Environmental Management Systems:

Do They Improve Performance?

NATIONAL DATABASE ON ENVIRONMENTAL MANAGEMENT SYSTEMS

Project Final Report: Executive Summary

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

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Do Environmental Management Systems Improve Performance?

INTRODUCTION: EMSS AND PUBLIC POLICY

Over the past decade, increasing numbers of businesses and government facilities have implemented formalized environmental management systems (EMSs) to manage the environmental aspects and impacts of their activities. From the introduction of the ISO 14001 international voluntary standard for EMSs in 1996 to the end of 2001, at least 1,645 U.S. businesses and other facilities were registered as conforming to this standard, and registrations were increasing at well over 50% per year. Worldwide, an estimated 36,765 organizations were registered.

Many more organizations have implemented EMSs similar to the ISO 14001 model without seeking certification, and still others have developed EMSs of their own design – in some cases more limited than the ISO model, but in others, systems which they considered more sophisticated and effective. Several major motor vehicle manufacturers have mandated that all of their first-tier suppliers implement certified EMSs, and all U.S. federal agencies have been directed by a presidential executive order. The chairman of the Bush Administration's Council on Environmental Quality has reaffirmed this policy and endorsed the introduction of EMSs at federal facilities for which EMSs would be appropriate.

Does the existence of an EMS, or of third-party auditing or ISO certification, represent evidence of superior environmental performance? Or, does it represent evidence of at least of more effective management of its environmental responsibilities, such as monitoring and reporting requirements, than at facilities that have not introduced these procedures?

Advocates argue that an EMS provides both environmental and economic benefits, to the public as well as to the user organization. A facility with an EMS, they argue, can demonstrate more reliable performance and compliance, can document its reporting requirements more efficiently and thus be inspected more quickly, and will have procedures for more consistently reducing the frequency of accidents, spills, and other environmentally damaging events. It may also identify more opportunities to improve its environmental performance beyond compliance, and to reduce unregulated environmental impacts such as energy and water use. It thus reduces its own cost and liability as well as environmental impacts and risks to its surrounding community. At the same time, it reduces government's inspection and enforcement costs, allowing government to redirect scarce regulatory resources toward higher-risk facilities.

EMSs represent an important innovation for achieving public policy goals as well as for the organizations that choose to introduce them. For example:

- The U.S. EPA and many state environmental agencies now confer positive public recognition on organizations that have implemented EMSs. Is such recognition warranted?
- Some environmental agencies also have granted increased regulatory flexibility – decreased frequency of inspection, reduced vulnerability to some types of penalties, more generic "bubble"-type permits, and negotiated terms of enforcement settlements – based in part on EMS implementation. Do the effects of an EMS justify such concessions?
- And finally, many federal and state agencies are now investing staff resources in promoting EMSs, and in providing technical assistance to organizations to implement them; and many government agencies are themselves now spending significant costs and staff effort developing EMSs themselves. Is this an effective use of limited personnel and other agency resources, and should more or less resources be committed to it?

THE NATIONAL DATABASE ON ENVIRONMENTAL MANAGEMENT SYSTEMS

The National Database on Environmental Management was designed to provide preliminary answers to these questions. Conceived as a pilot study, it was designed to examine the performance of a wide range of examples of both business and government facilities before, during, and after introduction of an EMS. It was the first – and so far, the only – study to collect longitudinal, real-time, facility-level comparative data on performance changes associated with EMS introduction. The study was sponsored by the U.S. Environmental Protection Agency's Office of Wastewater Management, with additional funding provided by EPA's Office of Policy, Economics and Innovation. It was conducted by the University of North Carolina at Chapel Hill in cooperation with ten state environmental agencies and the participating facilities, and with the Environmental Law Institute, the Multi-State Working Group on Environmental Management Systems, the Star Track Program of EPA's Region I, and the Global Environmental Technology Foundation.

RESEARCH QUESTIONS

The primary purpose of this study was to answer the question,

- What effects does the implementation of an EMS have on a facility's environmental performance, regulatory compliance, and economic performance?

The study also shed light on important related questions, including:

- What costs and benefits do facilities experience as a result of introducing (and where applicable, certifying) an EMS, and how do these vary with their characteristics and motivations?
- Do technical assistance and other incentives from governments make a difference? If so, to what kinds of organizations?

- What factors motivate organizations to introduce and certify EMSs, and what differences in facility characteristics and motivation are associated with these decisions?
- To what extent are EMSs themselves similar or different – in their content, their priorities, and their development processes – and is variability itself an important finding?
- Who is involved in developing and implementing an EMS, and what difference does such participation make to EMS outcomes?
- What difference, if any, does third-party auditing and registration make?
- Why have even some non-market organizations, such as municipalities, state agencies, and federal facilities, decided to adopt such systems, and what have they gained from it?
- And finally, how do organizations' commitments to their EMSs evolve over time?

STUDY DESIGN

The NDEMS database was designed as a longitudinal study of EMS implementation in real time, using site-specific facilities as the principal unit of analysis. For each facility, the research team administered a baseline protocol capturing three years' retrospective data, in order to establish the environmental performance levels prior to EMS implementation. They then administered an EMS design protocol, which collected data on the EMS design process as well as its substantive content (for instance, each facility's specific environmental aspects, impacts, determinations of significance, objectives and targets). Finally, they administered two update protocols at approximately one-year intervals, to identify changes in environmental, economic and other outcomes after introduction of the EMS as well as refinements to the EMS itself. All data were subject to detailed quality-control procedures to ensure data quality and completeness, including reconfirmation of all data with the facilities themselves before final inclusion in the database. Figure 1 illustrates the timeline for data collection from each facility.

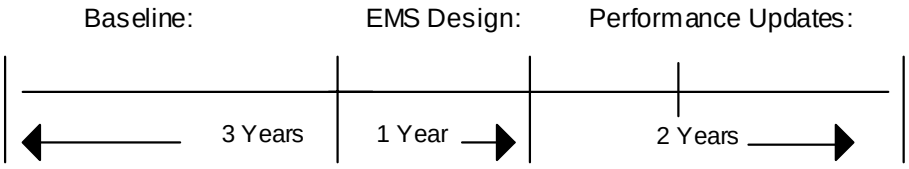


Figure ES-1. Timeline for NDEMS Data Collection

This study reports the consequences of EMS implementation by a sample of 83 facilities in 17 U.S. states. All 83 of these facilities provided baseline data, and 58 of them also provided

detailed data on their EMS design processes and content. Thirty-seven also provided detailed initial update data on environmental, compliance, and economic performance during the year after introduction of their EMS – about 2½ years after the end of the baseline period, on average – and 22 provided second-update data approximately one year later. These facilities were drawn from 20 business sectors, and included both publicly traded, privately held, and government facilities such as military bases and wastewater treatment plants. They ranged from major manufacturers, electric utilities, and branch plants of large multinational corporations to small independent businesses such as electroplaters and auto parts suppliers. About two-thirds of them were registered or intended to seek registration to the ISO 14001 international voluntary standard for EMSs; the remainder were using the ISO 14001 framework as a guide to their own efforts but did not intend to seek ISO 14001 conformity registration.

The NDEMS data and all related outputs of this research program are available on a public web site, http://ndems.cas.unc.edu/. As of September 2002 over 400 users had downloaded NDEMS data: most frequently interested businesses, but also government agencies and researchers both in the United States and around the world.

Highlights of key findings include the following:

ENVIRONMENTAL PERFORMANCE CHANGES

The core objective of this study was to provide answers to the question, what effects does the implementation of an EMS have on a facility's environmental performance, regulatory compliance, and economic performance? Twenty-seven facilities provided update data for baseline environmental performance indicators (EPIs) that the facility had reported during their baseline period and which the facilities continued to monitor, as well as data for new EPIs that were developed after the baseline period. The data covered a period of approximately 2.5 years, on average, after reporting their baseline data; this period included the period during which the EMS was being developed and introduced.

EMSs and Environmental Performance Change

More than 80 percent of the facilities that reported both baseline and update data tracked at least one environmental performance indicator (EPI); most tracked between one and ten such indicators. Nearly half of the facilities reported performance outcomes that included both improvement and deterioration, as well as many that were essentially unchanged (figure ES-2).

More than two-thirds of the total environmental performance indicators (EPIs) for which a change in performance was observed showed improvement, and improved indicator performance was observed in at least half of the performance indicators for more than half (56 percent) of the reporting facilities. These results offer support for the proposition that the introduction of an EMS is associated with improvements in environmental performance.

Conversely, while a similar percentage of the facilities reported that at least one performance outcome was worse than expected, overall, only 18 percent of the EPIs examined exhibited worse performance outcomes, and only one facility reported worse performance outcomes for half or more of the indicators monitored. On balance,

accordingly, the introduction of an EMS was associated with overall improvements in reported environmental performance.

ID	Score	n
17	1.00	6
14	1.00	3
1	1.00	2
3	1.00	2
11	0.75	8
6	0.75	4
19	0.67	3
20	0.64	11
23	0.60	5
16	0.60	5
26	0.56	9
4	0.53	17
18	0.50	4
24	0.50	4
12	0.50	2
7	0.46	11
21	0.45	9
27	0.42	17
5	0.38	24
8	0.34	65
10	0.31	29
9	0.26	47
13	0.23	13
25	0.20	15
22	0.15	13
2	0.00	4
15	0.00	17

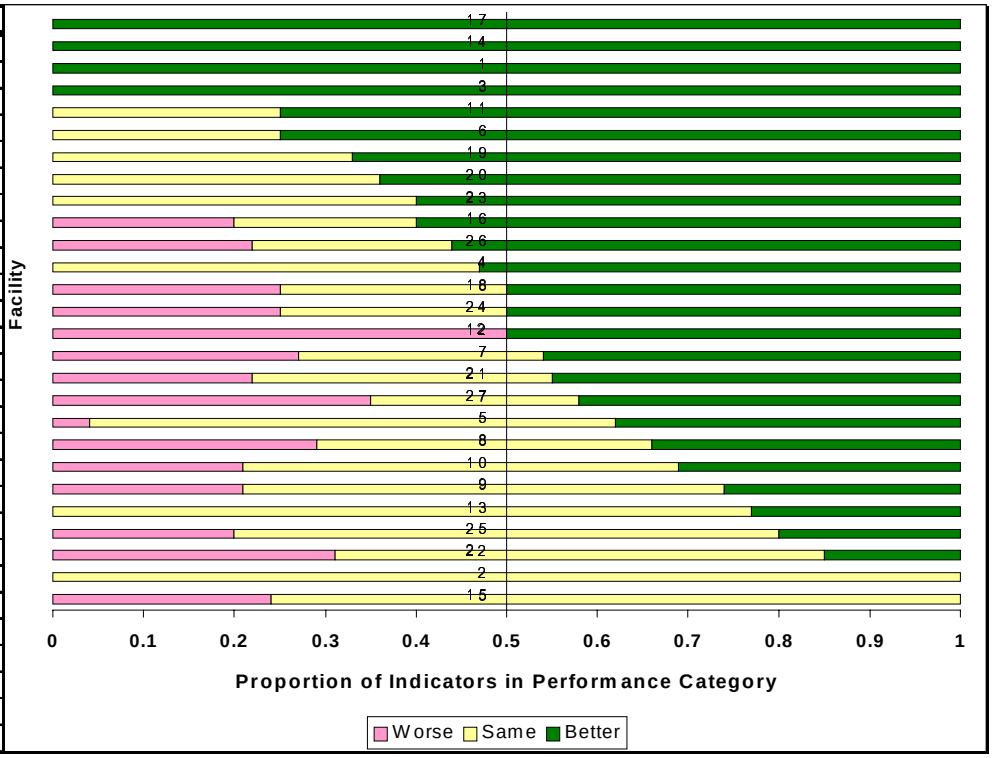


Figure ES-2. Environmental Performance Indicator Results, by Facility, for All Indicators.

EMSs designed using the ISO 14001 voluntary standard as a model must include specific objectives and targets for EMS improvement (figure ES-3). ***Over 60 percent of the reporting facilities reported improvements in at least half the indicators associated with their EMS objectives and targets. Less than one-third reported any worsening of these performance indicators.*** These observations suggest that environmental performance improvements may be somewhat greater for indicators that have been singled out for priority through the EMS process. Statistically, however, this difference was not significant.

The fact that environmental performance indicators overall showed a clear pattern of improvement (and not just those associated with EMS objectives and targets) suggests that environmental performance improvements associated with EMS introduction may be broadly based. That is, the effect of the EMS may be to raise the attention of all employees toward opportunities for environmental performance improvement, and not merely to improve those indicators singled out for emphasis in the EMS objectives and targets.

ISO Registration and Environmental Performance Change

The majority of reporting facilities (59 percent) intended both to certify their facility EMS to ISO 14001 and to use a third party to audit their system. ***The environmental performance***

changes of the facilities that were certifying their EMS to ISO 14001 and utilizing third-party auditors were not statistically different from the others. These results do not provide support for the proposition that an externally audited, ISO-certified EMS is associated with greater improvements in environmental performance than uncertified facilities.

ID	Score	n
17	1	4
11	1	4
23	1	2
1	1	2
19	1	1
18	1	1
14	1	1
3	1	1
20	0.8	5
6	0.75	4
26	0.56	9
4	0.57	14
24	0.5	4
21	0.5	2
16	0.5	2
10	0.5	2
12	0.5	2
27	0.39	13
5	0.33	3
22	0.25	4
25	0.17	6
2	0	3
7	0	1
13	0	8
8	0	10
15	0	10
9	0	2

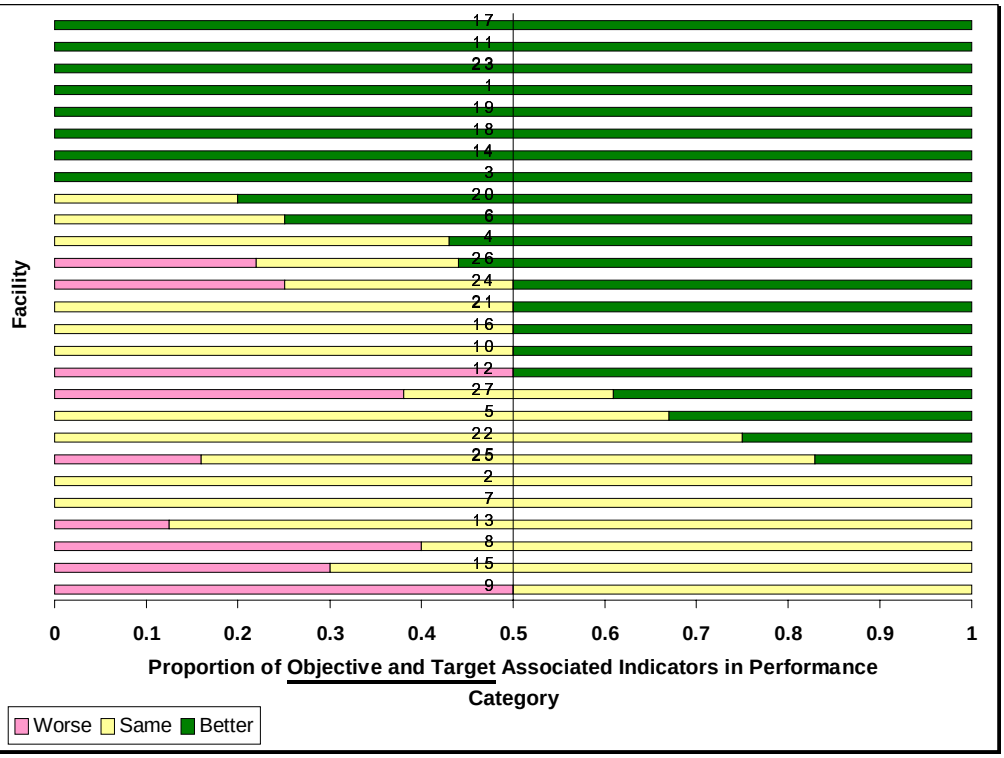


Figure ES-3. Environmental Performance Indicators for All Facilities, for Indicators Associated with Objectives and Targets.

Motivations and Environmental Performance Change

Do facilities' motivations for adopting an EMS make a difference to how much it improves their environmental performance? We speculated that the relationship between EMS and environmental performance would differ depending on the facility's motivations for adopting the EMS, such as the influences of external drivers (regulatory and social pressures and market forces) and internal drivers (management capabilities, resources).

The results show that motivations matter. ***Facilities that reported that the prospects for marketing potential, competitive advantage, increased revenues, or support of other professionals were important influences on their EMS adoption decisions showed significantly higher aggregate scores for improvement in their environmental performance indicators.***

Compliance History and Environmental Performance Change

Regulatory compliance history also was strongly associated with environmental performance outcomes, whether or not the facility reported that regulatory considerations were important to EMS adoption decisions. ***Facilities that reported at least one instance of a violation or non-***

compliance during their baseline period scored lower on post-EMS environmental performance when compared to facilities without regulatory infractions.

Pre-Existing Capabilities and Environmental Performance Change

Some facilities had already developed far more of the underlying capabilities for EMS introduction than others. Some, for instance, had already introduced formal quality management systems, such as ISO 9000; some had already introduced formal waste-minimization or pollution-prevention plans; some had already introduced a number of the formal elements of an EMS. These differences mattered to the environmental performance outcomes. ***Facilities that had already developed internal capabilities for EMS adoption (such as prior implementation of continual improvement and environmental management programs) improved more than those that had more limited internal capabilities.***

Many of these differences in pre-existing capabilities were also associated specifically with the facility's ownership status (publicly traded, privately held, government). ***Publicly traded firms scored higher on environmental performance improvement than did privately held and government facilities.*** We attribute this particularly to the stronger pre-existing internal capabilities and greater access to organizational resources that publicly-traded firms had relative to privately held and government facilities.

COMPLIANCE CHANGES

The effects of EMS introduction on regulatory compliance rates is one of the outcomes that holds greatest interest to federal and state policymakers, but also one about which it is most difficult to reach definitive conclusions from the NDEMS data. The sample is small (35 facilities), and many of the participating state agencies deliberately screened out facilities that had had histories of violations. Given this sample, a finding of significant further improvements in compliance would be a dramatic outcome indeed, while a finding of no evidence of significant improvement by these facilities would not necessarily mean that an EMS would have no impact on compliance at facilities that had more problematic compliance records to begin with.

Compliance Improvement Opportunities

Even given this screening process, ***nearly half (fifteen) of the reporting facilities had experienced violations during the baseline period – mostly minor rather than major violations – comprising a total of 86 official notices of violations (NOVs). Five had been fined. Fourteen facilities also reported a total of 127 non-compliances*** during the baseline period (three facilities accounted for nearly 80 percent of these observations; most facilities had fewer than nine non-compliances apiece). Even among these facilities, therefore, there was evidence of opportunities to improve compliance outcomes.

Evidence on the ways in which compliance problems were discovered, and the length of time necessary to remedy them, corroborated these opportunities. ***At 90 percent of the facilities reporting violations or non-compliance situations during the baseline period, at least one violation was discovered by regulatory inspections or operating procedures.*** The formalized procedures associated with an EMS might be expected to reduce such incidents. Moreover, ***15 to 20 percent of the non-compliances and violations, respectively, went undiscovered for***

more than two months, a gap that also could conceivably be reduced by an effective EMS. Finally, ***while the causes of violations and non-compliances fell into no single dominant category, the most frequently cited included "unknown" (30 percent), deficiencies in operational procedures (23 percent), and lack of proper monitoring (16 percent).***

An important consideration in these types of compliance problems is that ***all these problems could potentially be improved by introduction of an EMS.*** Whether or not an EMS improves actual environmental performance outcomes, it clearly should produce improvements in standard operating procedures, in record-keeping, in monitoring and prompt identification and correction of non-compliance situations, and in other compliance-related management practices.

Changes in Compliance

On the whole, however, ***there was no statistical difference between the total numbers of violations, non-compliances or fines at these facilities during these two reporting periods.*** Eighty-six total violations were reported during the baseline period, and a slightly higher number (88) during the first update period. Non-compliance observations also were statistically similar (127 baseline, 116 update), as were the average fines levied by regulators on these facilities during the baseline and update periods (mean difference = $587, standard deviation $2,476). Comparing by numbers of facilities reporting non-compliances, the results were also similar (14 during baseline, 12 during update) as were the numbers of facilities reporting fines (five facilities and three facilities, respectively).

The ***number of facilities*** at which a ***violation*** was observed did differ statistically from the baseline to the update period, however. ***During their baseline period, nearly half of the reporting facilities (15 of 33 facilities) reported at least one instance of a regulatory non-conformance that led to a NOV by the regulatory agency, comprising a total of 86 official NOVs issued to these facilities. After EMS introduction, occurrences of the same type were observed at only six facilities: eleven had no NOVs.*** These results were rechecked to assure that regulatory inspections had in fact occurred during the update period, and were reconfirmed.

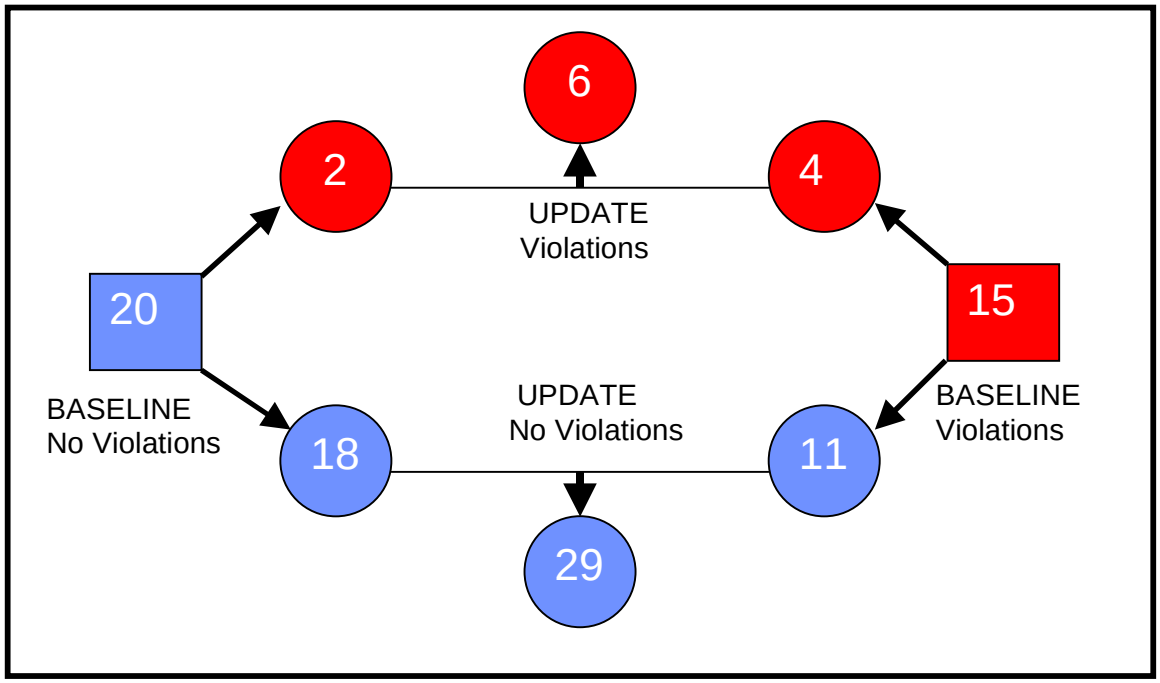


Figure ES-4. Changes in Observed Violations after EMS Introduction.

The fact that an appreciable fraction of the facilities that had violations during the baseline period did reduce or eliminate them after EMS implementation was a hopeful sign deserving further corroboration. On a statistical basis, however, the NDEMS pilot data did not show that the introduction of an EMS had any significant effect on regulatory compliance.

ISO 14001 Certification and Compliance Rates

What factors, if any, were associated with differences in compliance outcomes? ***ISO auditing and certification, or intentions to pursue them, made no observable difference.*** There was no significant difference in compliance improvement between facilities that intended to certify to ISO and those that did not.

Motivations and Compliance Rates

However, ***market-oriented motivations did make a difference. In each case, facilities that had improved their compliance rates had also rated the influence of market considerations in their EMS adoption decisions higher than did unimproved facilities.*** Facilities that improved their compliance had all rated the following factors as higher motivators for introducing their EMS than had unimproved facilities: the influence of domestic customers, international customers, use of EMS as a marketing tool, pressure from shareholders or owners, and potential for competitive advantage.

Ownership Status and Compliance Rates

The difference in ownership status between facilities that did and did not improve their compliance outcomes was statistically significant and stark. ***All eleven of the facilities that improved their compliance rates were publicly traded or privately held firms. More than two-thirds of the facilities that had not improved were government installations.*** The high number of privately held facilities that improved their regulatory compliance suggests a strong influence by market pressures, since these facilities generally had more limited internal management capabilities – an alternate explanation for such improvements – than publicly traded firms (albeit more than government facilities). Further research would be useful to test this result in a larger sample of facilities and to understand this relationship more clearly.

COSTS OF EMS ADOPTION

What costs do facilities experience in introducing and certifying an EMS, and how do these costs vary – if at all – with characteristics of a facility such as its size and complexity, pre-existing management capabilities, access to resources, and other factors?

Overall, ***the median reported cost for EMS design was approximately $64,000.*** The highest reported was $273,000, the lowest $3,000. ***Labor was the most costly component of designing an EMS for all types of NDEMS facilities, accounting for more than half of the average total costs.***

The majority of NDEMS facilities (59 percent) reported no additional monetary costs during the first update period after EMS introduction. For those that did report additional costs, the average cost reported was approximately $24,500. The majority of these costs were attributed to the acquisition or upgrading of equipment (62 percent). Staff and materials costs during the update period accounted for approximately 10 percent on average, respectively. Average costs for consultants, auditors and registration accounted for an additional 14 percent. These figures did not include any costs reported for corrective actions.

Costs, Capabilities and Resources

The reported costs of EMS introduction varied widely with the ownership status of the facilities, and with the associated differences in access to pre-existing management capabilities and to resources (Table ES-1). ***The average costs of EMS introduction varied from an average of $267 per employee for publicly traded facilities to $531 per employee for privately held facilities, to $1,441 per employee for government facilities.*** Compared to privately owned and government organizations, ***publicly traded facilities experienced lower total costs to design and implement an EMS, and government facilities spent the most.*** In addition, ***labor costs for government facilities were 2.6 times more than privately owned companies' costs, and 4.1 times more than publicly traded facilities' costs.***

The large differences in costs between publicly traded, privately held, and government facilities are probably best explained, we believe, by the differences in their access to internal capabilities and resources. ***Organizations with stronger organizational capabilities prior to EMS adoption incurred lower EMS implementation costs, whereas organizations with fewer organizational capabilities incurred higher implementation costs.***

TABLE ES-1: COSTS OF EMS DESIGN PER EMPLOYEE BY OWNERSHIP TYPE

Cost Category	*Publicly Traded (n=20)*			*Privately Owned (n=16)*			*Government (n=6)*		
	Mean	***S.D.***	***Percent***	***Mean***	***S.D.***	***Percent***	***Mean***	***S.D.***	***Percent***
Labor	$206	219.5	77.2%	$317	371.6	59.7%	$822	1041.6	59.8%
Consultants	$ 12	19.9	4.5%	$ 37	60.6	7.0%	$499	775.6	36.3%
Travel/Training[1]	$ 14	32.2	5.2%	$ 34	99.8	6.4%	$ 50	111.8	3.6%
Equipment	$ 0	1.7	0.0%	$ 33	88.9	6.2%	$ 0	0.0	0.0%
Materials	$ 7	14.6	2.6%	$ 22	46.6	4.1%	$ 1	1.5	0.1%
Auditors, ISO 14001 Registration[2]	$ 28	51.0	10.5%	$ 88	125.6	16.6%	$ 0	0.0	0.0%
AVERAGE TOTAL COST/EMPLOYEE	$267*		100%	$531*		100%	$1441[3]*		100%

* Results of Wilcoxon-Mann-Whitney test show that costs are less for publicly traded facilities than for other facilities (p=0.04). For-profit (publicly traded and privately owned) costs are less than government costs (p= 0.03). In comparing all three facility types EMS design costs per employee also differ (p=0.08).

Publicly traded facilities are more likely to have access to financial, technical, and intellectual support from a parent company than are privately owned entities, in part because the former are more likely to be large, multiple-plant operations, while the latter are more likely to be smaller, single-plant businesses that are more isolated. Government enterprises are more likely to have parent organizations than are privately owned enterprises, but the support that government entities receive from their parent organizations also is expected to be lower than for publicly traded enterprises, in part because these entities often have less discretionary control over slack resources.[4] In combination with their lower overall internal capabilities, less parent-organization support is likely to create a greater reliance on external assistance from consultants and other external sources during EMS design and implementation.

The results of the analyses are consistent with these expectations. ***Almost all publicly traded facilities (90 percent) had instituted either ISO 9000 or other total quality management (TQM) systems prior to EMS development, whereas none of the government pilot facilities had adopted quality management programs prior to EMS development. More than three***

[1] These costs were reported by facilities under the heading of "Other Costs".

[2] Auditors and ISO 14001 certification costs were combined because these costs are often closely related.

[3] Individual row items do not sum to the column total because one facility was able only to provide total cost of EMS Design. Individual costs by category were not reported by this facility.

[4] All three types of facilities were asked whether or not they were part of a larger business or government organization, and whether their facility or its parent organization was publicly traded, privately owned, a municipality, or a federal facility. For government facilities, this relationship might be exemplified by a facility that was part of a larger municipal government or federal agency; it was assumed not to include capabilities and resources provided by the pilot programs themselves, since these were provided by other federal or state agencies (U.S. EPA, state environmental agencies) rather than by the government organizations of which the facilities were subsidiaries.

quarters of the publicly traded facilities (76 percent) also had adopted at least one other innovation in their management systems (such as just-in-time inventory or materials accounting) prior to EMS development, whereas none of the government facilities had done so. Privately held organizations had introduced such management capabilities at similar rates as publicly traded facilities, although development of these systems was less extensive than at publicly traded facilities.

Similarly, ***48 percent of publicly traded and 44 percent of privately held facilities reported that they had already incorporated pollution prevention into their routine business planning, whereas none of the governmental facilities reported having done so. Fully 81 percent of publicly traded facilities also reported use of advanced environmental management techniques such as life-cycle analysis or risk assessment; only 25 percent of privately held facilities did so, however, and only 7 percent of government facilities.***

These data confirm and flesh out the differences in internal capabilities associated with facility ownership status. Publicly traded facilities had developed higher levels of environmental management capabilities prior to EMS implementation than either privately held or government owned facilities, and government facilities had developed the least.

Parent Organizations as a Source of Capabilities and Resources

One important source of management capabilities and resources was the presence of a parent organization – a larger corporation or more comprehensive governmental unit, for instance – that can provide such things as greater management sophistication and experience, technical assistance, EMS templates, and additional resources to a subsidiary unit to help them get an EMS (or other management innovation) off the ground. ***There were striking differences among the three types of facilities in their access to assistance from parent organizations in EMS design. The parent organizations of publicly traded facilities (95 percent) were far more likely to provide some support to the site for EMS development than were parent organizations of either privately owned facilities (27 percent) or government facilities (20 percent).*** More than two-thirds of the publicly traded parent organizations provided template EMSs to assist their subsidiary facilities, for instance; by contrast, none of the government facilities' parent organizations provided such templates, and they were nearly as rare at privately owned facilities (18 percent). These findings have important implications for government agencies that are encouraging the widespread adoption of EMSs, as some types of operations may need additional assistance in order to make implementation of an EMS a viable option.

Differential Use of Consultants

The dearth of support by parent organizations of government facilities may in part explain the greater reliance and large expenditures of these facilities on consultant services.

Government facilities were similar to private companies in that they spent over half of their average total costs on staff time. However, ***government facilities relied on consultants to a much greater degree than either publicly traded or privately held facilities.*** In addition, ***government facilities spent more dollars per employee on EMS consultants than either publicly traded or privately held facilities,*** investing approximately $499 per employee (36.3 percent of their average total cost), as compared to the $37 per employee (7 percent) that

privately owned enterprises chose to invest. Publicly traded facilities relied even less than privately held facilities on consultants, investing only 4.3% of their average total costs ($11 per employee) for their expertise and instead relying on in-house labor, which accounted for 77.2 percent of their EMS design costs.

Government EMS Assistance Programs

These findings have important implications for the use and targeting of government technical assistance programs. ***Half of all facilities that rated the importance of this assistance "high" or "medium" in their adoption considerations were privately owned, and more than 80 percent of government facilities considered these additional resources important to their EMS adoption decisions.***

In contrast, ***almost all publicly traded facilities (90 percent) gave a "low" rating to the impact of governmental assistance on their adoption decisions, and none rated it "high."***

These results suggest a clear difference between the availability of resources to facilities from parent organizations and accordingly in their reliance on external help from consultants or government technical-assistance programs. ***Privately owned and government facilities were far more likely to seek resources for EMS development from external sources such as consultants or governmental technical assistance programs, apparently because they were less able to obtain the necessary level of support for EMS implementation from their parent organizations.*** Conversely, ***publicly traded facilities paid much less for consultants and appeared to have little interest in government technical-assistance programs.*** Such programs thus appear to be best targeted at government facilities and at those privately held facilities that lack access to the resources and capabilities of a parent organization.

BENEFITS OF EMS ADOPTION

Other than improved environmental performance and compliance, what benefits did facilities believe they gained from EMS adoption? In both the EMS Design and Update Protocols, facilities were asked to identify both perceived and quantified benefits, if any, which they attributed to introduction of the EMS.

Perceived Benefits

A large majority of the NDEMS facilities (86 percent) reported benefits associated with introduction of their EMS, though many of these were not quantified. Together, these facilities described benefits of six broad types: increased management efficiency, increased operational efficiency, reduced liability, regulatory benefits, improved community relations, and improved customer/supplier relationships (Table ES-2).

Improvements in management efficiency were the most commonly reported non-quantified benefits, reported by 94 percent of the reporting facilities. These were concentrated predominantly in the EMS design period, and were most frequently associated with increased employee involvement.

More than three-quarters of the reporting facilities also reported improvements in the operational efficiency of their facility as non-quantified benefits. Common examples included reductions in inputs such as energy, water and materials or in waste generation and

disposal**.** Perhaps not surprisingly, these were concentrated more frequently in the first update period, after initial EMS design.

Reductions in liability also were identified as benefits by more than half the reporting facilities (53 percent). Benefits from reductions in insurance costs, environmental and health and safety liability, and improved relationships with regulators – such as improved compliance, reduced violation fines, and expedited permits – also were reported by a majority of the facilities (53 percent).

TABLE ES-2: BENEFITS OF EMS DESIGN AND IMPLEMENTATION

Benefit Category	Percentage of NDEMS Facilities Reporting Benefits		
	DESIGN PERIOD n=30	**UPDATE PERIOD n=29**	**DESIGN or UPDATE n=32**
Increased Management Efficiency	93%	79%	94%
Increased Operational Efficiency	47%	72%	78%
Reduced Liability	23%	52%	53%
Regulatory Benefits	27%	48%	53%
Improved Customer/Supplier Relations	10%	14%	19%
Community Relations Improvement	3%	13%	13%

By their nature, claims of non-quantified benefits represent the subjective perceptions and judgments of the individual reporting them. Notwithstanding this caution, ***these results suggest that even though many economic benefits were not quantified, many of these facilities perceived benefits that in the long run might be subject to more quantitative estimation,*** as facilities became more adapt at identifying and tracking changes to their operations and management practices.

Quantified Benefits

Thirty-two facilities reported information on quantified benefits associated with introduction of their EMS. ***The average benefits for those facilities reporting quantified benefits was $90,320*** through the first update period (including the design period). Average savings per facility from ***reduced materials use*** totaled approximately $45,077, which accounted for 57 percent of the average total benefits.

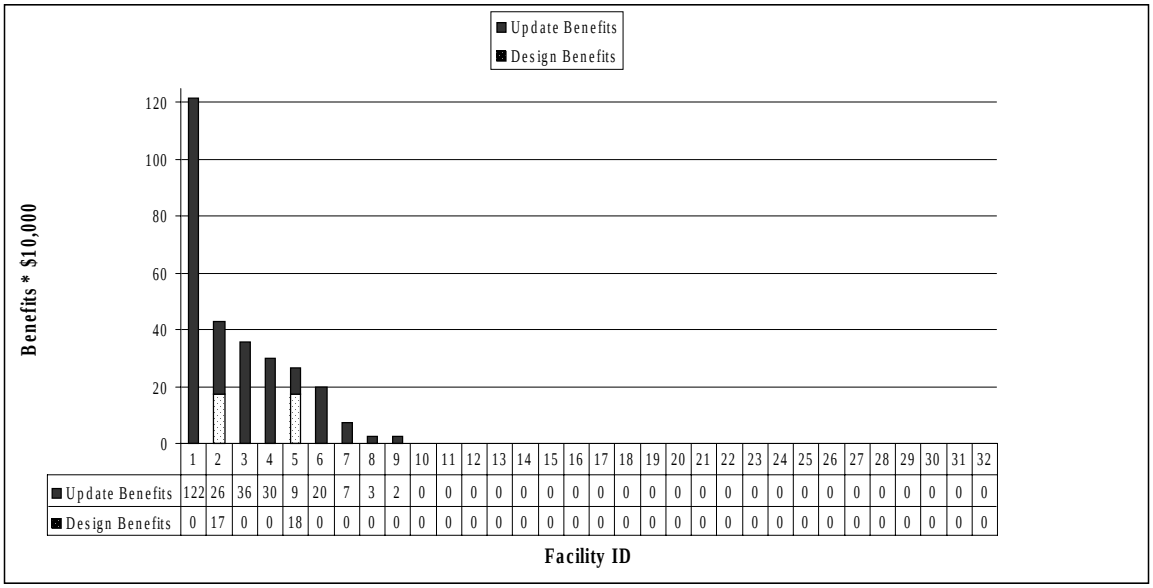
One facility, but only one, reported ***increased revenue*** attributed to implementation of its EMS. In this single instance the facility reported generating more than $40,000 in additional revenue due to their ability to reduce VOC emissions below permitted amounts and to sell these excess ATU (Air Toxics Units) on an emissions permit market. Table ES-3 shows the benefits reported, and the categories to which they were attributed.

TABLE ES-3: AVERAGE FACILITY BENEFITS FROM EMS INTRODUCTION

	Average EMS Development and Implementation Benefits								
	Total	**Staff**	**Mater-ials**	**Insur-ance**	**Waste**	**Fines**	**Water**	**Un-specified**	**Revenue Gained**
	N = 32	N = 32	N = 32	N = 32	N = 1			N = 1	
Design	$10,906	$0	$0	$0	$175,000	--	--	$174,000	--
	N = 32	N = 32	N = 32	N = 32	N = 8	N = 2	N = 2	N = 2	N = 1
Update	$79,413	$357	$45,077	$31	$91,391	$111,250	$16,361	$50,000	$40,250
Total	$90,320 (N = 32)								

The experience of one facility provides a number of examples of the savings and revenue benefits that were quantified by the NDEMS pilots. This facility reported approximately $273,000 in savings from the reduced use of materials at the site by using more efficient chemical processes in the production of their primary product and by modifying the packaging of the final product. Monetary benefits reported in the "other" category, which averaged approximately $34,000 per facility, accounted for an additional 43 percent of the average total benefits. Of the savings that were characterized as "other," three common categories emerged: reduced waste disposal costs, reduced fines, and reduced water costs.

While these benefits were moderately impressive for the facilities that realized them, ***this result reflected gains to only a relatively small number of the pilot facilities.*** Of those facilities reporting savings during the first update period, the highest was approximately $1,217,000, while the lowest was $24,000. Two facilities reported approximately $350,000 apiece in total savings during their design phase; half of this total was reported by one facility as savings in waste disposal costs. ***Three quarters of the facilities (76 percent) did not identify any quantitative monetary benefits from their EMS during the first update period.*** The total benefits per facility are shown in Figure ES-5.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Update Benefits	122	26	36	30	9	20	7	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Design Benefits	0	17	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure ES-5. Total Facility Benefits

Taking into account the EMS-related costs reported in the previous section along with these benefits, for most facilities ***the median quantified net benefit of EMS introduction was a net cost of about $40,000*** (Table ES-4)**.** Median net costs during the EMS design period alone were approximately ($64,000). During the first update period, the mean economic benefit was $55,032, reflecting the positive benefits for a minority of the reporting facilities; the median economic impact was zero, representing neither net economic benefits nor costs for most facilities.

TABLE ES-4: NET EMS DEVELOPMENT AND IMPLEMENTATION BENEFITS

	TOTAL		DESIGN		UPDATE	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
N=32						
Costs	($116,492)	($78,500)	($92,002)	($64,000)	($24,461)	($0)
Benefits	$90,399	$0	$10,906	$0	$79,493	$0
Net	($26,063)	$(40,020)	($81,096)	($64,000)	$55,032	$0

The fact that for most facilities, the net excess of costs over benefits were concentrated in the EMS design period and did not continue into the update period offers a reasonable expectation that longer-term implementation could generate increasingly positive cumulative economic benefits. It is reasonable to assume that by far the highest costs of an EMS are concentrated in the labor-intensive process of system design, initial identification of aspects and impacts and priorities, the transitional costs of initial training, consultant assistance, and initial certification audits where certification is included. Once in place, the ongoing costs would be expected to be limited to the maintenance of monitoring, reporting, and review systems – many of which

might in fact be streamlined compared to prior practice by the EMS process itself – and periodic surveillance audits for those facilities maintaining ISO certification.

Benefits of EMS Registration

For facilities that chose to design their EMS to the ISO standard and to pursue a registered environmental management system, one might expect that net benefits would be different due to the additional costs of registration and auditing fees. Conversely, one might also expect that the additional scrutiny of outside observers might push the facility to design a system that was capable of extracting real economic benefits from the program. However, ***the results showed no statistical differences between the net quantified benefits observed at facilities that were registering their EMS to the ISO standard and those without registration intentions.*** Similarly, ***non-registering facilities were no less likely to have reported at least one perceived or quantified benefit (14 of 19 facilities) than were registering facilities (16 of 18 facilities).***

Benefits in Relation to Motivations

A question that runs throughout this report concerns the motivations of facilities to adopt EMSs. ***Facilities that rated "a desire to increase revenues" higher among their motivations for EMS adoption achieved more impressive net quantified benefits than those that did not.*** This offers preliminary evidence that facilities expecting economic benefit from EMS adoption were more likely to realize at least some economic gains.

Costs of EMS design and implementation also were significantly lower at revenue-motivated facilities (averaging $58,705) than at non-revenue motivated facilities (averaging $112,409). These results seem to imply that instead of garnering greater benefits from their EMS, facilities that anticipated monetary benefits held the line on design and implementation costs. This result also is consistent with the fact that nearly all quantified benefits at these NDEMS facilities resulted from reduced costs rather than from increases in facility revenues. What these results appear to show is that motivations play a role in the benefits observed at these facilities.

With these exceptions, however, ***few associations were observed between net quantified benefits and facilities' adoption motivations.*** Total quantified benefits at those facilities motivated by revenue concerns were statistically the same as at those rating increased revenues less important in their decision making process. While more than half of the NDEMS facilities reported perceived benefits from improved regulatory relationships, for instance, facilities that considered the potential for improved regulatory compliance important to their adoption decision were no more likely to report benefits of this nature than were other facilities. These considerations are relevant for policy makers as they attempt to balance benefits to the public good of environmental protection and improvement with the motivations and expectations of facility and organizational management.

SIMILARITIES AND DIFFERENCES AMONG EMSS

In addition to these principal findings about changes in environmental performance, compliance, costs and benefits of EMS introduction, and factors such as motivations that

appear to influence them, the NDEMS data shed light on a number of related questions associated with similarities and differences among EMSs themselves.

Even in the context of the standardized elements of the ISO 14001 EMS template, the actual design and content of an EMS are voluntary and highly discretionary actions. What then does it signify that a facility has a formal EMS, or even that it has an EMS that is registered as conformant to ISO 14001? What should a government regulator or interested citizen infer from the existence or registration of an EMS?

Most of the NDEMS facilities had adopted the ISO 14001 model for their EMSs, and approximately two-thirds of them stated that they had obtained or intended to seek ISO 14001 registration. For all of them, the ISO standard provided a widely available benchmark for comparison of similarities and differences in current practice as to what an EMS contains and means. The following sections highlight similarities and differences in the actual content and process of the EMSs developed by the 58 facilities that reported EMS design data to NDEMS.

Activities and Environmental Aspects

The ISO 14001 model includes consideration of all "activities, products, and services" that may generate environmental impacts. ***Overall, the facilities focused their EMSs predominantly on site-specific operations and production processes, and to a lesser degree on materials and energy use. With very few exceptions, they did not use the procedure to identify or improve environmental aspects of their products.*** The facilities' approaches to aspect identification also revealed great differences in levels of detail.

Impacts

The ISO 14001 model recommends identification of all impacts that a facility has on the natural environment, both negative and positive. ***Most facilities considered the impacts of their activities on waste generation, pollution, and natural resources. A majority considered impacts on regulatory compliance, and a surprisingly large fraction (nearly half) also included at least some impacts on health and safety.*** This was surprising inasmuch as the ISO 14001 model and its associated guidance focused on impacts on the natural environment, and specifically not on health and safety considerations.

However, ***less than a third specifically identified positive impacts*** for continued support and improvement. Many facilities, both businesses and government alike, may have positive impacts on the environment associated with their site conditions, management practices, products, and other aspects of their activities, as well as negative ones, and may have the potential for many others not yet recognized or explicitly incorporated into their management decisions. If such environmental benefits are to be realized, or even maintained where they may already exist, it is important that they be formally identified and incorporated into the facility's EMS.

There also were noticeable differences among EMSs associated with some facility characteristics and motivations. ***Large facilities and facilities intending to seek ISO 14001 registration paid attention to a wider range of impacts than did those that were not.*** However, ***government facilities paid more attention to health and safety and to beneficial impacts than did publicly traded or privately held businesses.***

Significance Determination

Significance meant very different things to different facilities. Nearly three-quarters used a formal scoring system to rank the significance of their impacts, but the factors they considered – environmental impact, regulatory compliance, cost, and others – differed considerably. One EMS may represent a facility that is so thorough in its analysis – or so relatively benign in its overall environmental effects – that it considers even oil-contaminated swabs to be significant environmental impacts, while another may be so focused on major industrial hazardous waste streams or air pollutant emissions – or simply on compliance for regulated impacts – that it has not even thought to identify such aspects as swabs, let alone designate them as significant. ***Two arguably "similar" facilities may have different EMS design processes and criteria that lead to quite different judgments of significance.***

This finding is important to governmental environmental agencies, other public policy makers, and the general public who are considering what significance to attribute to the existence or certification of an organization's EMS. ***Significance determinations may or may not prioritize all the impacts that an external government agency or community considers most important. What must be asked by these external parties, therefore, is not simply whether an EMS is in place or has been certified, but what impacts were identified as significant, what objectives and targets were set for their improvement, and what actual performance or compliance results have been achieved.*** Fortunately, a facility's assertion that an EMS is in place (and in particular, an ISO-certified EMS) is in effect a claim that such information is available and regularly tracked within the facility, and therefore could easily be made available by the facility if it chooses to do so.

Objectives and Targets

Facilities set four distinct types of objectives and targets: performance-based, project-based, management-activity-based, and compliance-based. Performance-based objectives were those specifically measured by changes in actual environmental outcomes. Project-based objectives focused on one-time changeovers in equipment or processes that could be expected to produce direct environmental performance improvements but were not measured by those changes per se. Management-activity-based objectives represented changes only in intermediate outcomes such as additional training and improved procedural manuals that were hoped to improve environmental outcomes but had no actual environmental outcome measures to determine their impact or success. Finally, compliance-based objectives were limited to measuring impacts on regulatory compliance outcomes, typically in terms only of remaining within regulatory parameters rather than actually improving environmental performance.

Small and independent facilities on average set more objectives and targets for improvement than did larger facilities and subsidiaries, but their objectives were less often quantified and more often oriented to intermediate outcomes (such as managerial tasks or compliance) than to specific environmental performance improvement outcomes. ***Large facilities and subsidiaries of larger organizations, however, set a higher proportion of their objectives and targets on actual environmental performance-improvement objectives and on specifically quantified targets for achieving those results.*** Consistent with earlier sections above, these results suggest that small facilities may realize their greater gains from EMSs

simply through building the more formalized management procedures associated with an EMS (as with quality management systems and other basic management capabilities), whereas larger ones already have the management capabilities and resources allowing them to focus on direct improvements in environmental performance.

However, ***very few facilities set objectives and targets related to improving the environmental performance of their products.*** This suggests one possible area for future continual improvement of their EMSs.

Finally, ***all the target dates reported by the NDEMS facilities fell into one of three categories: already accomplished (a few cases), the current year, or "continuous" or "ongoing" (as for instance in maintaining compliance).*** None mentioned any objectives or targets for two or more years into the future.

Implications

In short, facilities have considerable discretion in how they design their EMSs to reflect their environmental goals and objectives and their management priorities and culture. These findings suggest that in practice, ***EMSs differ quite significantly in their interpretations, approaches, and levels of detail, and in their judgments, priorities, and aggressiveness in pursuing environmental performance improvement.***

These findings strongly suggest that ***the content of the EMS***—the scope of activities, products and services considered, the impacts whose significance is identified or overlooked, the objectives and targets selected for improvement, and the organization's actual performance in achieving them—***will probably prove to be far more important and informative to examine than the mere existence of an EMS or even the fact of ISO 14001 EMS registration.*** In particular, the objectives and targets actually set and achieved by each facility will be among the most important subjects for future examination, both by researchers and by government and the public, as an indicator of EMS success. The present study design did not allow us to categorize the relative difficulty/robustness of the various targets and objectives for which environmental performance indicators were reported, nor to identify to what extent these represented "stretch goals" as opposed to easy incremental improvements.

A TYPOLOGY OF EMSS

Are there broader patterns or "types" of EMSs that can be characterized from the examples of the NDEMS facilities?

A three-dimensional EMS typology was constructed to characterize the kinds of EMSs that NDEMS facilities built. Within this typology, facility EMSs were rated along three dimensions: EMS goals, involvement (breadth of participation in EMS development), and degree of external legitimacy sought. Each facility's EMS was located within the three-dimensional space circumscribed by these three axes, and cluster analysis was used to identify patterns of groupings within this space.

EMS goals ranged from a narrow emphasis on regulatory compliance to the addition of pollution prevention and eco-efficiency and, in the most ambitious cases, product stewardship and a broader vision of environmental sustainability. Involvement ranged from the Environment, Health and Safety (EHS) staff alone to the addition of other managers, non-

management employees, external groups, and in the most open cases external individuals. Degree of legitimacy ranged from EMSs developed for internal management purposes only to the addition of self-certification, external audits, ISO-14001 "readiness", and in the strongest case ISO 14001 certification.

Results of this analysis showed three distinctive types of EMSs: "Middle-Roaders," which did not reach for high-level goals nor involve many stakeholders in design, and whose EMSs were less likely to be certified; "Efficiency Experts," whose EMSs were more likely to be ISO 14001 certified and which focused on eco-efficiency; and a small cluster of "Visionaries," whose EMSs included more far-reaching environmental sustainability goals and broader participation in EMS development than the others.

For the 14 "Middle-Roader" facilities, the EMS was a means to achieve and maintain compliance and to focus on pollution-prevention activities such as waste minimization and recycling. Most had few environmental management programs in place prior to beginning the EMS development; for them, development of an EMS was a way to get a handle on increasingly complex environmental issues and to increase environmental management capacity within the facility. "Middle-Roaders" most often used EHS staff and facility managers to develop their EMSs; most did not seek ISO 14001 certification.

A majority of the 33 "Efficiency-Expert" facilities used their EMSs to increase the eco-efficiency of their production processes and to achieve ISO 14001 certification. These facilities often had reliable environmental management programs in place prior to designing their ISO 14001-conformant EMSs. They were consistently in compliance with environmental rules and regulations, and had long relied on pollution-prevention plans to achieve waste minimization, recycling and input substitution goals: many had employed waste-minimization practices and pollution-prevention planning for at least eight years, and more than half had used compliance audits for over 10 years. Efficiency Experts therefore focused on using the EMS to increase the efficiency of their production processes, through more effective use of process inputs, natural resources and energy. They also tended to rely primarily on EHS staff and facility managers to develop their EMSs, rather than inviting broader participation.

Finally, the six "Visionary" facilities designed EMSs to achieve broader goals such as product stewardship and environmental sustainability. Compliance, pollution prevention, and eco-efficient process goals were included as well, but these facilities' EMSs went beyond these to incorporate additional EMS goals focusing on product stewardship issues such as product disposal effects and on examining impacts on sustainability beyond the facility boundary. Visionaries did not necessarily have longstanding environmental management programs to build upon in designing their EMS, as did some of the Efficiency Experts, but these facilities used the opportunity of developing an EMS to incorporate ambitious goals.

The Visionary facilities built EMSs with the help not only of EHS staff but also of other managers, non-management employees and in one case, assistance from external stakeholders. All six Visionaries engaged external auditors to assist them in measuring the adequacy of their EMSs, but had not sought or declared an intention to seek ISO 14001 certification, although they did not discount the possibility that they might pursue certification in the future. One facility also provided opportunities for a community group to review the results of the external EMS audits.

CASE STUDIES

The report includes seven brief case studies of facilities illustrating the three broad EMS types and the varied patterns of goals, involvement practices, and external legitimacy aspirations described in the typology. Examples include one "Middle-Roader" facility, four "Efficiency Experts," and two "Visionaries." The cases also shed light on key factors that were especially influential in particular organizations, such as prior experience and capabilities, anticipated demands of business customers, and the roles of key senior managers or other influential personnel as leaders and advocates for EMS introduction.

EMSS IN GOVERNMENT FACILITIES

Many government facilities have predictable types of aspects and environmental impacts that could be significantly improved through the use of EMS procedures. Examples include motor pools, construction and maintenance operations, water supply and wastewater treatment facilities, schools, universities, hospitals, and others.

Other government units also have distinctive environmental management missions less commonly found in the private sector, for which EMSs might provide a framework worth consideration: examples include multi-purpose management of public lands and waters, and management of other common-property resources such as fisheries, wildlife species and ecosystems. All federal agencies have been directed by Executive Order to consider introducing EMSs at all appropriate facilities.

EMSs have been shown to be applicable to operations managed by state and local governments as well as federal facilities. ***Public-sector pilot facilities found their EMSs to be a useful tool for managing environmental issues, promoting compliance and pollution prevention approaches, increasing environmental awareness and stewardship, and improving operational control and efficiency.***

Where prior to EMS adoption organizations had described their environmental goals primarily in terms of compliance with environmental laws and regulations, after EMS implementation many facilities began seeking opportunities to prevent pollution, to reduce the demand side of their operations, and to initiate programs for non-regulated issues such as odor management and energy efficiency.

Overall benefits of EMS utilization in government facilities included better operational control in areas that impact the environment; better understanding of the root causes of non-compliance; improved operational efficiency and cost savings; improved communications within the organization and with outside stakeholders and contractors/vendors; and better relationships with regulators and stakeholders.

However, government facilities also face different incentives and constraints for EMS adoption than private-sector organizations, and often have less access to internal resources and capabilities, all of which may affect both their adoption and their successful and cost-effective use of EMSs.

Barriers to EMS adoption included management issues (integrating new approaches in strongly bureaucratic organizations); insufficient leadership (visibility and involvement

from top management); organizational issues (time, employee buy-in); lack of public awareness; understanding and buy-in; and political uncertainty.

The costs associated with implementing EMS, although significant, were primarily from increased labor hours of the workforce and the hiring of external consultants, both of which could diminish over time as each facility became more adept at implementing its EMS. ***Costs could also be diminished through the use of government EMS assistance programs to develop widely-applicable EMS templates for many of the major types of government facilities, activities and services. Examples include motor pools, construction and maintenance operations, water supply and wastewater treatment facilities, schools, universities, hospitals, and others.*** Such template development has been valuable to many private-sector facilities that are subsidiaries of larger parent organizations, but has been far less commonly available so far for government facilities.

LESSONS FROM ATTRITION

Over the five-year period from the initial Baseline Protocol to the EMS Design and First and Second Update Protocols, the number of facilities providing data gradually diminished from 83 facilities to 58 (EMS Design), 37 (First Update) and ultimately 30 (Second Update). Attrition is a normal problem in longitudinal studies, and especially so in a study such as this one that lasts for as long as five years and involves repeated voluntary submission of detailed information. The study investigated possible reasons for this attrition, however, in part to assure that these losses did not bias the study findings, and also to determine whether or not such attrition affected the reliability of facilities' long-term commitment to the EMS framework itself, and to continual improvement of environmental management procedures and outcomes.

Several explanations were possible for such attrition, either from the study or from EMS implementation more generally. One plausible explanation would be a major disruptive event at the facility, such as a major layoff or downsizing, management or ownership change, or a catastrophic event such as a major fire or shutdown. Facilities dropping out of the Pilot Program might have had significantly more adverse events take place during the period of our investigation, and such facilities might also be less likely to continue implementing their EMS after dropping out of the study. Alternatively, some facilities might simply not have the internal resources (staff time in particular) to continue participating in the pilot program, or perhaps to continue implementing the EMS as well: attrition might reflect a management decision that either participation in the pilot program or EMS implementation more generally was more costly than it was worth, or at least more costly than could be afforded.

A comparison of these factors for facilities that remained in the study versus those that did not provided some evidence that ***attrition from the study was probably due primarily to resource constraints, and also associated with major disruptive changes affecting late-stage attrition by some facilities***. Nearly half the facilities experienced at least one major disruptive event during the study period, and the occurrence of such events had a statistically significant association with late-phase attrition (though not with early departures). Six facilities shut down entirely during the period of the study, for instance, and another six were purchased. Two facilities had serious problems with compliance during the study, and this adversely affected their participation in their state Pilot Programs and also in our study.

It appears, in short, that many of the facilities that dropped out of the Pilot Program and the National Database study did so most often because of a lack of resources, often directly expressed as a loss or shortage of personnel, and often in association with a major disruptive event. A number of facilities reported that they had lost customers or contracts and re-evaluated their priorities, or that they had lost key personnel due to retirement, maternity leave, or reassignment. Several of the Pilot Programs provided technical assistance and grants to facilities as incentives for participation, and this appears to have helped to retain facilities in the study.

However, within the time period of this study, ***these changes did not appear to have had a strong detrimental impact on the commitment of these organizations to continue to develop and implement their EMSs***. The frequency of disruptive events for the 20 facilities that had stopped working on the EMS was nearly identical to the frequency for the 47 facilities that continued the EMS. Even five of the six facilities that were purchased by other firms during the study period, for instance, reported that they were continuing to develop and implement their environmental management systems. While a high rate of adverse events and loss of resources may explain attrition from the NDEMS Pilot Study, these factors did not distinguish the facilities that continued their EMSs from the group that did not do so.

Even among those facilities that did complete all four protocols over the five years of the project, however, the continued commitment to the EMS was not universal: 17 percent of the Second Update facilities (5 of 30 facilities), and approximately one third of all facilities, reported that they were not continuing their EMSs. We explored the reasons why these facilities appeared no longer to be implementing their environmental management systems. The few explanations given cited varied reasons – cultural conflicts within the organization, a fire, other events – but the most frequent explanation was a lack of resources, especially personnel.

STUDY LIMITATIONS

The NDEMS database has valuable potential for investigating many sorts of questions concerning EMS implementation. Its limitations, however, should also be noted.

First, the number of facilities included is too small and too diverse to generalize about the practices of all facilities. The database consists of a heterogeneous group of 83 facilities, enough to document many important similarities and differences but not enough to produce statistically conclusive generalizations about entire industrial sectors or about the performance of all EMS adopters. For many of the analyses, the number of facilities for which data are available is less than 83, since not all facilities responded to all the data requests.

Second, the facilities we studied were volunteers recruited by EPA or state environmental agencies, most of which received favorable government recognition and many of which received government technical assistance for developing their EMSs. As such, they may not be fully representative of facilities that introduced or chose not to introduce an EMS in the absence of such inducements, and their EMSs may themselves have been subject to some homogenization due to the common influence of government technical assistants.

Third, the facilities may not all have provided complete or unbiased information. Participating facilities have been extremely generous about sharing data with this project, but in at least a

few known instances they have found it necessary to withhold specific data elements to protect confidential business information, and there may be additional unknown instances as well. Some of the information in this study reflects the judgments of the individuals who provided us the information, who may also have biases favoring the success of their EMSs.

Fourth, our results compare EMS practices during a particular time period (1998-2002), a long enough period and late enough after introduction of the ISO 14001 model to learn a great deal about the EMS adoption process and its initial impacts, but still too soon to expect objective evidence of change in performance and compliance outcomes to be clearly evident in government data sets.

Finally, facility-level data on U.S. implementation practices do not by themselves answer all important questions about the value and effectiveness of EMSs. Some important EMS-related decisions and practices may require investigation at the firm or corporate level, and international comparisons are necessary to determine whether similar or different motivations and practices occur in facilities located in countries other than the United States. Examples include the possibility that European facilities registering EMSs to the EMAS standard may show stronger performance than firms registering only to the ISO 14001 standard, or that Asian businesses may be motivated more strongly than U.S. facilities to use ISO registration as a factor in competition for U.S., European and Japanese business customers.

Such limitations are unavoidable in a detailed longitudinal pilot study such as this, and are offset by the distinctive benefits of this type of study. A comparative study using volunteer facilities allowed us to collect far more detailed information on each facility than could be gathered by mail or telephone surveys of large numbers of organizations, and to obtain far richer qualitative as well as quantitative information about how their EMSs were developed. Case studies also allowed us to illustrate more specifically the similarities and differences among their experiences. Finally, the longitudinal design allowed us to monitor and interact with these facilities over a far longer period of time, through a critical period in the evolution of their management practices, than would have been possible in a one-time survey or other types of studies.

CONCLUSION

Overall, the evidence of the NDEMS EMS pilot facilities suggests that ***the introduction of an EMS can be expected to be at least somewhat beneficial to the environmental performance of most facilities, as well as to their operating and management efficiencies, and in some cases to their regulatory compliance patterns.*** These results are more likely for facilities that are subsidiaries of publicly traded corporations, owing to their greater access to management capabilities, resources, and assistance from their parent organizations, but they occur in privately held and government facilities as well.

The evidence also suggests that EMSs are highly variable in their content, priorities, and judgments of significance. ***The existence or certification of an EMS per se does not necessarily provide any clear information, or information comparable to other facilities, about the facility's actual environmental performance, compliance, or rate of improvement.*** This is not necessarily a negative finding, but simply the identification of a reality that may be important to government environmental agencies and others in interpreting the significance of an EMS. ***The existence of an EMS, and particularly of an ISO-certified EMS, does however***

establish a presumption that that information exists, and could be made available and used to achieve performance and compliance goals.

Finally, the evidence also suggests that ***government-sponsored EMS assistance programs are most effectively targeted toward government facilities and toward privately-held businesses that do not have access to the management capabilities and resources of a parent corporation.*** These types of facilities generally incur proportionally higher costs to implement EMSs than do publicly-traded corporations, and have less resources and less management experience to bring to the task. They also recognize and value the benefits of such assistance.

IMPLICATIONS FOR PUBLIC POLICY

The findings of the NDEMS pilot study indicate that government policies and incentives make a difference to EMS adoption, and to the degree of success that these systems can achieve during implementation. Which policies and incentives, and with what effects on which kinds of facilities, are important questions for further consideration in the design of public policies.

First, for instance, the report found that ***EMS adoption and success are influenced both by external pressures – including regulatory expectations in particular -- and by the resources and internal capacity available to the facility to do so. Government policies enter into both these considerations.***

Regulatory pressures, for instance, were perceived by all types of facilities as the most important external influences on their decisions to adopt an EMS, and other government incentives such as public recognition programs may also be influential. If decisions about EMSs and other voluntary initiatives are made in the context of continued expectations about regulation, it will be important to assure that those expectations are maintained. In this context, EMSs may function not so much as alternatives to such regulation, but as instruments for improving compliance assurance along with other objectives such as eco-efficiency (and in some cases, more visionary organizational objectives such as environmental stewardship and sustainability). In light of these findings, it will also be useful to consider further when to use regulatory pressure for EMS adoption and performance and compliance improvement, and on what types of facilities. For which categories of potential EMS adopters does it work best as a motivator?

Government capacity-building assistance programs -- technical assistance programs, templates for EMSs, best-practices conferences and workshops, and other support, for instance – were also reported to be important but different influences on EMS introduction, especially for privately-held facilities, for facilities that are not subsidiaries of a larger parent organization, and for government facilities. These findings suggest possible criteria for targeting of public policy incentives and assistance services on organizations for which they will be most valuable and effective.

Second, the report found that ***facilities' prior histories matter to EMS adoption and success.*** These histories include both their prior compliance histories, and their prior experiences with other capacity-building initiatives: management innovations such as ISO 9000, other environmental management initiatives such as pollution prevention plans, and initial elements of an EMS per se. The influence of these prior histories on subsequent environmental performance suggests additional implications for public policy design. ***Facilities with more***

problematic compliance histories and more limited capacity histories may need stronger combinations of incentives and assistance – and probably, different combinations of these – than facilities that start from more favorable pasts. Which potential EMS adopters is it worthwhile to motivate? The better implementers appear to have stronger managerial and other capacity characteristics: would they then be the best population of adopters to try to increase? On the other hand, policy incentives that focus mainly on facilities with favorable compliance histories and prior capacity development may achieve apparently greater success, but may simply be rewarding those facilities that were more likely to succeed anyway.

Third, the fact that government facilities themselves had distinct differences from private-sector facilities has important implications both for implementation of the presidential executive order on EMSs and for EMS adoption and success by government facilities. In particular, ***government facilities typically had markedly less prior capacity developed for environmental management than businesses, and they were far more reliant on consultants and other higher-cost services. They also were typically more focused on the use of an EMS for regulatory compliance assurance than on other potential benefits such as cost savings.***

These findings suggest the particular importance of capacity-building assistance for public-sector facilities, and perhaps of additional emphasis on cost-saving as well as environmental performance indicators as benefits of an EMS to public-sector facilities. ***Especially for government facilities, the costs associated with implementing EMS could probably be significantly reduced through the use of government EMS assistance programs to develop widely-applicable EMS templates for many of the major types of government facilities, activities and services.*** Examples might include motor pools, construction and maintenance operations, water supply and wastewater treatment facilities, schools, universities, hospitals, and others. Such template development has been valuable to many private-sector facilities that are subsidiaries of larger parent organizations, but has been far less commonly available so far for government facilities.

Fourth, the report's findings showed that ***EMSs vary widely in their content.*** An important implication of these findings for public policy is that ***the content of an EMS—the scope of activities, products and services considered, the impacts whose significance is identified or overlooked, the objectives and targets selected for improvement, and the organization's actual performance in achieving them—will probably prove to be far more important and informative as a basis for public policy rewards and other incentives than the mere existence of an EMS or even the fact of ISO 14001 EMS registration.***

Finally, the report's findings identified several kinds of potentially important ***differences among facilities that focused their EMS processes on compliance and capacity-building, on eco-efficiency, or on more visionary innovation strategies.*** It may be important for public policy makers to consider carefully which of these approaches they most wish to encourage, and to differentiate their strategies and incentives accordingly.

Left unexamined by this study, but deserving of future investigation, are the implications of EMS use as an element of enforcement and sanctions policies. EPA and a number of state environmental enforcement officials have begun to experiment with including EMSs as "supplementary environmental projects" within negotiated enforcement settlement agreements. It will be important to determine whether such EMSs add significant value to

improvement of compliance rates and related performance outcomes in facilities that start with more problematic compliance and performance records than the NDEMS pilot facilities.

FURTHER RESEARCH

A number of important questions deserve continuing investigation beyond the time period and evidence of this study.

First, ***how does the performance of the EMS pilot facilities compare with the performance of the full universe of facilities that introduce EMSs, and particularly with those that start with more serious deficiencies*** in environmental performance and regulatory compliance? In particular, further research should examine whether any facilities that start with serious deficiencies have used an EMS to achieve greater improvements than the NDEMS pilot facilities, and what success factors were associated with this achievement. Additional studies would be worthwhile on the range of adaptations of EMSs to diverse sectors and circumstances, leading perhaps to development of replicable sector-specific EMS templates for particular sectors and facility types.

Second, ***what will the experience of such facilities be beyond the initial 1-2 years after EMS introduction?*** In particular, the objectives and targets actually set and achieved by each facility will be among the most important subjects for future examination, both by researchers and by government and the public, as an indicator of EMS success. It should also soon become possible to examine environmental performance changes of larger numbers of EMS-adopting and ISO-certified facilities as reflected in data collected by federal and state regulatory programs. "Continual improvement" is an admirable ideal, but in practice it may not be easy to achieve. Some facilities may indeed use a system such as the EMS to drive their environmental performance to more and more ambitious levels and to more and more fundamental rather than merely incremental improvements; or they may at least maintain the performance benefits of the more formalized management system. Others, however, may face a gradual attenuation of their improvement once they have "harvested the low-hanging fruit," the most immediately and significantly cost-effective changes in practices and processes. Still others may experience outright attrition from their commitments to the EMS process and objectives, as a consequence of shifting priorities, market setbacks, changes in ownership or management, or other factors.

Third, ***do public reporting and broad stakeholder participation produce better environmental performance results?*** The NDEMS pilot study produced some useful findings on involvement of stakeholders internal to the facility, but only limited findings concerning external stakeholders (community groups, neighbors, local governments) since such stakeholders were involved in only a small fraction of the pilot facilities' EMS processes (and even then, in some cases, only because of state mandates). Further and more systematic study of this topic would be useful. Further research also would be useful on the relationships between environmental performance outcomes and public reporting on environmental performance indicators.

Fourth, ***how will government incentives for EMS adoption and use – public recognition and regulatory flexibility, for instance, as well as technical assistance – affect environmental performance and compliance over the longer term?*** Incentives for EMS adoption are now being introduced by EPA and an increasing number of states, on the presumption that EMS

introduction will improve outcomes. Do these external sources of support lead to the development of permanent competencies for environmental management and continual performance improvement? Do facilities that rely heavily on external resources develop EMSs that are as rigorous as the EMSs developed by facilities that did so entirely on their own? Do facilities that rely on external incentives and assistance continue to support and improve their EMS over time? All these are essential questions for further investigation.

Fifth, ***how do successful EMS adopters overcome implementation issues, and what models do their experiences offer for success by subsequent adopters?*** Successful EMS implementation requires not only leadership and changes in operating procedures, but also the negotiation of numerous behavioral and organizational barriers. What detailed fixes, techniques, and adjustments have been used by successful adopters to overcome internal resistance and to energize important program elements? The NDEMS study includes seven brief case studies illustrating some of these changes, but more systematic study of such cases is needed. This sort of information would assist future adopters in increasing the chances for successful implementation.

Sixth, ***how do facility-level EMS decisions interact with decisions made at the level of a larger corporate or government organization?*** The NDEMS study focused on facility-level decisions, but many important decisions affecting environmental outcomes are made at the corporate level (or for government facilities, at the level of the overall governing body rather than the particular facility). Many facilities have adopted EMSs because of corporate mandates or encouragement, and many other key decisions affecting environmental performance – including supplier mandates as well -- are often made at the corporate rather than facility level. A key question for future research, therefore, is what factors influence parent organizations to mandate or encourage EMS adoption in their facilities, and how their aspects, impacts, judgments of significance, and potential objectives and targets might differ from those available at the facility level.

Seventh, ***how can EMSs be used most effectively to improve the performance and compliance of government facilities?*** EMSs originally were developed as an instrument of private-sector business management, shaped by market incentives, capabilities and resources that are often absent for government facilities. Yet government facilities generate many of the same environmental impacts, they typically start with less capabilities and resources for improving, and they appear to incur higher costs per employee for EMS introduction. Unlike many private-sector businesses, many government organizations also have environmental management as a specific mission to which EMSs might have particular relevance. Targeted government EMS assistance programs could perhaps contribute both to better environmental management and to better management more generally at government facilities.

Eighth, ***how do U.S. facilities' uses of EMSs compare with those in other countries?*** The introduction of EMSs is a global phenomenon, and the ISO 14001 model is an international voluntary standard for such systems. Far more facilities so far have been certified to this standard in other countries than in the United States, including many that are suppliers, competitors, customers, or corporate sister facilities to U.S. businesses. What can be learned from their experiences? Are they introducing EMSs for the same reasons? Achieving similar results, or better or worse? Are they finding competitive advantages in EMSs that U.S. facilities should also recognize and seek? These questions are important to U.S. public

policymakers as well as to businesses, since they affect the competitive environment in which U.S. businesses themselves introduce and implement the commitments of an EMS.

Ninth, ***do externally audited and certified facilities demonstrate better environmental performance than non-certified facilities?*** The NDEMS pilot study did not find evidence to confirm this result, but more systematic investigation might more clearly determine whether regular external surveillance audits create stronger and ongoing incentives for better data management, for more accurate and trustworthy reporting, and for continual improvement of environmental performance.

Finally, can groups of facilities in the same community or ecosystem achieve more significant results by coordinating their EMS objectives and targets to improve the environmental outcomes for particular shared impacts, such as smog reduction or improvement of water quality in a shared lake or river? Under the ISO EMS model, the selection of objectives and targets is entirely an internal process: their objectives and targets reflect only the priorities of managers within the facility, which may or may not match the most important environmental problems and priorities of the communities and ecosystems in which the facility is located. As EMSs become more widely adopted, the potential for coordination of objectives and targets across facilities contributing to high-priority community environmental problems deserves experimentation and evaluation. If successful, such experiments could make EMSs far more useful instruments for achieving important environmental policy goals.