laboratory services	21%	79%	45%	55%
* General practice planners had the option to provide information both about an individual facility and about their own experience with multiple facilities.				

#### 4.4.2 How useful are TURA program services?

Of the facilities and general practice planners making use of TURA program services, 90 percent or more considered the program websites, trainings, conferences, workshops, and TUR planner course to be very or somewhat useful. More than 80 percent of individual facility respondents considered TURA program written resources, compliance assistance, and library and reference services to be very or somewhat useful; 93, 88, and 91 percent of general practice planners cited these resources as useful, respectively.

Of those who made use of site visits, 74 percent of individual facility respondents and 90 percent of general practice planners found the visits to be “very” or “somewhat” useful. Cleaner technology demonstration sites and laboratory services were considered to be very or somewhat useful by two-thirds of individual facility respondents, and over 70 percent of general practice planners. In general, individual facility respondents and general practice planners provided similar assessments of the relative usefulness of each service, with a slightly higher proportion of general practice planners categorizing each service as useful.

<i>Resource</i>	<i>How useful was [item] in helping your company implement TUR? (% of respondents that used each resource)</i>		
	<i>Very</i>	<i>Somewhat</i>	<i>Not useful</i>
TURA Program trainings, conferences, and workshops (154)	33	56	10
TURA Program websites (148)	26	66	8
TURA Program written resources (120)	15	68	18
TUR Planner Course (101)	33	57	10
Compliance assistance (94)	28	55	17
Library and reference services (72)	18	63	19
Site visits to your facility (69)	16	58	26
Cleaner technology demonstration site events (64)	14	53	33
Laboratory services (42)	14	52	33

(#) = Number of respondents for specific resource

<i>Resource</i>	<i>How useful was [item] in helping your company implement TUR? (% of respondents that used each resource)</i>		
	<i>Very</i>	<i>Somewhat</i>	<i>Not useful</i>
TURA Program trainings, conferences, and workshops (45)	58	38	4
TURA Program websites (45)	36	60	4
TURA Program written resources (45)	27	67	7
TUR Planner Course (42)	29	67	5
Compliance assistance (34)	18	71	12
Library and reference services (32)	28	63	9
Site visits to your facility (30)	20	70	10
Cleaner technology demonstration site events (27)	7	67	26
Laboratory services (21)	5	67	29

(#) = Number of respondents for specific resource

*General Comments.* In their open ended comments, many filers responded by noting the value they have gained from the TURA program overall. Several respondents found that the program increased their knowledge of TUR and helped to raise, maintain, and promote awareness of environmental issues, specifically TUR.

- One company that is no longer a TUR reporting facility still uses TUR principles in implementing its EHS program and ISO14000 system, indicating that TUR principles have lasting value for the facility.
- For another company, “the TURA program has helped us by providing the leverage we need with manufacturing to reduce the hazardous materials we use in our products.” That respondent noted that TUR can facilitate communication among departments within a facility.
- Related more specifically to the TUR planning process, one facility respondent commented that the TURA resources and planning process helped them plan and focus on product related chemical reformulations. That is a practice which may not have occurred, they note, without TURA.

*Trainings, conferences and workshops.* Several respondents made specific suggestions related to the program’s trainings, conferences, and workshops. Some general practice planners commented that they particularly value detailed information on TUR options for individual sectors. Some emphasized their interest in receiving information on proven TUR and resource conservation techniques that can be applied directly to their work with individual clients. Some offered suggestions on ways to ensure planners are well informed about program events and resources; suggestions included providing a schedule of all training events, conferences and workshops six months to a year in advance; providing email updates for all planners on program resources as they are developed; and providing a single web link for any resources related to new planning options under the 2006 amendments.

Some facilities may find resources useful, but disagree with the larger concept of the program. One filer noted that although they found “workshops are generally excellent,” they do not support the TURA program in general and feel that businesses should not have to incur the associated administrative costs and fees.

*Site visits.* Some who have found TURA program services to be useful in the past also hope to make use of additional services in the future. Respondents made reference in particular to the demonstration sites and the site visit service provided by the Office of Technical Assistance. One respondent offered a suggestion on how to improve the services offered by the OTA by continuing to market OTA services to small and medium sized facilities that may not have the resources to do research on TUR alternatives.

*New resources responding to the 2006 amendments.* The survey did not pose questions about facilities’ experiences with the 2006 amendments, since implementation is in its early stages. However, some respondents commented on resources related to these amendments in their open-ended responses.

Several respondents made comments directly related to the recent addition of the option of resource conservation planning under the 2006 TURA Amendments. Several general practice planners praised the existing resource conservation information made available by the TURA program, while others stated they would like more information on energy savings and on-line resource conservation methods and resources. Over all, the open-ended responses indicated that respondents have found new TURA resources related to water and energy conservation have been found to be useful. Comments included the following:

- “The recent [Resource Conservation] technical sessions put on by OTA were outstanding.”
- “The Resource Conservation programs which I have attended in the last year have all been very useful, and they have been useful for a much broader sector of clients.”
- One respondent noted that a recent TURA workshop on "energy improvement plans" was very useful. Based on this workshop, the respondent convinced the owner to approve launching an Energy Improvement Management team to start working on energy conservation.

*Web and print resources.* Each of the TURA agencies maintains a website, or portion of a website related to TUR and the services and resources offered by that agency. Each web site focuses on the particular specialty of that agency and provides links to many other resources. The agencies make every effort to ensure that the resources and links on those sites are kept up to date and relevant to companies, municipalities, small businesses, and communities across Massachusetts. Respondents noted the value of the web sites. Suggestions for improvement included creating a web resource that categorizes TUR projects by chemical name, technology involved, and planning tips; and providing more TUR advice organized by business sector.

Several survey respondents expressed interest in materials that share information about TUR successes. For example, one respondent was interested in receiving information on how others have been successful in increasing awareness of upper management. Another respondent expressed interest in seeing more detailed case studies of successful TUR, including specific production and financial figures. Information of this kind is reflected in many of OTA’s case studies. However, these comments indicate continued interest in documentation and dissemination of case study material.

*Program staff.* Filers and planners have varying degrees of interaction with program staff, depending on their needs and situations. The survey did not include questions about respondents’ interactions with program staff, but several respondents commented on these interactions in their open-ended responses. Comments included the following:

- “[T]he staff [at TURI] was a great resource and very helpful - we are a small company and they provided clarification to our questions.”
- “[A] DEP staffer has been an absolutely outstanding and valuable resource. Extremely knowledgeable, always pleasant, most patient with our questions, and always returns our calls in a timely manner!!”
- “I have found TURA, OTA, and TURI staff to be helpful whenever I have contacted them.”

One respondent who has not had a significant need for TURA program resources after 2000 stated that the facility has continued to find OTA to be an excellent resource. Another respondent noted that the facility had not worked with OTA or TURI since 2004, but would welcome a site visit.

*Laboratory services.* Some survey respondents noted their positive results using the TURI Laboratory. For example, one respondent described the facility's experience working with the laboratory to replace methyl ethyl ketone (MEK) with a greener solvent, and purchasing new process equipment to handle the new solvent.

*Planner services.* A core service of the TURA program is training of TUR Planners. Some facilities hire outside planners, while others use facility staff members who have gone through the TUR Planner certification course. One respondent to the survey noted that using a TURA Planner to assist in their planning process yielded better and more focused direction and results than they would have achieved on their own. This topic was not included in the quantitative portion of the survey, but respondents provided comments on it in their open ended responses.

*Services not used.* Some services were listed by a large percentage of respondents as "not used." In particular, 79 percent of respondents had not used the laboratory services; 67 percent had not participated in cleaner technology demonstration site events; 65 percent had not received site visits at their facility; and 63 percent had not used library and reference services. A larger percentage of general practice TURA planners have made some use of the TURA services and resources, in part reflecting the fact that planners are required to attend a certain number of training events.

As noted above, although the question did not explicitly limit respondents to the period 2000 to 2006, some of the facilities listed as not having used a given service may have made use of it earlier in the program history.

The survey results indicate that there is an opportunity to do more outreach to ensure that facilities make use of program services. Some specialized program services are only relevant to select facilities. For example, laboratory services related to cleaning solutions are relevant only for the subset of TURA filers that use toxic chemicals in cleaning applications. However, the survey results indicate that these program services have been helpful for many facilities, so it is important to ensure that all facilities are aware of the resources that are available to them.

It is also worth noting that the laboratory and library provide substantial resources online. Respondents that did not report having used library or laboratory services directly may nonetheless have benefited from their services through the internet, in print format, or through continuing education conferences.

TURA program services are also used by facilities that do not file under TURA, and by the public. The survey responses do not reflect the value of the program services for these other users.

#### 4.4.3 Value of TUR Plan Elements and TUR Planner Services

The TUR planning process includes a number of steps: identification and screening of TUR options; materials accounting and process characterization; developing a management policy; technical evaluation of potential TUR projects; environmental health and safety evaluation of potential TUR projects; financial evaluation of potential TUR projects; developing chemical use and byproduct reduction goals; and soliciting TUR ideas from employees. In the online survey, respondents had the opportunity to rate the usefulness of each element of the TUR planning process.

Table 12: Opinion of TUR Plan Elements: Respondents on behalf of a facility			
Plan element	How useful was [item] in helping your company's TUR efforts? (% of respondents for each plan element)		
	Very	Somewhat	Not useful
Materials accounting and process characterization (190)	41	43	16
Environmental health and safety (EH&S) evaluation of potential TUR projects (186)	35	49	16
Identification and screening of TUR options (188)	34	52	14
Technical evaluation of potential TUR projects (186)	31	54	16
Financial evaluation of potential TUR projects (187)	27	55	18
Soliciting TUR ideas from employees (190)	26	46	27
Developing a management policy (188)	26	59	16
Developing chemical use and byproduct reduction goals (188)	26	52	22

(#) = Number of respondents for each plan element

All the plan elements were ranked as “very” or “somewhat” useful by the majority of respondents. The plan element that was rated as “very” or “somewhat” useful by the largest number of respondents was “identification and screening of TUR options” (chosen by 86 percent of respondents). Four more plan elements were rated as “very” or “somewhat” useful by 84 percent of respondents. The survey results do not indicate major differences among plan elements in the extent to which respondents find them useful. Over all, the results indicate that TUR plan elements in general are useful.

Statistically, soliciting TUR ideas from employees was designated least frequently as being useful. However, in their open-ended responses some respondents described significant benefits from employee ideas. These results indicate that there may be scope for additional training to ensure that facilities are conducting employee consultations in such a way as to maximize the likelihood of meaningful results.

- A respondent on behalf of a facility in the textiles sector noted that the facility relies heavily on ideas from employees. The facility uses the Kaizen approach to generating and implementing employee ideas through meetings and brainstorming. TUR suggestions come from employees throughout the organization, with shop floor employees contributing the most. For example, shop floor employees identified options to reduce the volume of landfilled waste.
- Another respondent marked all plan elements as “very useful.” In the questions on benefits of TUR project implementation, this respondent noted improved worker health and safety as well as financial savings. At this facility, a special employee feedback form is distributed every three

months to invite TUR suggestions. Winners are declared for the best improvement ideas, and several of their projects have been proposed in this manner.

- This respondent also provided an example of a specific TUR technique that resulted from consultation with employees. In their reclamation process, a series of chemical baths are used to strip different coatings, including copper, from wafers. Some of these baths would “boil over” with the reactions. Employees designed a new bath shape to save money, prevent spills, and reduce exposures to the chemicals.

#### **4.4.4 Suggestions on improving effectiveness of TUR planning**

Some of the general practice planners provided suggestions on ways to increase the effectiveness of the TUR planning process. For example, one general practice planner observed that many facilities commit one month or a month and a half to preparing or updating their plans, but that a process of at least four months is more useful. The planner noted that if facilities conduct initial planning meetings by the beginning of March of each planning year, identify action items, conduct research, and engage vendors, before submitting their plan summary in July, this process allows sufficient time for successful generation of new ideas and background research to learn more about individual options. The planner noted that facilities that spend more time on planning tend to have increased TUR option discovery with each planning cycle, leading to additional option implementation and TUR. These suggestions point to a potential opportunity for the program to encourage and facilitate early engagement with the TUR planning process.

The respondent also suggested that greater sharing of TUR plans among facilities would facilitate generating of more ideas. This respondent also suggested that the program could compile plans and distribute them among facilities, in order for facilities to learn from one another. Again, this suggestion points to a potential opportunity for the TURA program to promote and facilitate sharing of plan information among facilities.

### **4.5 Changes in facilities’ experiences over time**

#### **4.5.1 Overview**

One of the goals of the program assessment was to determine how facilities’ experiences in the program have changed over time. The TURA program is designed in part to ensure that facilities monitor their use of toxic chemicals and are able to take advantage of readily available opportunities to reduce their use of toxics. As a result, the most dramatic reductions in toxics use, byproduct, and emissions are likely to occur in the early years of the program.

Based on the TURA data, we know that the rate of toxics use reduction has decreased over time. It is also reasonable to expect that financial savings would be greatest in the early years of the program. As facilities identify options for toxics use reduction, they are likely to undertake those associated with significant savings first. Over time, low-hanging fruit opportunities may become less frequent.

At the same time, other factors counterbalance this trend toward declining marginal returns. Facilities may gain greater understanding of the TUR process over time, and may be increasingly able to identify

promising opportunities. They may also gain confidence through small TUR projects, building institutional capacity to take on more ambitious projects. Technological change can also play a role. Development of new technologies can make TUR an option where it was previously impossible. This pattern has been seen in the development of new lead-free electronics technologies, as well as the increasing availability of safer alternatives to chlorinated solvents in a range of applications.

#### 4.5.2. Usefulness of first and subsequent plans

One of the questions posed in the survey was whether the TUR planning requirement remains useful over time.

Some respondents indicated that they find that planning is no longer as useful as it was earlier in the program. Comments included the following:

- “I feel that TURA was very useful and successful in the beginning, but at least in our case [it] is just a repetitive action at this point.”
- “The TUR program is very helpful in looking at different options for reducing the use of toxics but after initial options are identified and tested for their feasibility, it is difficult to identify additional new options in the following planning years.”

Others indicated that they do continue to identify new options over time. For example, one commented:

- "Every time we conducted a TUR plan, we saw something that could be improved. This last time we were able to reduce our emissions."

Seventy percent of planners “always” or “usually” found new TUR opportunities or options when doing a client’s plan the first time. Just over a third “always” or “usually” found new opportunities in the second TUR plan, and another third “sometimes” found opportunities in the second plan. Fewer opportunities were found on successive rounds of planning, but just under a quarter of respondents indicated that they “sometimes” found opportunities in subsequent plans.

Plan	Always	Usually	Sometimes	Not Often	Never	Don't Know
First TUR Plan	36%	34%	15%	6%	2%	6%
Second TUR Plan	2%	34%	34%	21%	2%	6%
Subsequent TUR Plans	0%	4%	23%	55%	9%	6%

\*Totals may not add up to 100% due to rounding.

One of the general practice planners commented that the key to finding continued value from TUR planning over time is to shift the perspective of the planning periodically:

- "Usually, if we re-metric (use something else other than BRI [byproduct reduction index]) we can find other options that are not readily apparent. I find that a planning process using the

same metric that exceeds 5-6 years usually lacks value and is unable to find new options. However, when I establish new metrics, then new 'low hanging fruit' is uncovered providing new options."

Another respondent noted that additional regulatory motivators become increasingly important after the first two planning cycles.

- "After the first two plans pick off the low hanging fruit ... either regulatory changes (RoHS, lead) or a major commitment to capital and technology improvements that drive further TUR [are needed]."

Several respondents noted that the attitude of management toward TUR was key in doing effective TUR planning. In some cases, a change in management enabled a facility to identify new areas for progress.

- "Revisiting the planning process in one instance resulted in an option which had been rejected three times previously being implemented the fourth time, when management was more open to it and financial pressures shifted."

Based on comments over the years indicating the diminishing value of planning over time, the TURA program developed the 2006 amendments, which provide additional flexibility for facilities. In future years, it will be important to assess whether facilities are benefiting from these changes.

#### **4.5.3 Comments relevant to the 2006 amendments**

Over the years, the TURA program has heard from facilities that some of them were experiencing declining marginal returns on their investment of time, effort and resources into TUR planning. For this reason, in 2006 amendments to TURA were adopted that were designed to update the program and ensure that it continues to meet the needs of Massachusetts industry and communities. Under these amendments, facilities that have already completed one TUR plan and one update have the option to develop a resource conservation plan, or to implement an Environmental Management System that includes TUR elements.

As noted above, the survey did not pose questions about the 2006 amendments specifically because the goal of the survey was to gather information on facilities' experiences up to the time that implementation of these amendments began. However, some respondents did provide information related to the 2006 amendments in their open-ended responses.

A number of respondents commented on the need for updates to the program of the kind that are provided by the 2006 amendments. Several respondents also commented that they were looking forward to the new flexibility provided by the 2006 amendments. Comments included the following:

- "Intend to implement a TURA EMS now that the regulations have changed."
- "I like the expansion into allowing for alternative planning in energy and water, etc."

- “TURA's new modifications regarding the tie in to the ISO 14001 management system make more sense from a business standpoint to streamline continuous improvement efforts.”
- “Because the facility already has a Continuous Improvement Process, Environmental Management System and Pollution Prevention Program in place most of the aspects of TURA are covered within these existing processes. I believe that the current direction of tying TURA into these existing programs will benefit the reporting facilities and the overall TURA program.”

It is clear from the survey results both that some respondents feel they have exhausted the possibilities offered by traditional TUR planning, and that some respondents are eager to take advantage of the new planning options provided by the 2006 amendments. In future surveys it will be possible to assess facilities' experiences with these new options.

#### **4.6 Community Survey Results**

In addition to its work with industrial facilities, TURI is charged under TURA with providing education, information and resources to communities. The Institute accomplishes these goals through written information, internet resources, presentations, public education events, technical assistance to individual small business sectors, and its community grant program.

To supplement the findings of Abt's survey of TURA filers and planners, in December 2008 and January 2009 TURI conducted an online survey of individuals who had been involved with toxics use reduction projects in their communities, including past recipients of community grants.

The online survey was sent to a total of 350 individuals. Responses were received from 62 individuals, including 18 past grantees, 40 non-grantees, and four respondents who were not sure whether their organizations had received a grant in the past from TURI. Of the 18 past grantees, 14 completed the survey in its entirety.

The survey was not designed to ensure that respondents were representative of the larger population of individuals and organizations associated with TURI's community program. Thus, unlike the responses to Abt's survey of facilities and planners, the responses to this survey cannot necessarily be extrapolated to a larger population.

TURI also hired a consultant to conduct telephone interviews with representatives of the organizations that had received a TURI grant in fiscal year 2006, 2007, or 2008. The interviewer conducted detailed interviews with representatives of fourteen organizations that received a TURI community grant in this time period. The interviews included questions about the organization's experience working with TURI, the role of the TURI grant in the development of the organization's agenda and activities, the organization's ability to raise funds prior to and after receipt of a TURI grant, and media recognition of the organization's work. Table 14, below, shows the organizations that were interviewed.

<b>Table 14: Telephone interviews with community grant recipients</b>
Regional Environmental Council, Worcester
Boston University School of Public Health
Town of Westford Water Department
Town of Watertown Health Department
Boy Scout Troop 5, Milton, Lead Fishing Weight Exchange
Massachusetts Coalition for Occupational Safety and Health (MassCOSH)
Boston Public Health Commission
Worcester Youth Center
Cape Cod Cooperative Extension
Town of Townsend Conservation Commission
Northeast Organic Farmers Association Organic Land Care Program
Vietnamese-American Institute for Development (Viet-AID)
Brazilian Women’s Group
Friends of Tyler Park

The following sections present the findings of both the online survey and the telephone interviews.

#### **4.6.1 Project longevity and leveraging of additional support**

One of the goals of the community grants is to help begin projects that can continue independently after the grant period has ended. In the online survey, of fourteen respondents that had received a TURI grant, only three had received any type of funding prior to the TURI grant. Eleven of the projects, or 79 percent, continued after the grant period ended. Ten of them were still continuing with support from other funding sources at the time of the survey. Three had been continuing for more than five years at the time of the survey.

The telephone interviews gathered additional information on the role of TURI grants in project development and future funding prospects. The fourteen grant recipients participating in the telephone interviews received, collectively, a total of just over \$190,000 in TURI grant funds. In a number of cases, the TURI grant served as seed money, making it possible for the organization to raise significant additional amounts of funding after receipt of the TURI grant. The interviewees reported a total of \$1,458,000 in non-TURI grants received after receipt of the TURI grant (a leverage factor of 7.5).

For example, the respondent on behalf of the Regional Environmental Council (REC), a grassroots organization in Worcester, indicated that prior to applying for and receiving a grant from TURI, the organization focused primarily on more traditional environmental issues, such as recycling. A series of grants from TURI helped the organization to develop expertise in toxics, environmental justice, and health, areas that are now an important focus of the organization. REC later leveraged this expertise to apply successfully for larger grants from Federal, state, and city sources. The respondent indicated that “The TURI grants helped us to break new ground and develop the confidence needed to get additional funding.”

In another example, the Vietnamese-American Institute for Development (Viet-AID), a community development organization, received grants from TURI in fiscal years 2007 and 2008 to educate Vietnamese floor finishers about hazards of, and safer alternatives to, certain floor finishing materials. Earlier outreach efforts had been unsuccessful, but with the additional staff time and resources that were made possible by the TURI grant, Viet-AID was able to educate a large number of floor finishers. Building on the expertise and track record developed under the TURI grant, Viet-AID later applied successfully for EPA support.

#### **4.6.2 Benefits of a Community Grant**

*Economic benefits.* Six of the online respondents that had received a grant indicated that their project had led to economic benefits in addition to reducing toxics. These included benefits for small businesses, such as landscaping companies and janitorial services. Economic benefits for municipalities included the provision of training to municipal employees and boards, and potential long-term savings from reducing hazards to water supplies. Several respondents mentioned savings associated with shifting to safer cleaning products.

*Value added by the grant.* When asked what the grant added to their existing project, respondents indicated that it provided access to scientists and professionals working in the field, access to media, and credibility for applying for additional grants and environmental awards. One respondent noted that the grant had “unified multiple similar projects in neighboring communities.”

For example, a TURI grant supported the Westford Water Department’s Healthy Lawns for Healthy Families project. This project brought together fourteen towns to collaborate in educating residents on the healthy lawn care. As part of the project, the Town of Westford sponsored a workshop for landscapers. Fees paid by the landscapers were used to fund additional workshops beyond those funded by TURI. The Town of Westford adopted a pesticide use policy and continued to provide outreach and education for residents after the grant period had ended.

Respondents drew attention to the assistance the Institute provides for increasing project visibility. Of the 14 online respondents, all but one indicated that the TURI grant raised the visibility of their project in their community. For several others, the grant allowed the organization to focus on toxics use reduction for the first time, or made it possible to create and distribute outreach materials more quickly than the organization had been able to accomplish in the past.

*Project replication.* Projects supported by community grants are intended to serve as models for other organizations, municipalities, and individuals across the state. All materials created under past grants are available online at [www.turi.org](http://www.turi.org). Of the 14 grantees that responded to the online survey, four were certain that their projects had served as a model to other organizations, either inside or outside of Massachusetts; the others were unsure.

One respondent described how TURI funding helped an organization build an environmental justice project that later attracted larger sources of funding: “TURI really did provide the seed money and the vote of confidence for us to start our original Safe Products in Neighborhoods (SPIN) program in the early

2000s. Since then, SPIN has evolved into our current Environmental Justice program [with funding from the National Institute for Environmental Health Sciences and Clark University]. Participating in this type of multi-year, large scale collaborative project would not have been possible without the original support of TURI, which helped us develop our TUR expertise.”

#### **4.6.3 Benefits of the TURA program for communities**

*Reductions in use of toxics and protection of worker health and safety.* Forty-one respondents responded to the questions about whether they had witnessed reductions in the use of toxics in their community or improvements in worker health and safety related to toxics use reduction. Eighteen had witnessed reductions in the use of toxics in their community and five had witnessed improvements in worker health and safety related to TUR. It is worth noting that many of these organizations do not target the worker environment, but rather the health and safety of community members in general.

Several respondents elaborated on improvements they had witnessed:

Reduction in the use of pesticides:

- “Specifically, our community is focusing more and more on safer landscaping and building practices.”
- “No pesticide use for City of Boston parks and open spaces and DCR [Department of Conservation and Recreation] parks in Jamaica Plain.”
- No pesticides on town land; and an obviously knowledgeable citizenry about organic lawn care. Organic landscapers now working in the area.”
- “...the demand is out there for additional workshops on the topic of organic lawn care and landscaping.”
- “Our project would not have existed without [the TURI grant]. The Living Lawn Project gave us the focal point we needed to start our awareness through an educational campaign on the related issues of toxics use reduction/elimination and organic lawn care.”

Reduction of toxic products in homes:

- “The students who participated in the program have all changed the products they use at home.”
- “We have numerous anecdotes about the parents, organizations, and janitors who have gone through training with us telling us stories about how and how much they have reduced the use of toxic products in their homes.”
- “We have witnessed reductions because the women that join [our] cooperative use all natural cleaning products [to clean homes] and use themselves.”

Reduction of toxics in outdoor uses:

- “Our program has raised awareness and decreased lead usage among fishermen.”
- “Town departments have purchased LED flares to replace perchlorate flares in emergency situations.”

In addition to direct health and safety benefits from implementing TUR practices, there are other benefits such as networking and new relationships that result from the implementation of TUR projects. Of 40 respondents to the question “has your involvement with TURI allowed you to build new relationships with industry, business, government, or other organizations?” 19 said yes, 12 said no, and nine were not sure. Respondents indicated that they built relationships with scientists, local emergency responders, small businesses, trade associations, and state organizations in their sector of interest.

#### **4.6.4 Challenges, Recommendations and Opportunities**

*Challenges in project execution.* Most grantee respondents had not faced major challenges in implementing their projects. Some noted that they had difficulty completing their project within a single fiscal year. Others had difficulty coordinating all the partners and activities involved in the project.

*Recommendations.* Respondents offered a variety of recommendations about ways in which the program can continue to serve communities effectively. Some respondents emphasized the need for materials in a variety of languages. Others stressed the need to make the link between environmental exposures and rising rates of certain diseases, such as breast cancer. Respondents suggested a variety of formats that would be useful, including brochures, television and online information, and pre-written articles that individual organizations can distribute and publish. One respondent recommended that the program develop fact sheets targeted specifically for health professionals. Another emphasized the importance of providing project templates for community organizations: “We were fortunate enough to have a project ready to go; If TURI had a set of ready-made projects that groups could tailor to their circumstances that would be great. For example, our project could easily be replicated by other communities/groups, with little alteration. TURI could facilitate that.”

Other suggestions included focusing program resources on environmental justice communities; making contact with each town's Local Emergency Planner; and developing informational materials in the emerging area of nanomaterials.

#### **4.7 Non-Filers Study**

At the conclusion of the Abt survey for TURA filers, a small separate study by Pure Strategies, Inc., investigated the experience of non-TURA filers that had received assistance from OTA.

Pure Strategies interviewed eleven companies. Of these companies, four provided quantitative information about recent cost savings. The net present value of the projects implemented at the four firms was \$870,000. In addition, seven companies provided qualitative information on benefits resulting from the technical assistance they received. Qualitative benefits cited most often were improved worker health and safety and improved environmental compliance.

In addition to these cost savings, worker health, and compliance benefits, Pure Strategies' interviews identified one firm that credited its continued existence to OTA. According to the company owner, OTA's work to reduce the VOC content of the company's coatings kept the business alive. The company was faced with the prospect of shutting down operations because of difficulties meeting federal and state permitting requirements. Because of OTA's assistance, the company was able to continue operating. As a result, it has continued its manufacturing activities in New England and continues to employ more than thirty people at its Massachusetts headquarters.<sup>22</sup>

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## Section 5: Conclusions and Opportunities

### Toxics Use Reduction Act (TURA) Program Assessment

The survey results indicate that the TURA program elements and the TUR planning process continue to be useful for many Massachusetts facilities. Facilities continue to experience a range of benefits from implementation of TUR options, including improved communication about environmental issues within the facility; financial savings; and improvements in efficiency and product quality. Facilities also continue to make use of a variety of program elements, and cite both agency staff and TUR planners as useful resources. The survey results also point toward a number of opportunities, summarized below.

**Identifying TUR opportunities.** In some areas, generating ideas for TUR opportunities is straightforward. In other areas, the solutions are less obvious. In certain aspects of the production process, it is commonly assumed that there is little or no scope for toxics use reduction. However, the survey results indicate that facilities are finding TUR options even in areas in which the options are not obvious. For example, some facilities have found ways to reduce their use of toxic substances in water treatment, an area in which it may be generally assumed that there is little or no possibility for TUR.

**Product quality.** Some facilities see product quality problems as a barrier to TUR. At the same time, others have indicated improvements in product quality as a benefit from TUR. There is an opportunity to extend knowledge about the potential for product quality improvements, or maintenance of product quality, bearing in mind the case specific nature of any given facility's experience. It may be useful for the program to gather information about successful cases of product quality improvement, and to disseminate this information via demonstration sites and case studies. There is also an opportunity to sponsor research in areas where product quality continues to be an issue. In some cases, product quality concerns can be overcome through collaborative efforts involving multiple actors in the supply chain.

Where TUR has been found to have a negative effect on product quality, it is important to ensure that one bad experience does not lead a facility or manager to conclude that TUR is always bad for product quality. It is also important to provide education about the fact that product quality issues that were a problem in the past may no longer be a problem. For example, some of the early work to develop wire and cable coatings that were free of lead and other heavy metals led to decreased product quality in the early iterations, but this is now an established practice with no adverse effect on product quality.

In some cases, TUR leads to improvements in product quality and/or development of new products. Demonstration sites, peer networking opportunities, and similar activities can ensure that facilities learn from one another about opportunities to improve product quality through TUR.

It is clear that in some cases product quality concerns are a barrier, and in some cases product quality improvements are a benefit from TUR. This makes sense since it is bound to be very case specific and product specific. It is also an important issue to consider, especially since OTA's research has indicated that product quality concerns are one of the main barriers to TUR implementation.

**Use of program services.** It is important to ensure that facilities are aware of the services available through the TURA program, and that they are making use of the services that are relevant for them. For example, companies have made significant progress as a result of site visits. However, there are many companies that have not received a site visit in recent years. Thus, there is an opportunity to do additional outreach. One-on-one contact between program staff and facility staff can help to generate additional returns from the planning process. OTA plans to do more outreach to make sure facilities know about the opportunities associated with site visits.

**Organizational opportunities.** As mentioned in the section on benefits, above, the TURA program helps to shape internal dynamics within a facility. This includes affecting the level of management attention to environmental issues, as well as helping to ensure that employee ideas are solicited and valued.

Several respondents noted that the attitude of management toward TUR was key in doing effective planning. In some cases, a change in management enabled a facility to identify new areas for progress. "Revisiting the planning process in one instance resulted in an option which had been rejected three times previously being implemented the fourth time, when management was more open to it and financial pressures shifted."

In the benefits discussion, more than half the respondents indicated that TURA helped to increase management attention to environmental issues within the facility. Responses regarding the value of soliciting employee ideas were mixed; some respondents provided anecdotal information on major improvements that resulted from soliciting employee ideas, but a number of respondents indicated that this plan element was not useful to them.

This finding points to an opportunity to work with facilities to ensure that they make use of this process in a meaningful way. It may be possible for the TURA program to do additional training and outreach to encourage facilities to make meaningful use of the employee consultation element of the TUR planning process. For example, documenting and publicizing the results from employee consultations may be useful in showing facilities and planners the value of this plan element. Additionally, it might be useful to teach planners new techniques for eliciting useful ideas from employees, going beyond a simple posting/notification process. It could also be useful to develop a training curriculum specifically targeted to shop floor employees.

In summary, TURA provides a valuable opportunity to empower shop floor employees, ensuring that their concerns and ideas are heard. There is no overlapping state program that provides the same guarantee. There may be an opportunity to encourage better use of this plan element by facilities.

**Targeting resources and training.** Respondents provided comments on the types of informational materials and training that they find most useful. Many of these comments refer to areas that are already a focus of program materials, but they indicate a need for continued focus in these areas. Some of the suggestions indicate potential areas for improvement. For example, respondents indicated that they find TURA program resources on the internet to be useful. They also made some suggestions about additional internet resources. For example, one respondent suggested creating a web page that

categorizes TUR projects by chemical name, technology involved, planning tips, and other categories that may be useful for planners.

Some respondents expressed interest in specific categories of information that can be provided through case studies, such as information on how others have been successful in increasing upper management awareness of TUR opportunities, and more generally, case studies of successful TUR, including specific production and financial figures. Though many case studies have been documented, these comments may indicate an opportunity both to document successes and share that information with facilities. Some respondents emphasized the need, both in informational materials and in training events, to provide sector-specific information on TUR opportunities for individual business sectors. One respondent suggested providing materials with a focus on identifying TUR options for facilities that have already completed several years of planning and need new ideas.

**Opportunities to maximize quality of planning.** Some of the general practice planners offered suggestions about ways to maximize the benefits from the TUR planning process. For example, one commented that changing metrics periodically can reveal options that were not previously apparent. Another mentioned that extending the planning process over four or more months significantly increases a facility's likelihood of identifying useful TUR options. There may be opportunities for the TURA program to encourage facilities and planners to maximize the value of the planning process. For example, the TURA program could send reminders to facilities encouraging them to start the planning process early; and schedule training events in such a way as to encourage facilities to start their planning early. The program could also offer training for planners on ways to re-metric the planning process, and on other ways to ensure useful planning results after the first and second planning cycles.

These opportunities are in addition to the changes that will result from the new planning options allowed under the 2006 amendments. Based on comments over the years indicating the diminishing value of planning over time, the TURA program developed the 2006 amendments, which provide additional flexibility for facilities.

**Increasing implementation rates.** Sixty-eight percent of survey respondents representing facilities that reported under TURA in 2006 implemented a TUR project in at least one plan year between 2000 and 2006. Nearly half (48 percent) implemented such projects in more than one year. However, although many facilities were able to identify and implement TUR options, nearly a quarter (22 percent) of respondents stated that their facility did not do so in any of the 2000-2006 plan years. This finding indicates that there are opportunities to work further with these facilities. The alternative planning options created by the 2006 amendments to TURA can be expected to help improve the numbers of facilities that implement TUR options in future years.

**Understanding why certain projects not implemented.** Implementation of toxics use reduction projects is voluntary. Thus, projects that are time consuming, technically challenging, or expensive to implement are likely to be given low priority by facility decision-makers unless there is a compelling reason to carry them out. The barriers that were identified can thus be understood, at least in part, as answering the question: Why were some projects prioritized over others?

**Previous findings regarding barriers to implementation.** In a July 2008 report by OTA<sup>23</sup>, costs, potential impacts on quality, and negative perception of environmentally preferable alternatives were identified as the primary barriers to implementing toxics use reduction projects. Those results are consistent with those of the current survey.

**Opportunities identified by community program survey.** The survey of individuals and organizations associated with TURI's community program also produced insight into a variety of potential opportunities. For example, it made it clear that the TURI grants frequently function as seed grants, enabling organizations to pursue further funding opportunities later. Other themes examined in the community survey included benefits stemming from the project and results in the community; improvements to worker health and safety; and ways in which TURI can help the organizations to reduce toxics.

**Opportunities to link TUR with other management systems.** The TURA program has undertaken a variety of activities designed to integrate the TUR approach with other environmental quality management systems, such as Lean Six Sigma and ISO. The 2006 amendments took this effort a step further by making it possible for facilities to develop an Environmental Management System (EMS) in place of a standard TUR plan under some circumstances. Comments from a number of respondents indicate that this type of integration of management systems is useful to facilities.

**Benchmarking progress.** As noted in the "responses to recommendations" section in the literature review, there is an opportunity to "benchmark" firms in similar industries, identifying leaders and laggards. This could be combined with one-on-one work to ensure that facilities are able to identify and implement case-specific solutions.

**Helping facilities learn from one another.** The survey results support the idea that there continue to be many opportunities to help facilities learn from one another. For example, there are opportunities for multiple facilities to learn from an innovation initially pioneered at a single facility. There are opportunities to analyze the TUR data to determine sectors and facilities where there may be useful 'lessons learned.'

**Energy and water saving techniques.** With the implementation of the 2006 amendments, the TURA program has the opportunity to encourage and facilitate adoption of new energy- and water-saving techniques. The experiences of facilities that have already undertaken some activities of this kind may indicate opportunities for progress by other facilities.

**Reducing use of toxic solvents.** A number of TURA program activities have focused on helping facilities to reduce their use of toxic solvents. These include the TURI Laboratory's work to identify safer cleaning solutions for individual applications, site visits by OTA, and demonstration sites sponsored by both TURI and OTA. The TURA data show that facilities have made steady progress over time in reducing their use of toxic solvents. The survey responses provide additional detail showing that facilities continue to make progress in this area, and that technological developments over time have facilitated continuing progress.

Going forward, the TURA program can potentially assist facilities in replacing toxic solvents in a variety of ways. The TURI Laboratory can continue to provide assistance in identifying practical solutions for cleaning applications. In addition, the program can assist facilities in identifying appropriate alternatives for solvents in formulations, including coatings and other products. The program can also sponsor research and development activities within universities to help develop or identify appropriate alternatives.

The program can also help facilities to address the challenge of communicating up and down the supply chain about alternatives to toxic solvents. The program already has supply chain projects in several sectors, but there may be reason to expand to other sectors to address additional needs within the community of TURA filers. OTA has expanded this model in its work with individual facilities; for example, OTA facilitated communication up and down the supply chain in a project to develop safer wood coatings. The program can build on the experience of projects of this kind as well. Good communication up and down the supply chain is useful not only in helping facilities to manage immediate substitution needs, but also in helping them to anticipate new reformulation needs that may arise in the future.

The designation of higher hazard substances under TURA can also be an important vehicle for continued progress on reduction or elimination of toxic solvents. For example, trichloroethylene (TCE) has been a focus of efforts by the TURI Laboratory and OTA over a number of years, and its use has decreased dramatically over time. Remaining, lower-volume uses of TCE are a focus of current program activities. As of 2007, TCE is designated as a higher hazard substance under TURA, meaning that facilities in TURA covered sectors that use more than 1,000 pounds per year are now subject to reporting and planning requirements.

Some of toxics use reduction techniques described by individual respondents may be of interest to a broader range of filers. For example, as noted above, one facility dramatically reduced its use of TCE by purchasing new vapor degreasers. There may be other, similar facilities that could achieve equally important reductions by purchasing new vapor degreasers, or by replacing vapor degreasing with an alternative process.

### **Directions for future analysis**

**Future surveys.** The survey upon which this report is based considered the time period from 2000 to 2006. It became clear in the process of designing and conducting the survey that the program would also benefit from conducting brief, more frequent surveys. Thus, a recommendation coming out of this project is that the program should conduct a brief annual survey to collect information on facilities' experiences in the program.

This annual survey can collect information on a number of themes. It can collect annual information on the financial consequences of facilities' efforts to implement TUR options. It can also be used to determine whether facilities are making good use of specific program services. For example, it may be useful to ask respondents whether they have attended a demonstration site, and whether they have made any changes at their facility based on information they gained through the demonstration event.

Another important goal of future survey work will be to assess facilities' and planners' experiences with the 2006 amendments. The present survey established a baseline, inquiring into facilities' and planners' experiences up to 2006. In future years, the program should make an effort to determine the extent to which facilities are benefiting from the 2006 amendments. For example, although some respondents indicated that the TUR planning process continues to provide value in every two-year cycle, many indicated that the value of planning declines significantly after the second cycle. It is reasonable to expect that the number of facilities that find later planning cycles to be useful will increase under the 2006 amendments, since the amendments provide significant flexibility to vary this process.

*Economic impacts of the TURA program.* The TURA program is currently working on a follow-up study that will consider the effects of the TURA program on the Massachusetts economy. This economic analysis will draw in part on information gathered through the online survey and telephone interviews with TURA filers, and with individuals and organizations associated with TURI's community program. In addition, the analysis will include information on the experience of non-filing facilities that receive services from the TURA program.

## Endnotes

<sup>1</sup> Until 2005, the TURA program analyzed changes in use of toxics by a core group of facilities that were in the program from 1990. Since 2006, the program has analyzed changes for an updated core group of facilities that have been in the program from 2000 to the present. Figures for the period 1990 to 2005 are drawn from Massachusetts Department of Environmental Protection, *2005 Toxics Use Reduction Information Release* (April 2008), available at <http://www.mass.gov/dep/toxics/priorities/05relin.doc>. Over the period 2000 to 2006, the Program helped facilities to reduce use of toxic chemicals by 14 percent, toxic byproducts by 31 percent, and on-site toxic releases by 39 percent. Figures for the period 2000 to 2006 are drawn from Massachusetts Department of Environmental Protection, *2006 Toxics Use Reduction Information Release* (February 2009), available at <http://www.mass.gov/dep/toxics/priorities/06relin.doc>. All figures cited here are adjusted for production. The original sources also provide figures not adjusted for production.

<sup>2</sup> Recent MassDEP publications include the TURA Reporting Regulation Amendments (June 2007) and the TURA Planning Regulation Amendments (December 2007). Guidance documents from the MassDEP include TUR Planning, Resource Conservation Planning Guidance, Environmental Management Systems (EMS) Planning Guidance, Environmental Management Systems Frequently Asked Questions and Reporting Instructions and Appendices. MassDEP also created fact sheets on the 2006 Revisions of TURA, and TURA Resource Conservation Plans and Environmental Management Systems.

<sup>3</sup> Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (EU Directive 2002/95)

<sup>4</sup> Massachusetts Toxics Use Reduction Institute, *Five Chemicals Alternatives Assessment Study* (Lowell, MA: Toxics Use Reduction Institute, University of Massachusetts Lowell, 2006). Available at [http://www.turi.org/library/turi\\_publications/five\\_chemicals\\_study](http://www.turi.org/library/turi_publications/five_chemicals_study).

<sup>5</sup> Mark Rossi and Ken Geiser, *Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies* (Lowell, MA: Toxics Use Reduction Institute, University of Massachusetts Lowell, January 1993). Executive summary available at <http://www.p2pays.org/ref/32/31555.pdf>. Full text available at <http://www.turi.org/content/view/full/998/offset/12/year/month/day/>.

<sup>6</sup> <http://www.innovations.harvard.edu/awards.html?id=3833>

<sup>7</sup> Jessica Champness, *Carcinogen Use and Release to the Environment in Massachusetts, 1994-1998*, (Environmental League of Massachusetts, July 2001). Available at <http://www.environmentalleague.org/images/CarcinogenReport.pdf>.

<sup>8</sup> Cora R. Roelofs, Rafael Moure-Eraso, and Michael Ellenbecker, "Pollution Prevention and the Work Environment: The Massachusetts Experience," *Applied Occupational and Environmental Hygiene* 15:11 (2000), 843-850.

<sup>9</sup> These principles have been developed in: M. Porte and C. van der Linde, "Green and competitive: ending the stalemate," *Harvard Business Review*, September-October, 73:5 (1995), 120-134.; Nicholas Ashford, "Government and Environmental innovation in Europe and North America," *American Behavioral Scientist*, 45:9 (May 2002), 1417-1434.; D. Fiorino, "Environmental Policy as Learning: a New View of an Old Landscape," *Public Administration Review* 61:3 (May-June 2001), 322-334. All sources noted here are cited in O'Rourke and Lee 2004.

<sup>10</sup> Dara O'Rourke and Eungkyoon Lee, "Mandatory Planning for Environmental Innovation: Evaluating Regulatory Mechanisms for Toxics Use Reduction," *Journal of Environmental Planning and Management* 47:2 (March 2004), 181-200.

<sup>11</sup> Michael Wilson, *Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation* (University of California Berkeley: California Policy Research Center, 2006).

<sup>12</sup> Three of the policies were in California (Safe Water Drinking Act, Pollution Prevention Act, Birth Defect Prevention Act); two in New Jersey (Worker and Community Right-to-Know Act, Pollution Prevention Act); and one, TURA, was in Massachusetts.

<sup>13</sup> Wilson 2006, p. 67.

<sup>14</sup> Arnold Schwarzenegger, Governor, State of California; Linda Adams, Secretary, California Environmental Protection Agency; Maureen Gorsen, Director, Department of Toxic Substances Control, *California Green Chemistry Initiative: Final Report* (December 2008). Also see California Environmental Protection Agency, *California Green Chemistry Initiative, Phase I: Compilation of Options* (January 2008); and Michael Wilson et al., Centers for Occupational and Environmental Health, University of California, *Green Chemistry: Cornerstone to a Sustainable California* (2008).

<sup>15</sup> Findings of the Ontario government's Toxics Reduction Scientific Expert Panel are summarized in a July 23, 2008 memorandum, available at <http://www.ene.gov.on.ca/en/toxics/memorandum072308.php>. The full study is not publicly available.

<sup>16</sup> See, for example, <sup>16</sup> Samuel S. Epstein, "Legislative Proposals for Reversing the Cancer Epidemic and Controlling Run-away Industrial Technologies," *International Journal of Health Services* 30: 20 (2000), pp. 353-371. Available at [http://www.preventcancer.com/press/pdfs/legislative\\_proposals.pdf](http://www.preventcancer.com/press/pdfs/legislative_proposals.pdf);

<sup>17</sup> Samuel S. Epstein, "Legislative Proposals for Reversing the Cancer Epidemic and Controlling Run-away Industrial Technologies," *International Journal of Health Services* 30: 20 (2000), pp. 353-371. Available at [http://www.preventcancer.com/press/pdfs/legislative\\_proposals.pdf](http://www.preventcancer.com/press/pdfs/legislative_proposals.pdf)

<sup>18</sup> Liz Armstrong, Guy Dauncey and Anne Wordsworth, *Cancer: 101 solutions to a preventable epidemic* (New Society Publishing, 2007).

<sup>19</sup> The sector shown here refers to the facility as a whole, not the specific production unit discussed in the example.

<sup>20</sup> General practice planners had the option to provide information both about an individual facility and about their own experience with multiple facilities. Of the 86 general practice planners that responded to the survey, 50 provided some information on behalf of an individual facility, while 36 only provided information about their experiences with multiple facilities. For the material presented in this section, there is some overlap: some general practice planners responded on behalf of an individual facility and also provided information on their own experiences working with multiple facilities.

<sup>21</sup> Note: Two general practice planners indicated that they have not used the TUR planner course. Since planners must complete the course in order to be certified, this response may be an error; alternatively, the respondents may have interpreted the question to refer only to the period 2000 to 2006, and may have taken the course in an earlier year. Also note that two general practice planners said they had not used TURA program trainings, conferences, and workshops. Similarly, planners are required to attend some of these events in order to maintain their certification. Planners who indicated they had not used TURA program trainings, conferences, and workshops may be new planners who have not yet had the opportunity to attend these events, or may have provided this response in error.

<sup>22</sup> Personal communication, Pure Strategies interview with Fred Churchill, owner, Churchill Coatings.

<sup>23</sup> Massachusetts Office of Technical Assistance and Technology. "The Assessment of Barriers to Toxics Use Reduction, Pollution Prevention, and Resource Conservation," July 2008. Available at [http://www.mass.gov/Eoeea/docs/eea/ota/programs/barriers\\_to\\_tur.pdf](http://www.mass.gov/Eoeea/docs/eea/ota/programs/barriers_to_tur.pdf).