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Assessment of Cost Savings of DOE's Return-on-Investment Program

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Executive Summary

The U.S. Department of Energy (DOE) Office of Pollution Prevention (EM-77) created a successful internally competed program to fund innovative projects based on projected returns. This is called the Return-on-Investment (ROI) program. EM-77 conducted a successful ROI pilot, developed and implemented sound management practices, and successfully transferred the program to several Operations Offices. Over the past 4 years sites have completed 262 ROI projects (costing $18.8 million) with claimed first-year savings of $88 million and claimed life cycle savings exceeding $300 million. EM-77 requested that Oak Ridge National Laboratory perform an independent evaluation of the site-led, DOE-HQ-funded pollution prevention (P2) ROI program to assist the Department in determining whether claimed savings are real.

The approach for conducting this evaluation was to analyze a sample of P2 projects to identify actual project cost savings and other actual benefits — e.g., amount of waste avoided. To determine the projects for review, EM-77 provided a list of EM-funded projects at two Operations Offices: Oak Ridge and Richland. Sixteen projects (eight from each Operations Office) were selected at random from this list for review. Project documentation was requested from the sites, and this was followed by face-to-face interviews with project personnel. Of the 16 projects selected at random, two are still awaiting implementation, and no project interview was conducted for one project. Because the purpose of this study was to review projects after they have been implemented, the two uncompleted projects were eliminated from further consideration. The remainder of this report addresses the 13 completed projects for which we received documentation and performed interviews with project personnel. Both Oak Ridge and Richland staff pointed out that because of the selection approach used, this study did not review the most successful projects at their sites.

P2 projects perform better than expected. For 8 of the 11 projects that estimated the ROI in the project proposal, the ROI as determined through our interviews exceeded the ROI in the project proposal. In some cases, the improvement was due to increased throughput (e.g.,analyzing more samples than anticipated) or finding additional uses for the new equipment. In other cases, the P2 projects had understated their financial benefits because project managers neglected benefits accruing to other organizations.

P2 projects produce significant cost savings

Average ROI from project proposal	558%
Average actual ROI	611%
Number of projects reviewed	13
Total implementation cost	$606,000
Total life cycle savings	$30,000,000

P2 projects yield high returns. The 13 P2 projects saved 50 times the initial P2 investment. The implementation cost of $606,000 for the 13 projects will result in life cycle savings of $30 million. Only one of the projects did not realize any cost savings. In addition to significant cost savings, DOE realized environmental, health and safety, and programmatic benefits from the projects (e.g., eliminating 260,000 gallons per year of mixed low-level waste, reducing release of tritium into groundwater, reducing exposure to toxic materials, and making it possible to meet Tri-Party Agreement milestones). The analysis is summarized in Fig. ES-1 and Table ES-1. Cost estimates reported here reflect the total cost of each individual project over the total life of the project. However, they do not include what could prove to be a major benefit of the P2 program: sparing the Department the cost of building additional waste management facilities (e.g., additional disposal cells) in the future. Consequently, the true benefit of P2 investments may be even larger than reported here.

Most cost savings are diffused across the DOE, not returned to the implementing project. As Fig. ES-1 shows, the majority of life cycle savings occur as avoided costs to DOE (primarily in the area of waste management), not as direct savings to the implementing project. Of the $30 million life cycle savings, only 10% ($3 million) represent direct savings to the implementing project. These savings are realized as labor savings ($2.6 million) and avoided purchases ($419,000). The remainder of the savings — $27 million — accrues to other projects; the implementing project does not reap these savings.

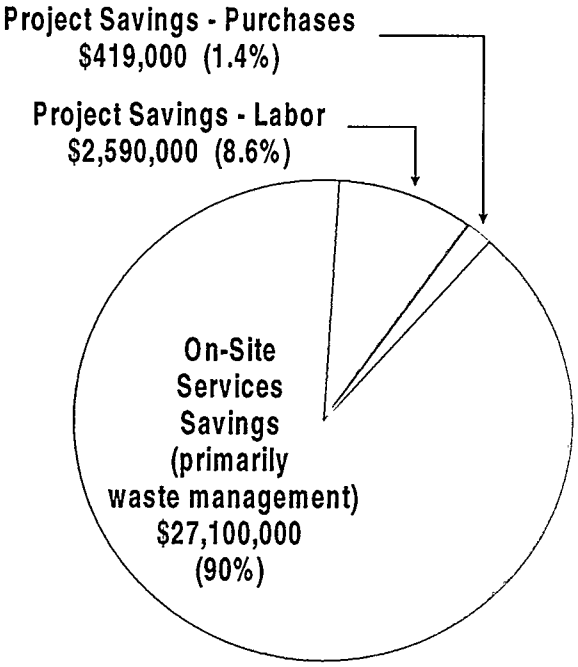

Fig. ES-1. The majority of P2 cost savings accrue to waste management, rather than to the implementing project.

P2 cost savings are diffused between the implementing project and DOE Headquarters program offices (e.g., Office of Science, Office of Environmental Management, Office of Defense Programs), field offices, and different field organizations (e.g., EM-30, 40, 50, 60, 70). For example, waste management costs are shared among the Office of Waste Management and multiple generator organizations. For the Oak Ridge projects reviewed, generators did not pay for disposal of their waste; therefore, they do not reap the benefits of waste reduction investments. Richland does have a charge-back system in place to charge generators for the operating (not fixed) costs of waste management facilities; however, charges apparently accrue to the larger generator organization and are not always assigned to individual project budgets. As a result, a project engineer would not reap the cost savings resulting from his waste reduction investments.

Of the 13 projects reviewed, one project accounted for 74% of the total savings. This P2 project modified an evaporator at a cost of $233,000. This action eliminated generation of 370 cubic meters of liquid mixed low-level waste per year and resulted in life cycle savings from avoided waste management of $22 million. Although the larger organization (the Tank Waste Remediation System) realized both the costs and benefits of the evaporator modification, the implementing project engineer saw only the cost and did not have access to funds within his project to pay that cost.

This example illustrates a key role of the ROI program: bridging the gap when the implementing project does not have access to funds to implement an action that will benefit the Department overall. The ROI program serves to bridge the gap any time there are stovepipes that cause one account to realize a cost and another account to reap the benefits. The most common example is a waste generator incurring the cost of waste reduction while the waste management organization realizes the savings; however, there are other instances as well.

Program Management. Both the Oak Ridge and the Richland Operations Offices have developed successful grassroots programs using streamlined processes which could serve as examples for the DOE complex. Dedicated teams administer the effort, champion the program, and assist generators in identifying P2 opportunities.

Because financial investments and returns accrue to different entities, projects sometimes do not have sufficient incentive and/or access to funds to implement P2 opportunities if the funding must come from their direct program budgets. In addition, we were informed that lack of regulatory drivers and lack of management discretion contribute to managers' inability to make P2 investments from their project funds — and the consequent need for separate P2 funding. In Richland in particular, all discretionary funds are applied to meet regulatory requirements associated with the Tri-Party Agreement, leaving no funds available for worthwhile projects that lack regulatory drivers.

The ROI Program provides incentives to reap "hidden" benefits

Waste generators may have disincentives to incur the costs of P2 work when

- all or most of the savings accrue to a different organization,
- the savings are diffused among different offices and organizations,
- the benefits are related to health and safety, the environment, or programmatic costs.

By looking past stovepipes and focusing on the overall benefits to DOE, the ROI program encourages projects that are cost-effective from the standpoint of the Department.

Furthermore, non-monetary benefits of P2 projects, such as protection of natural resources, are typically not fully considered in decision-making. This, too, may contribute to an under-investment in P2 opportunities. This study found that P2 projects produce significant non-monetary benefits in addition to the documented financial rewards.

EM-77's ROI program serves a key role in optimizing the function of the system within these constraints to achieve the significant financial, health and safety, environmental, and programmatic benefits of P2 investments. For example, the ROI program looks past organizational "stovepipes" to fund projects that are cost-effective from the standpoint of DOE and taxpayers. It is recommended that DOE aggressively capture the documented benefits of pollution prevention by continuing to fund the ROI program.

Table ES-1. Life cycle analysis reveals that P2 projects produce significant financial and non-monetary rewards

Project Name	Implementation Cost ($1000s)	Life Cycle Savings ($1000s)	Pollution/ Waste Prevented	Environmental Impacts	Health and Safety	Programmatic Impacts
ORNL Cyanide by MIDI Distillation Upgrade	49	766	◒	○	◒	◎
ORNL Mercury Analyzer Upgrade	23	349	◒	○	◒	◎
ETTP Purchase Data Security Degausser	28	274	◒	◒	○	◒
ETTP Substitution of Poly Tanks for Drums to Collect Acids	21	105	◒	○	◒	◎
Y-12 Source Reduction of Heavy Equipment Oils	37	<0 [a]	◓	◓	◓	◒
RL Basin Overflow Retention Tank	13	1,450	◒	○	◎	◎
RL TWRS Evaporator Modification	233	22,300	◎	◎	◒	◎
RL Mixed Waste Rain Curtain	149	791	◎	◒	◒	◎
RL Isolate Diversion Box	18	3,410	◎	○	◒	◒
PNNL Microconcentric Nebulizer	2	3.0	◒	◒	◒	○
RL Eliminate Solid Waste Stream with Treatment and Recycling	5.6	296	◒	◒	◒	◒
RL In-Line Solvent Recovery	22	49	◒	◒	◒	◒
PNNL Metallography Photochemical Reduction	6.7	249	◒	◒	◒	◒

Key: Project produced:

◎ Major improvement relative to baseline approach

◒ Some improvement

○ No change relative to baseline approach

◓ Somewhat worse than baseline

● Major decline relative to baseline approach

a Not quantified

1. INTRODUCTION

1.1 BACKGROUND

In 1994-1995, the Pollution Prevention (P2) Executive Board of the U.S. Department of Energy (DOE) conducted a successful grassroots-style Return-on-Investment (ROI) pilot, based upon an effective industry program at Dow Chemical-Louisiana. This program was then implemented by five Operations Offices — Albuquerque, Oak Ridge (OR), Oakland, Richland (RL), and Savannah River. During the past 4 years, these sites have completed 262 ROI projects (costing $18.8 million), with claimed first-year savings of $88 million and claimed life cycle savings exceeding $300 million.

Over the past four years five DOE sites have completed 262 ROI projects:

- *cost — $18.8 M*
- *claimed first-year savings — $88 M*
- *claimed life cycle savings — more than $300 M million.*

1.2 OBJECTIVE AND APPROACH

The objective of this task was to assess the site-led, DOE-Headquarters (HQ)-funded, P2 ROI program. This assessment had two major guidelines: (1) perform a statistical sampling of completed ROI projects to validate estimated project costs and benefits and determine how the cost savings are returned to the site, and (2) evaluate site-level program management procedures and methods implemented to administer the ROI program.

The approach chosen for this assessment was to review 16 randomly-selected EM-funded ROI projects at two Operations Offices, OR and RL. Although this assessment does not constitute a comprehensive analysis of the program, the number of projects reviewed allows for a deeper understanding of the value of P2 investments. The 16 projects (8 from OR and 8 from RL) are listed in Attachment 1.

The 16 projects selected for evaluation were chosen from a list of completed ROI projects provided by EM-77. We used statistical sampling procedures to select eight projects from each Operations Office from this list. According to site representatives, some projects on the list had not yet been implemented, and some projects were not funded from the HQ ROI program, while some ROI projects were not listed. For example, OR informed us that the list of projects did not include the DOE HQ ROI funded projects for which EM money was awarded in 1994-1996. There were eight projects from the Oak Ridge Y-12 Plant that were funded through this program and there is a great deal of documentation for those projects from which an evaluation could have been supported. Therefore, the list from which the sample was drawn may not have been representative of the breadth of P2 projects funded by the ROI program. Based on a review of the randomly selected projects, P2 coordinators believe that a more representative project listing could have resulted in a sample of projects that would have shown higher savings and increased non-monetary benefits. Therefore, the project approach may have contributed to an underestimate of the positive results reported in Sect. 3.

The projects randomly selected for this evaluation may not have been representative of the breadth of P2 projects funded by the ROI program. The savings and the non-monetary benefits of the ROI program may be even higher than the results reported in this review.

Of the 16 randomly selected projects:

- Twelve projects were completed and implemented as planned. Project interviews were conducted for 11 of these (no interview was conducted for ORNL Digital Conversion in Materials Analysis Labs — project 14 in Attachment 1 — because it was funded before more formal ROI project proposal and tracking procedures were adopted.)
- One project has been partially implemented. The ORNL Cyanide by MIDI Distillation Upgrade Project (project 1) purchased equipment that is now being used for other P2 applications because its intended use has been delayed by certification problems.
- One project was unsuccessful. Y-12 Source Reduction of Heavy Equipment Oils (project 5) expended funds to purchase equipment, but the technology failed in field application.
- Two projects are not yet implemented. These projects -- the ETTP Direct Injection Nebulizer (project 16) and the ORNL Better Orange Parts Washer Project (project 15) expended funds to purchase equipment but have not yet been implemented (although they are expected to be) because of technical difficulties and organizational changes, respectively.

This report focuses on the 13 completed projects for which we conducted interviews (projects 1-13 in Attachment 1).

To evaluate the projects, we conducted face-to-face interviews at both OR and RL with the P2 coordinators and the project engineers and managers. During these meetings, the projects were described, project implementation costs were reviewed, and cost savings (over time) were assessed (see Sect. 3.1). Other project benefits were also evaluated (as discussed in Sect. 3.2).

2. P2 PROJECT EVALUATION METHOD

A life cycle analysis was performed to understand the full costs and benefits of the 13 P2 projects. Life cycle analysis is a systematic and comprehensive process for identifying, assessing, and comparing alternatives and for selecting and documenting a preferred alternative. A life cycle analysis includes all of the impacts that result from a course of action over the entire period of time affected by the action. For this study, the 13 projects were evaluated on four financial criteria and four non-monetary criteria.

2.1 FINANCIAL EVALUATION CRITERIA

Life cycle analysis — a systematic and comprehensive process for identifying, assessing, and comparing alternatives — was used to evaluate the full costs and benefits of the thirteen P2 projects. Four financial criteria and four non-monetary criteria were used in the evaluation.

The financial evaluation criteria were implementation cost, life cycle savings, ROI (%), and life cycle savings per dollar invested (%). Each is defined below.

- **Implementation cost** — Costs incurred to implement the P2 project, such as equipment and material purchases, and staff time.

- **Life cycle savings** — The total cost savings to the government over the life of the P2 project. The approach to making this criterion operational is to estimate all cash flows over the project life (regardless of which DOE program pays those costs) and discount future cash flows to produce a net present value. This is done for both the baseline (absent the P2 project) and the P2 project; the difference is the life cycle savings of the P2 project. A discount rate of 2.7% was used for this analysis, per Office of Management and Budget (OMB) Circular A-94.

The following five categories were used to further analyze the life cycle savings. The savings in these categories sum to the life cycle savings of the project.

1. *Project savings on external purchases*—Savings associated with the purchase of goods and services from commercial suppliers. Included in this category are costs for chemicals, new tanks and drums, motor oil, and commercial waste disposal services.

2. *Project labor savings*—Savings associated with reducing the time needed for site staff to complete their tasks. Often new technologies and procedures will reduce the labor-time needed, thus allowing staff to work on other tasks.

3. *Savings on on-site services*—Savings associated with services supplied by other organizations at DOE sites to the project. These savings include waste disposal services, analytical services, and security services.

4. *Delayed savings*—A category used to capture reductions in future (not current) work scope. For example, the project may eliminate work scope that otherwise would have become part of an environmental cleanup activity.

5. *No cost savings*—This category is used for projects that have not been completed or have not produced cost savings.

- **ROI (%)** — A formula established by DOE to measure return on investment. It places emphasis on first-year savings. An ROI of 181, for example, would be interpreted as "the project returns 1.8 times more in savings in the first year than the project implementation cost." P2 coordinators use the ROI to estimate the time to pay back the initial P2 investment.

- **Life cycle savings per dollar invested (%)** — This criterion represents a second way to assess the financial merit of a project by calculating the life cycle savings per dollar invested in the project. Unlike the ROI criterion, this criterion encompasses all cost savings accrued over the lifetime of the project. A number such as 1427 would be interpreted as "the project returns 14.27 times more in savings over the lifetime of the project than the project implementation cost."

2.2 NON-MONETARY EVALUATION CRITERIA

In addition to financial measures, the projects were evaluated on the following non-monetary attributes: pollution/waste prevented, environmental impacts, public and worker health and safety, and programmatic impacts. Definitions for each criterion and explanations of how each is implemented follow.

- **Pollution/waste prevented** — Did the project reduce the amount of pollutants released into the environment? If so, by how much? The approach to implementing this criterion was to specify seven subcriteria. The first six refer to types of wastes [mixed, hazardous, low-level (LLW), transuranic, TSCA, and sanitary] that could have been released into the environment. A seventh category labeled "other" was included as a placeholder to include unique P2 consequences of alternatives, such as those that may be related to energy conservation. P2 projects were evaluated based on the quantity and type of waste they avoided.

- **Environmental impacts** — A criterion used to capture all other potential impacts a P2 project may have upon the environment. These include direct impacts on the site environment (e.g., the project reduces tritium released into the groundwater at the site) as well as secondary effects (e.g., reducing the need to manufacture new materials or products). The approach to implementing this criterion was to specify five subcriteria. Specifically, an alternative was assessed as to its consequences upon greenhouse gas emissions, air quality, drinking-water quality, land use, and biodiversity. The evaluation of each P2 project was based on the improvement in environmental impacts relative to the status quo absent the P2 project.

- **Public and Worker Health and Safety Impacts** — A criterion used to capture the changes in risk to public and worker health and safety directly attributable to a P2 project. This encompasses the risk to the total exposed population from both radiological and nonradiological causes (e.g., chemical exposure, transportation accidents, and occupational accidents).

- **Programmatic Impacts** — A criterion to capture the relationships between a P2 project and institutional issues of importance to program managers. Included in this category are factors such as improved ability to meet regulatory commitments and carry out specified procedures, improved productivity of staff (e.g., through reduced regulatory compliance record-keeping and reduction in time needed to complete tasks), potential for replicability at other sites, and improved competitiveness or effectiveness of the program.

3. LIFE CYCLE ANALYSIS

3.1 ANALYSIS OF COST SAVINGS

Table 1 summarizes the cost information about each of 13 projects. Details on the cost analysis are provided in Attachment 2. As can be seen in Table 1, project life ranges from 0 to 20 years. Implementation cost ranges from $2,000 to $233,000, with an average of $46,600 and a total expenditure of $606,000. Life cycle savings ranged from 0 to $22.3M, with an average of $2.3M, and a combined life cycle savings of $30M. Overall, these results indicate that P2 projects yield high returns: 50 times the initial investment was saved by these 13 P2 projects.

P2 projects perform better than expected

Number of projects that estimated ROI	11
Average ROI from project proposal	558%
Average actual ROI	611%

As seen in the ROI columns of Table 1, the cost savings reported herein are, in most cases, greater than those initially estimated by the projects. For 8 of the 11 projects that estimated the ROI in the project proposal, the ROI as determined through our interviews exceeded the ROI in the project proposal. In some cases, the improvement was due to increased throughput (e.g.,analyzing more samples than anticipated) or finding additional uses for the new equipment. In other cases, project managers had under-estimated the ROI by not including the total benefits of their actions, but only the benefits to their projects. The fact is that many project benefits accrue to other organizations or programs. For example, project managers in OR do not always include in their P2 project assessments the cost savings and other benefits of reducing generation and disposal of wastes because their projects are not always charged for waste disposal services. Likewise, the ETTP Substitution of Poly Tanks Project did not take credit for providing tanks to another project, an action that directly prevented the recipient

project from incurring a cost. Materials accounting such as that conducted for this study — tracking the physical flow of materials into, through, and out of a facility — can improve savings analyses.

Most of the cost savings are realized as reductions in demand for on-site services such as waste management (see Fig. 1). Of the $30 million savings, the preponderance—$27 million (90%)—is in on-site services, with $2.6 million (8.6%) in labor and $419,000 (1.4%) in avoided purchases from commercial vendors. The delayed savings category — used to capture reductions in future (not current) work scope — is not shown in Table 1 because none of the 13 projects showed savings in this category.

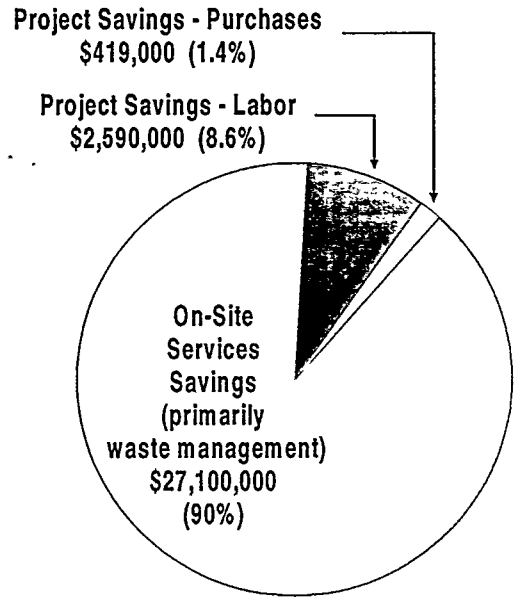

Fig. 1. Most of the cost savings occur as avoided waste management costs, not as direct savings to the project.

Since on-site services comprise the majority of the cost savings, that category merits further scrutiny. Of the reductions in on-site services costs, almost all is avoided waste management costs. RL and OR cost estimates were used to estimate the avoided waste management costs. These waste management savings are not seen immediately, for two reasons.

- First, waste management organizations tend to have a backlog of work and are receiving wastes from many different projects, so their work level (and funding level) is not typically reduced if a project does not send the expected quantities in a given year. Reducing waste quantities will allow the facility to work off its backlog more quickly; direct cost savings may not be seen until that time.
- Second, waste management facility costs consist of both a fixed-cost element and a variable-cost element. If generators produce less waste than expected, the variable-cost component is reduced, but in the near-term the fixed costs are unchanged.

While some of these on-site services costs may be charged back to the generator organization, typically the large fixed costs associated with waste management facilities are paid by the Office of Waste Management (EM-30) and not charged to projects.

P2 projects are like preventive maintenance — DOE spends money now to avoid large expenditures in the future

However, possibly the greatest cost impact of avoided waste quantities is not in these near-term savings but rather occurs in the future, as the Department is spared from having to build new disposal cells, waste treatment facilities, and storage units. In a real sense, P2 projects are like preventive maintenance — DOE spends money now to avoid large expenditures in the future. The estimates of avoided waste management costs include the avoided operating costs associated with waste management; they do not include all of the fixed costs associated with constructing these facilities. Consequently, the true benefit of P2 investments may be significantly larger than reported here, as the Department is spared the cost of building new waste management facilities in the future.

Table 1. P2 project costs and savings

Project name	Project life (years)	Implementation cost ($1000)	Life cycle savings ($1000)	Life cycle savings per $ invested (%)	Life cycle savings: Project savings--purchases ($1000)	Life cycle savings: Project savings--labor ($1000)	Life cycle savings: On-site services savings ($1000)	Life cycle savings: No cost savings	ROI: ROI-project proposal (%)	ROI: ROI-this study[a] (%)
ORNL Cyanide by MIDI Distillation Upgrade	15	48.8	766	1,570	-50.6	810	7.1		154	174
ORNL Mercury Analyzer Upgrade	15	22.5	349	1,550	-21.4	342	28.2		109	120
ETTP Purchase Data Security Degausser	10	27.8	274	987	255	11.1	8.11		52	108
ETTP Substitution of Poly Tanks for Drums to Collect Acids	2	21.4	105	489	-9.6	14.1	100		155	279
Y-12 Source Reduction of Heavy Equipment Oils	0	37.1	<0[b]	N/A	0	0	0	X	281	-100
RL Basin Overflow Retention Tank	4	13.1	1,450	11,000	0	660	787		1,590	2,760
RL TWRS Evaporator Modification	11	233	22,300	9,600	0	-253	22,600		370	764
RL Mixed Waste Rain Curtain	7	149	791	532	-39.8	95.6	735		1691	115
RL Isolate Diversion Box	10	17.5	3,410	19,500	0	677	2,736		1,356	2,100
PNNL Microconcentric Nebulizer	10	2	3.0	150	-2.0	0	5.0		na[c]	18[c]
RL Eliminate Solid Waste Stream with Treatment and Recycling	20	5.6	296	5,290	88.6	195	12.5		99	324
RL In-Line Solvent Recovery	10	21.6	48.9	226	-6.6	8.0	47.5		276	75
PNNL Metallography Photochemical Reduction	6	6.7	249	3,720	205	30.4	13.4		na[c]	650[c]
TOTAL	—	606	30,000	—	419	2,590	27,100	—	—	—
AVERAGE	9.2	46.6	2,310	4,200	32.2	199	2,080	—	558	611

[a] Calculations are presented in Attachment 2.

[b] Not quantified.

[c] PNNL internally funded projects; not funded through the ROI program. Not included in ROI average.

Table 1 also presents two additional financial metrics, the ROI and an analogous statistic based on life cycle savings (see Sect. 2 for definitions). The ROIs range from 18% to 2760%. The life cycle savings per dollar invested ranges from 150% to 19,500%. Note the large discrepancy between the life cycle savings per dollar invested and the ROI calculation. This is because the ROI calculation does not take into consideration project life, whereas the life cycle cost calculation does consider (discounted) savings over the total life of the project. The ROI is used to estimate the return in the first year and the time to pay back the initial investment. It does not provide the total return over the life of the project. Thus, the life cycle savings figure of merit provides a truer picture of the financial value of the project. To be sure, the life cycle cost, in itself, does not tell the entire story because it fails to incorporate difficult-to-quantify costs and benefits. To address this, we assessed the non-monetary benefits of each project. This is discussed in the next section.

3.2. ASSESSMENT OF NON-MONETARY BENEFITS

Table 2 summarizes the waste avoidance of the 13 P2 projects, and Table 3 summarizes the assessment of the projects over the four non-monetary evaluation criteria presented in Sect. 2. The projects prevent the disposal of a significant amount of waste. Several projects show positive environmental impacts, for example, reducing release of tritium into groundwater. Several projects show positive health and safety impacts, primarily by reducing exposure of staff to hazardous and radioactive materials and secondarily through safer technologies and procedures. In addition, several projects show positive programmatic impacts, for example making it possible to meet Tri-Party Agreement milestones.

Table 2. Reduced waste generation resulting from 13 P2 projects

Waste Stream	Waste Reduction
Mixed Low Level	260,000 gal/year
Low Level	460 cubic feet/year
Hazardous	460 gal/year
Sanitary Classified	20 cubic feet/year
Sanitary	4,100 gal/year

3.3 SUMMARY OF LIFE CYCLE ANALYSIS

The results of the life cycle analysis are summarized in Table 4. Table 4 depicts two financial criteria — implementation cost and life cycle savings — and the four non-monetary criteria. The latter are represented graphically to provide a more visual and intuitive method for understanding the assessment results. A guide to the ratings is provided in Attachment 3. Except for the one failed project, the life cycle analysis indicates that not only did the remaining projects provide substantial financial returns, but also in every case provided positive non-monetary benefits as well.

Table 3. Assessment of non-monetary benefits of P2 projects

Project name	Pollution/waste prevented	Environmental impacts	Health and safety impacts	Programmatic impacts
ORNL Cyanide by MIDI Distillation Upgrade	90 gal of hazardous waste per year	No impact	Less worker exposure; automated process reduces handling	Analysis time cut in half; currently being used for P2 applications for phosphate and ammonia, which were outside the original scope of the project
ORNL Mercury Analyzer Upgrade	624 L liquid LLW per year	No impact	Less technician exposure to radiation. safer machine to service	Analysis time cut in half, throughput capability increased, and instrument sensitivity improved
ETTP Purchase Data Security Degausser	481 kg classified sanitary waste per year	Reduced emissions from burnhouse: reduced need to manufacture storage media	No impact	Improves adherence to security procedures
ETTP Substitution of Poly Tanks for Drums to Collect Acids	2630 kg solid LLW per year	No impact	Less chance of radiation exposure	Less staff time needed for sampling, management, and staging. Tanks are being reused by other programs.
Y-12 Source Reduction of Heavy Equipment Oils	No benefit: Created additional leaking oil	No benefit: Created additional leaking oil	No benefit: Created additional leaking oil	Project led to used oil recycling program that is currently recycling 100% of the oil
RL Basin Overflow Retention Tank	1200 gal LLW per year 24 drums LLW per year	No impact	Less worker exposure to LLW and occupational hazards	Made it possible to meet Tri-Party Agreement milestone
RL TWRS Evaporator Modification	370 m^3 liquid mixed LLW per year	Reduced river water use, reduced fish kill, reduced chemical use, and reduced release of Tritium	Less worker radiation; less chemical exposure	Made it possible to meet Tri-Party Agreement milestone
RL Mixed Waste Rain Curtain	160.000 gal leachate per year for 5 years (mixed LLW)	Prevent failure of trench	Less radiological and chemical exposure	Extended life of trench; prevented occurrences and associated costs
RL Isolate Diversion Box	3000–5000 gal process waste water per year (mixed LLW)	No impact	Less worker exposure	Strengthened regulator support
PNNL Microconcentric Nebulizer	50 L LLW per year	Less need for chemicals	Less worker exposure	No impact

Table 3 (continued)

Project name	Pollution/waste prevented	Environmental impacts	Health and safety impacts	Programmatic impacts
RL Eliminate Solid Waste Stream with Treatment and Recycling	4,100 gal sanitary waste plus 300 gal hazardous waste per year	Less need for new oil and absorbent	Less worker exposure	Strengthened regulator support
RL In-Line Solvent Recovery	48 kg hazardous waste per year	Less need for new solvent	Less worker exposure	Reduced sample preparation time
PNNL Metallography Photochemical Reduction	200 kg hazardous waste per year	Reduced chemical need	Reduced chemical exposure	Improved productivity; improved information sharing

Table 4. Life cycle analysis reveals that P2 projects produce significant financial and non-monetary rewards

Project Name	Implementation Cost ($1000s)	Life Cycle Savings ($1000s)	Pollution/ Waste Prevented	Environmental Impacts	Health and Safety	Programmatic Impacts
ORNL Cyanide by MIDI Distillation Upgrade	49	766	Some improvement	No change relative to baseline approach	Some improvement	Major improvement relative to baseline approach
ORNL Mercury Analyzer Upgrade	23	349	Some improvement	No change relative to baseline approach	Some improvement	Major improvement relative to baseline approach
ETTP Purchase Data Security Degausser	28	274	Some improvement	Some improvement	No change relative to baseline approach	Some improvement
ETTP Substitution of Poly Tanks for Drums to Collect Acids	21	105	Some improvement	No change relative to baseline approach	Some improvement	Major improvement relative to baseline approach
Y-12 Source Reduction of Heavy Equipment Oils	37	<0 [a]	Somewhat worse than baseline	Somewhat worse than baseline	Somewhat worse than baseline	Some improvement
RL Basin Overflow Retention Tank	13	1,450	Some improvement	No change relative to baseline approach	Major improvement relative to baseline approach	Major improvement relative to baseline approach
RL TWRS Evaporator Modification	233	22,300	Major improvement relative to baseline approach	Major improvement relative to baseline approach	Some improvement	Major improvement relative to baseline approach
RL Mixed Waste Rain Curtain	149	791	Major improvement relative to baseline approach	Some improvement	Some improvement	Major improvement relative to baseline approach
RL Isolate Diversion Box	18	3,410	Major improvement relative to baseline approach	No change relative to baseline approach	Some improvement	Some improvement
PNNL Microconcentric Nebulizer	2	3.0	Some improvement	Some improvement	Some improvement	No change relative to baseline approach
RL Eliminate Solid Waste Stream with Treatment and Recycling	5.6	296	Some improvement	Some improvement	Some improvement	Some improvement
RL In-Line Solvent Recovery	22	49	Some improvement	Some improvement	Some improvement	Some improvement
PNNL Metallography Photochemical Reduction	6.7	249	Some improvement	Some improvement	Some improvement	Some improvement

Key: Project produced:

- Major improvement relative to baseline approach
- Some improvement
- No change relative to baseline approach
- Somewhat worse than baseline
- Major decline relative to baseline approach

a Not quantified

4. ASSESSMENT OF MANAGEMENT PROCESS

Both the Oak Ridge and the Richland Operations Offices have developed successful grassroots programs using streamlined processes which could serve as examples for the DOE complex. Dedicated teams administer the effort, champion the program, and assist generators in identifying P2 opportunities. Figure 2 provides a simplified view of Richland's ROI management process.

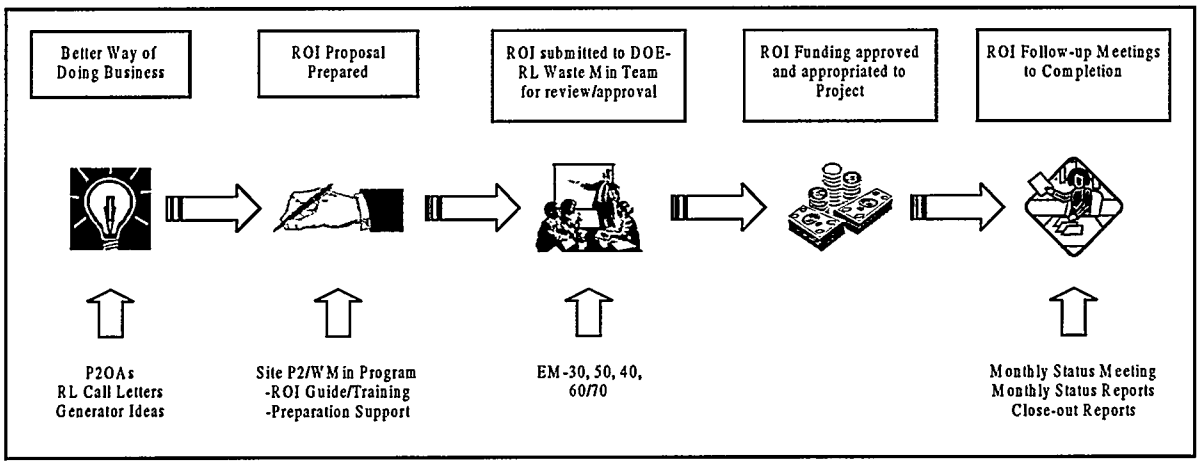

Fig. 2. Richland's ROI management process.

The P2 program has identified several elements of a successful DOE P2 ROI program. Some of the key elements are summarized in Fig. 3.

Fig. 3. Success factors for a successful DOE pollution prevention ROI program.

- Manage the program at the grassroots level in the field. Operate the program as an employee suggestion program.
- Set aside a separate source of funds from which the winning proposals are funded.
- Minimize paperwork burden. Provide simple proposal preparation guidelines and assist employees in preparing proposals. Provide tables that summarize site costs for waste, utilities, labor, materials, etc., to assist in determining life cycle savings.
- Integrate P2 education into the existing work structure (e.g., integrate with the ALARA program, NEPA program, energy efficiency program, training program, chemical management system, etc.)
- Identify a project champion — an essential ingredient in project success.
- Recognize employees for their efforts.
- Establish a simple, streamlined tracking system to monitor project progress and provide closure by confirming the savings.

Key management issues that were identified include the following:

- Project managers do not see all the benefits of P2 opportunities; the ROI program looks past organizational "stovepipes" to fund projects that are cost-effective from the standpoint of DOE and taxpayers. Often costs and benefits cross organizational or project boundaries. For example, the OR projects reviewed do not pay for disposal of the waste they generate. Therefore, the implementing project would see the cost of waste-reducing activities, but not the benefits. As a result, projects sometimes do not have sufficient incentive and/or access to funding to implement P2 opportunities if the funding must come from their direct program budgets. The ROI program serves to bridge the gap whenever there are stovepipes that cause costs to accrue to one account and savings to be realized by another account. A common example of this is a generating organization realizing the cost of waste avoidance and a waste management organization realizing the savings.

- P2 staff stated the importance of having National Program funding that could not be taken for other site needs; without dedicated ROI funding, many of these projects would not be implemented. They stated two key reasons for this:

  - Lack of regulatory or other drivers. Absent separate P2 funding, P2 projects must compete for funding with other site priorities. In this funding competition, "cost-effectiveness" loses out to "compliance-driven" projects and other mission needs.

  - Lack of management discretion. Project managers sometimes do not have management discretion to fund P2 projects within their project budget. In some cases, time constraints play a role. The project budget is fully committed for the year, and the manager has no discretionary funds. In other cases, the P2 projects require capital investments that projects sometimes cannot justify through routine maintenance and normal capital equipment requests.

- Non-monetary benefits of P2 projects, such as protection of natural resources, are typically not fully considered in decision-making. (In fact, the P2 ROI selection process is not structured to include questions related to benefits in the areas of health and safety, the environment, or programmatic impacts.) It is recommended that health and safety, environmental, and programmatic benefits be considered. In addition, it is recommended that, whenever possible, *actual quantities* of waste reduction be considered, rather than *percentage reductions* in current waste streams (as is done in OR). Attachment 3 provides an example of how these recommendations might be accomplished.

- We have two cautions on the use of the ROI formula developed by DOE:

  - The ROI formula does not work well in all cases. Examples include projects with a one-time savings, projects in which annual operating costs vary from year to year, and projects for which the significant operating cost savings are delayed. For example, consider a project that makes it possible to avoid a large one-time capital expenditure, with no effect on operating cost. If the ROI formula is blindly applied, the ROI would be negative and the project would not be funded. It must be emphasized that neither OR nor RL blindly applies the ROI formula. Both sites have attained the sophistication to break from rigid criteria when the situation warrants. However, less sophisticated people do struggle with cases for which the ROI formula is not well suited, and all sites should be cautioned not to blindly apply the formula.

- The ROI formula is used to estimate the first-year return and the time required to recover the initial investment. It does not provide information about the total return to the government over the total project life. Consider two projects: one with a life of 3 years, the second with a life of 30 years. Each requires an initial investment of $10,000 and saves $20,000 per year. The first project has an ROI of 167%; the second has an ROI of 197%, hardly different. Yet (neglecting discounting for this simple example) the first saves $50,000 over the project life; the second project saves $590,000, over half a million dollars more!

The life cycle savings figure of merit (reported in Table 1) is not susceptible to either of these problems and for this reason is recommended.

- A graded approach to project analysis and documentation is needed so that the time requirement is commensurate with the size and scope of the project. Excessive documentation can be a disincentive to participation in the ROI program. Both Oak Ridge and Richland have taken steps to streamline the process to reduce the administrative burden.

- The ROI program is changing the mind-set of site personnel. In addition to the reported benefits, P2 projects have produced unreported spinoff benefits because site personnel have developed the habit of looking for P2 opportunities. During the project interviews, several project managers discussed additional P2 ideas that were implemented -- for instance, recycling acid used to clean glassware, changing analytical techniques to reduce waste and manpower requirements, and recycling used transformers. Individuals, having developed the habit of looking for P2 opportunities, were implementing such changes in other aspects of their work. These spinoff benefits were not being documented in the P2 reporting system because personnel "don't want to stop working to document it." Although an analysis of these spinoff benefits is beyond the scope of this study, they seem to be a real benefit of the program.

In addition, we have an observation: there is an intentional bias toward near-term savings in the project selection process and a bias against projects that show no savings until the outyears. For example, RL told us that the selection process is biased against funding studies that could pay off in the future as reduced environmental cleanup costs. They view that as a programmatic initiative that the program should fund itself.

5. ACKNOWLEDGMENTS

We wish to acknowledge the excellent cooperation provided by the following P2 coordinators: David Wasserman, ORNL; Sheila Poligone, Y-12; and Anna Beard and Donna Merry, Richland.

Attachment 1. The Sixteen P2 Projects Selected for Assessment

The 16 randomly selected projects are listed in the table below. This report focuses on the first 13 projects listed, all of them completed projects for which we conducted interviews.

	Site	Project	Status
1	OR	ORNL Cyanide by MIDI Distillation Upgrade	Full implementation awaiting Utah certification approval; currently being used for P2 applications for phosphate and ammonia, which were outside the original scope of the project.
2	OR	ORNL Mercury Analyzer Upgrade	Complete
3	OR	ETTP Purchase Data Security HD-2000 Degausser	Complete
4	OR	ETTP Substitution of Poly Tanks for Drums to Collect Acids	Complete
5	OR	Y-12 Source Reduction of Heavy Equipment Oils	Technology failed in field use. However, the project led to discovery of a new way to recycle 100% of the oil.
6	RL	Basin Overflow Retention Tank	Complete
7	RL	Tank Waste Remediation System 242-A Evaporator Modification	Complete
8	RL	Mixed Waste Rain Curtain	Complete
9	RL	Isolate 151S Diversion Box	Complete
10	RL	Microconcentric Nebulizer	Complete
11	RL	Eliminate Solid Waste Stream with Treatment and Recycling	Complete
12	RL	In-Line Solvent Recovery	Complete
13	RL	Metallography Photochemical Reduction	Complete
14	OR	ORNL Digital Conversion in Materials Analysis Labs	Complete; no project interview conducted
15	OR	ORNL Better Orange & KeMac TL3 Aqueous Parts Washer	Incomplete; equipment not installed
16	OR	ETTP Direct Injection Nebulizer	Incomplete; scheduled for completion 12/99

Attachment 2. Life Cycle Cost Analysis of Projects

Project Title	RL In-Line Solvent Recyling
Pollution Prevented:	477.8 kg Haz waste total
Implementation Cost ($)	21,600
Project Life (years)	10
P2 Project Description	The purpose of the project was to allow reuse of recovered solvent resulting from high performance liquid chromatograph work int helaboratory and to achieve pollution prevention through reuse of solvent that would normally be disposed of as waste.
Year Initiated	1995

Annual Expenditures (Constant $)

Base Case	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Sum	Present Value in 1999
External purchases	3,215	3,215	1,608	643	643	643	643	643	643	643		12,539	$12,726
Labor	6,117	6,117	3,059	1,223	1,223	1,223	1,223	1,223	1,223	1,223		23,856	$24,213
Waste Management	27,585	27,585	13,793	5,517	5,517	5,517	5,517	5,517	5,517	5,517		107,582	$109,192
													$0
													$0
													$0
Total Base Case	36,917	36,917	18,459	7,383	7,383	7,383	7,383	7,383	7,383	7,383		143,976	$146,132

Net Present Value in 1999, Base Case $146,132

P2 Project:													
External purchases	12,866	1,866	933	373	373	373	373	373	373	373		18,277	$19,340
Labor	11,780	1,180	590	236	236	236	236	236	236	236		15,202	$16,190
Waste Management	15,587	15,587	7,794	3,117	3,117	3,117	3,117	3,117	3,117	3,117		60,789	$61,699
Analytical Services													$0
Other:													$0
													$0
Total P2 Project	40,233	18,633	9,317	3,727	3,727	3,727	3,727	3,727	3,727	3,727		94,269	$97,229

Net Present Value in 1999, P2 Project $97,229

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $48,903

Life Cycle Cost Savings per $ Invested = 226%

ROI Estimated by this Study 75%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title:	RL Eliminate Solid Waste Stream with Treatment and Recycling
Pollution Prevented:	4,100 gal/year sanitary waste (15.6 metric tons/year) plus 300 gal/year hazardous waste
Implementation Cost ($):	5600
Project Life (years):	20

Project Description: this project will purchase and install equipment to separate the oil component from the water matrix. This equipment will be installed at the 300 Area TEDF to provide centralized treatment for this waste stream from the entire Hanford Site. A coalescing oil removing system will be selected to ensure an oil free effluent. The oil-free effluent from the oil separator will be treated at EDF and discharged to the Columbia River under the existing NPDES permit. The oil recovered will be managed and recycled as used oil.

Year Initiated: 1997

Annual Expenditures (Constant $)

Base Case	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Sum	Present Value in 1999
External purchases	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	5672	113,440	$92,899
Labor	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	240,000	$196,542
Waste Management	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	762	15,240	$12,480
																						$0
																						$0
																						$0
Total Base Case	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	18,434	$368,680	$301,922
																					Net Present Value in 1999, Base Case	$301,922
P2 Project:																						
External purchases	4135																				4,135	$4,310
Labor	1465																				1,465	$1,527
Waste Management																						$0
Analytical Services																						$0
Other:																						$0
																						$0
Total P2 Project	5,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,600	$5,838
																					Net Present Value in 1999, P2 Project	$5,838

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	$296,084	ROI Estimated by this Study	624%
Life Cycle Cost Savings per $ Invested =	$287%		

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title	RL RMW Rain Curtain
P2 Project Description	Design and procure a rain collection system that will collect rain water prior to it contacting waste in a mixed waste trench and becoming regulated leachate.
Pollution Prevented:	FY2000-2004: base case: 200,000 gal/year P2 project: 40,000 gal/year
Implementation Cost ($)	148,500
Project Life (years)	7
Year Initiated	1998

Annual Expenditures (Constant $)

Base Case:	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Sum	Present Value in 1999
External purchases (rent tanker)	12,000	12,000	12,000	12,000	12,000	12,000	12,000					84000.00	$79,268
Labor	20,000	20,000	22,000	22,000	22,000	22,000	22,000.					150000.00	$141,332
Waste Management	0	0	200,000	200,000	200,000	200,000	200,000					1000000	$918,443
													$0
													$0
													$0
Total Base Case	32,000	32,000	234,000	234,000	234,000	234,000	234,000	0	0	0	0	1,234,000	$1,139,063
												Net Present Value in 1999, Base Case	$1,139,063

P2 Project:	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Sum	Present Value in 1999
External purchases	116,650	0	0	0	0	0	0					116650.00	$119,100
Labor	33,850	2,000	2,000	2,000	2,000	2,000	2,000					45850.00	$46,734
Waste Management	0	0	40,000	40,000	40,000	40,000	40,000					200000.00	$189,689
Analytical Services													$0
Other:													$0
													$0
Total P2 Project	150,500	2,000	42,000	42,000	42,000	42,000	42,000	0	0	0	0	362,500	$348,522
												Net Present Value in 1999, P2 Project	$348,522

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $790,541

Life Cycle Cost Savings per $ Invested = 532%

ROI Estimated by this Study 116%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title: ORNL Mercury Analyser Upgrade

P2 Project Description: Replace the current mercury analyzer equipment with a new CETAC M-6000A mercury analyser. This new equipment will reduce waste by 50% and manpower by one-half.

Pollution Prevented: 624 L/yr of Liquid Low Level Waste (LLW)

Implementation Cost ($): 22,541

Project Life (years): 15

Year Initiated: 1997

Annual Expenditures (Constant $)

Base Case	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Sum	Present Value in 1999
External purchases	763	763	763	763	763	763	763	763	763	763	763	763	763	763	763		11,445	$9,967
Labor	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997	51,997		779,960	$679,210
Waste Management	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241	3,241		48,609	$42,330
																		$0
																		$0
																		$0
Total Base Case	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	56,001	0	840,014	$731,506

Net Present Value in 1999, Base Case: $731,506

P2 Project																		
External purchases	21,304	763	763	763	763	763	763	763	763	763	763	763	763	763	763		31,966	$31,379
Labor	27,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637	25,637		396,552	$336,963
Waste Management	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080		16,203	$14,110
																		$0
																		$0
																		$0
Total P2 Project	50,021	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	27,480	0	434,741	$382,452

Net Present Value in 1999, P2 Project: $382,452

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $349,054

Life Cycle Cost Savings per $ Invested = 1549%

ROI Estimated by this Study: 120%

Real Discount Rate: 2.7%

Price Escalation: 2.1%

Project Title	PNNL Microconcentric Nebulizer
P2 Project Description	For ICPMS analysis of rad material, they currently aspirate samples at a rate of 1 mL/min. They typically request a volume of 5-10mLs of sample from the client. The microconentric nebulizer aspirates samples at a rate of only 0.1 mL/min.
Pollution Prevented:	Base Case: 60 L LLW/year P2 Project: 10 L LLW/year Savings = 50 L LLW/year
Implementation Cost ($)	2,000
Year Initiated	1998
Project Life (years)	10

Annual Expenditures (Constant $)

Base Case:	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Sum	Present Value in 1999
External purchases												$0
Labor												$0
Waste Management - Handling	66	66	66	66	66	66	66	66	66	66	660	$599
Waste Management - Disposal	600	600	600	600	600	600	600	600	600	600	6,000	$5,450
Analytical Services												$0
												$0
Total Base Case	666	666	666	666	666	666	666	666	666	666	6,660	$6,049

Net Present Value in 1999, Base Case $6,049

P2 Project:												
External purchases	2000										2,000	$2,042
Labor												$0
Waste Management - Handling	11	11	11	11	11	11	11	11	11	11	110	$100
Waste Management - Disposal	100	100	100	100	100	100	100	100	100	100	1,000	$908
Analytical Services												$0
												$0
Total P2 Project	2,111	111	111	111	111	111	111	111	111	111	3,110	$3,050

Net Present Value in 1999, P2 Project $3,050

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $2,999

Life Cycle Cost Savings per $ Invested = 150%

ROI Estimated by this Study 18%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title:	PNNL Metallography Photochemical Reduction
Pollution Prevented:	Project prevents 200 kg Haz/year
Implementation Cost ($)	6695
Project Life (years)	6
P2 Project Description	Current practice for metallography is to develop negatives and print micrographs for clients. Investing in a Closed Circuit Digital cameral for the metallograph would allow the image to be electronically stored. The image could either be sent to the client electronically or printed on a photo quality printer that does not produce any hazardous waste.
Year Initiated	1998

Annual Expenditures (Constant $)

Base Case:	1998	1999	2000	2001	2002	2003	Sum	Present Value in 1999
External purchases	37,000	37,000	37,000	37,000	37,000	37,000	222,000	$212,277
Labor	5,300	5,300	5,300	5,300	5,300	5,300	31,800	$30,407
Waste Management	2,340	2,340	2,340	2,340	2,340	2,340	14,040	$13,425
Analytical Services								$0
								$0
								$0
Total Base Case	44,640	44,640	44,640	44,640	44,640	44,640	267,840	$256,109

Net Present Value in 1999, Base Case $256,109

P2 Project:								
External purchases	6,695						6,695	$6,836
Labor								$0
Waste Management								$0
Analytical Services								$0
								$0
								$0
Total P2 Project	6,695	0	0	0	0	0	6,695	$6,836

Net Present Value in 1999, P2 Project $6,836

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $249,273

Life Cycle Cost Savings per $ invested = 3723%

ROI Estimated by this Study 650%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title	RL 242-A Evaporator Modification
Pollution Prevented:	Prevents 370 cubic meters of liquid mixed low-level waste per year
Implementation Cost ($)	232,700
Project Life (years)	11
P2 Project Description	the 242-A Evaporator facility is used to reduce the volume of mixed waste stored in the Hanford double-shell tanks by separating the mixed waste into two waste streams. The purpose of the evaporator modificatin is to replace the introduction of filtered raw water by recycling a portion of the process condensate stram. Process condensate will be pumped from the process condensate collection tank to the intake of the filtered raw system that feeds these two systems, thereby reducing the volume of waste stream produced.
Year Initiated	1995

Annual Expenditures (Constant $)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Sum	Present Value in 1999
Base Case:													
External purchases													$0
Labor													$0
Waste Management	1,800,000	3,570,000	3,570,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	23,340,000	$22,596,239
(this number is the net savings - i.e.,													$0
the difference bet. Base and P2 Project)													$0
													$0
Total Base Case	1,800,000	3,570,000	3,570,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	23,340,000	$22,596,239
												Net Present Value in 1999, Base Case	$22,596,239
P2 Project:													
External purchases													$0
Labor	232,700											232,700	$252,871
Waste Management													$0
Analytical Services													$0
Other:													$0
													$0
Total P2 Project	232,700	0	0	0	0	0	0	0	0	0	0	232,700	$252,871
												Net Present Value in 1999, P2 Project	$252,871

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $22,343,368

Life Cycle Cost Savings per $ Invested = 9602%

ROI Estimated by this Study 764%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title: RL 327 Basin Overflow Retention System

P2 Project Description: Provide proceduralized use of moving liquid from the 327 basin into 55 gallon drums during evolutions that will cuase an overflow from the 327 waster basin. Once the overflow conditions are returned to normal the liquid is put back into the water basin.

Pollution Prevented: 1200 gallons of liquid LLW per year
24 drums LLW per year

Implementation Cost ($): 13,100

Project Life (years): 4

Year Initiated: 1997

Annual Expenditures (Constant $)

Base Case:	1997	1998	1999	2000	2001	2002	Sum	Present Value in 1999
External purchases								$0
Labor	168,000	168,000	168,000	168,000			672,000	$673,376
Waste Management	197,544	197,544	197,544	197,544			790,176	$791,794
								$0
								$0
								$0
Total Base Case	365,544	365,544	365,544	365,544	0	0	1,462,176	$1,465,170

Net Present Value in 1999, Base Case $1,465,170

P2 Project:								
External purchases								$0
Labor	13,100						13,100	$13,656
Waste Management	1,200	1,200	1,200	1,200			4,800	$4,810
Analytical Services								$0
Other:								$0
								$0
Total P2 Project	14,300	1,200	1,200	1,200	0	0	17,900	$18,466

Net Present Value in 1999, P2 Project $18,466

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $1,446,705

Life Cycle Cost Savings per $ Invested = 11044%

ROI Estimated by this Study 2766%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title	ORNL Cyanide by MIDI Distillation Upgrade
Pollution Prevented:	90 gal/yr Liquid Hazardous Waste
Implementation Cost ($)	48,815
Project Life (years)	15
P2 Project Description	Replace the current analyser for cyanide with the Midi distillation and flow injection anlaysor . Changing this equipment will reduces waste generated by 90% and operator time will be reduced by one-half. Due to problems having this new method of analysis approved, the equipment is currently being used to help in the analysis of Nh3 & TPO4
Year Initiated	1996

Annual Expenditures (Constant $)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum	Present Value in 1996
Base Case:																		
External purchases				1,350													1,350	$1,350
Labor	153,022	153,022	153,022	91,608	91,608	91,608	91,608	91,608	91,608	91,608	91,608	91,608	91,608	91,608	91,608		1,559,362	$1,413,734
Waste Management	661	661	661	661	661	661	661	661	661	661	661	661	661	661	661		9,915	$8,859
																		$0
																		$0
																		$0
Total Base Case	153,683	153,683	153,683	93,619	92,269	92,269	92,269	92,269	92,269	92,269	92,269	92,269	92,269	92,269	92,269		1,569,627	$1,422,943
																	Net Present Value in 1996, Base Case	$1,422,876
P2 Project:																		
External purchases	48,815																48,815	$51,955
Labor	65,331	65,331	65,331	39,116	39,116	39,116	39,116	39,116	39,116	39,116	39,116	39,116	39,116	39,116	39,116		665,365	$603,202
Waste Management	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125		1,875	$1,667
																		$0
																		$0
																		$0
Total P2 Project	114,271	65,456	65,456	39,241	39,241	39,241	39,241	39,241	39,241	39,241	39,241	39,241	39,241	39,241	39,241		716,055	$656,824
																	Net Present Value in 1996, P2 Project	$656,824

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $766,051

Life Cycle Cost Savings per $ Invested = 1569%

ROI Estimated by this Study: 174%

Real Discount Rate: 3.7%

Price Escalation: 0.1%

Project Title	Purchase of Data Security HD-2000 Degausser
P2 Project Description	Magnetic computer data storage media (8mm and 4mm tapes) will be erased with a degauser and reused instead of being disassembeled and sent to the Y-12 burnhouse.
Pollution Prevented:	481 kg//yr Classified Sanitary waste Approximately 125 ft^3/yr
Implementation Cost ($)	27,761
Project Life (years)	10
Year Initiated	1997

Annual Expenditures (Constant $)

Base Case:	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Sum	Present Value in 1999
External purchases	30,603	30,603	30,603	30,603	30,603	30,603	30,603	30,603	30,603	30,603	306,030	$263,805
Labor	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	56,000	$51,933
Waste Management - Disposal	875	875	875	875	875	875	875	875	875	875	8,750	$8,115
Analytical Services												$0
												$0
Total Base Case	37,078	37,078	37,078	37,078	37,078	37,078	37,078	37,078	37,078	37,078	370,780	$343,852

Net Present Value in 1999, Base Case $343,852

P2 Project:												
External purchases	27,761										27,761	$28,939
Labor	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	44,000	$40,804
Waste Management - Disposal												$0
Analytical Services												$0
												$0
Total P2 Project	32,161	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	71,761	$69,744

Net Present Value in 1999, P2 Project $69,744

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $274,108

Life Cycle Cost Savings per $ Invested = 987%

ROI Estimated by this Study 108%

Real Discount Rate 2.7%

Price Escalation 2.1%

Project Title	Substitution of Poly-Tanks for Drums to Collect Lab Acids	**P2 Project Description**	Twenty 300 gallon poly tanks will replace the 55 gal drums currently used to collect waste acids. Collection in these larger tanks reduces the number of samples required for characterization of the wastes. They also eliminate disposal of the drums as these tanks are recycled.
Pollution Prevented:	2630 kg/yr of solid low level waste		
Implementation Cost ($)	21,405	**Year Initiated**	1997
Project Life (years)	2		

Annual Expenditures (Constant $)

	1997	1998	1999	2000	Sum	Present Value in 1999
Base Case:						
External purchases	7,492	5,619	0	0	13,111	$13,513
Labor	11,664	8,748	0	0	20,412	$21,039
Waste Management	13,168	9,800	0	0	22,968	$23,674
Analytical Services	43,000	32,300	0	0	75,300	$77,611
Recycling costs	7,438	5,579	0	0	13,017	$13,416
			0	0		$0
Total Base Case	82,762	62,046	0	0	144,808	$149,253
					Net Present Value in 1999, Base Case	$149,253
P2 Project:						
External purchases	21,859	341	0	0	22,200	$23,182
Labor	3,856	2,892	0	0	6,748	$6,955
Waste Management	169	127	0	0	296	$305
Analytical Services	7,800	6,000	0	0	13,800	$14,221
Total P2 Project	33,684	9,360	0	0	43,044	$44,614
					Net Present Value in 1999, P2 Project	$44,614

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	$104,639	**ROI Estimated by this Study**	278%
Life Cycle Cost Savings per $ Invested =	489%		

Real Discount Rate	2.7%
Price Escalation	2.1%

Project Title	RL Isolate 151-S Diversion Box
Pollution Prevented:	3000-5000 gal/year liquid mixed waste
Implementation Cost ($)	17,500
Project Life (years)	10
P2 Project Description	Precipitation accumulates in 151-S Diversion box located in Tank Farms. If the diversion box was not sealed to prevent precipitation accumulation, 151-S would have to be pumped and theliquid disposed of as radioactive mixed waste. Jumpers stored in 150-S are identified as ancillary equipment and will remain until the double shell tank closure. The structure was sealed with a foam preventing seepage until the structure is to be opened for retrieval of the jumpers.
Year Initiated	1997

Annual Expenditures (Constant $)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Sum	Present Value in 1999
Base Case:													
External purchases													$0
Labor	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000		750,000	$695,531
Waste Management	295,000	295,000	295,000	295,000	295,000	295,000	295,000	295,000	295,000	295,000		2,950,000	$2,735,756
													$0
													$0
													$0
Total Base Case	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	0	3,700,000	$3,431,287
												Net Present Value in 1999, Base Case	$3,431,287
P2 Project:													
External purchases													$0
Labor	17,500											17500.00	$16,243
Waste Management													$0
Analytical Services													$0
Other:													$0
													$0
Total P2 Project	17,500	0	0	0	0	0	0	0	0	0	0	17,500	$16,243
												Net Present Value in 1999, P2 Project	$16,243

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) = $3,413,044 ROI Estimated by this Study 2104%

Life Cycle Cost Savings per $ Invested = 19503%

Real Discount Rate	2.7%
Price Escalation	2.1%

Attachment 3. Guide to the Ratings

This attachment discusses how to develop qualitative ratings for non-monetary evaluation criteria. In this project, all the ROI projects were assessed over four non-monetary evaluation criteria: pollution/waste prevented, environmental impacts, health and safety, and programmatic impacts. These criteria are defined in Sect. 2.2. Thirteen ROI projects were evaluated over these four criteria, as shown in Table 4. The following five category scale was used for the evaluation:

1. Major improvements relative to baseline approach
2. Some improvement
3. No change relative to baseline approach
4. Somewhat worse
5. Major decline relative to baseline approach

For example, the first project listed in Table 4 — ORNL Cyanide by MIDI Distillation Upgrade — was evaluated over each non-monetary criterion by judging which evaluation category best describes the results of the project. In this case, it was judged that this project offered "some improvement" with respect to pollution/waste prevention over the baseline case (i.e., had the project not been funded and completed). Additionally, it was judged that this project resulted in "no change relative to the baseline approach" with respect to environmental impacts, "some improvement" with respect to health and safety, and "major improvements relative to baseline approach" with respect to programmatic impacts.

How were these and the judgments about the other twelve projects made? Generally, two approaches can be used to assist in this process. One, it useful to specify criteria that would guide how to rate the projects. For example, a project that prevented X kg or more of low level waste from being generated could be judged to show "major improvements relative to baseline approach." A project that prevented between 0 and X kg of low level waste from being generated could be judged to show "some improvement."

Two, it is also useful to specify examples of projects that would fall into each rating category. These examples could be hypothetical, generated prior to assessing actual projects. One could also start by identifying projects that seem to represent the range of ratings, rate those projects, and then compare the remaining projects to these exemplars. A small group of people could be given the task of developing the set of examples and arriving at a consensus among themselves about what ratings each project should receive over each non-monetary criterion.

The amount of time devoted to one or both of these approaches by staff needs to be commensurate with the overall scope of the evaluation effort. Only a minimal amount of time is needed to specify some general criteria with respect to approach one and to rate a few examples with respect to approach two. Once actual evaluation of the projects begins, there will be enhancements to both approaches as more is learned about all the projects.

This is how we conducted the evaluation of the thirteen projects over the four non-monetary criteria. We established some general specification criteria for three of the four non-monetary criteria: pollution/waste prevention, environmental impacts, and health and safety. With respect to the first criterion, prevention of mixed waste was given priority and prevention of more than a small amount of mixed waste was rated as "major improvements relative to baseline approach." Significant direct environmental impacts, such as reducing releases to groundwater, were given primary priority with respect to environmental impacts.

Any project that resulted in the slightest improvement in health and safety was judged at least "some improvement." With respect to programmatic impacts, we identified a project that "made it possible to meet Tri-Party Agreement milestone" as the example for the "major improvements relative to baseline approach" rating. Projects that did not achieve similar impressive programmatic results but did achieve some results received the "some improvement" rating.

We worked as a team to generate the ratings and we reconsidered the ratings as appropriate. The ratings we arrived at have internal validity. This means that we feel confident that the ratings illustrated in Table 4 are defensible and that the differences in the ratings among projects over the four non-monetary criteria are justifiable. This also means that the particular approaches to the ratings developed for this project do not have external validity and should not be generalized to other projects. In other words, it may not be the case that a rating of 'major improvements relative to baseline approach" for one of the projects listed in Table 4 would be equivalent to a similar rating for a different project being evaluated in another evaluation context. External validity is an achievable goal. However, it takes agreement among all parties who will be doing evaluations about what each rating means.

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