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Illinois
Waste
Management
and Research
Center

Annual Report
Fiscal Year 1996

Waste Management and Research Center

Annual Report

Fiscal Year 1996
(July 1, 1995 - June 30, 1996)



Waste Management and Research Center
One East Hazelwood Drive, Champaign, IL 61820
217/333-8940 FAX: 217/333-8944
<http://www.hazard.uiuc.edu/wmrc/>

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WMRC's Mission

The Waste Management and Research Center (WMRC), formerly the Hazardous Waste Research and Information Center (HWRIC), was formed within the Department of Energy and Natural Resources in 1984. In July 1995 it became a Division within the Office of Scientific Research and Analysis in the Department of Natural Resources (DNR). WMRC was charged with a mission to combine research and education; information collection, analysis and dissemination; and direct technical assistance to industry, agriculture, and communities. Our name was changed in September 1996 to reflect our expanding role in helping companies wherever they are in the waste management hierarchy—from pollution prevention, to recycling, to treatment, remediation and disposal. Our emphasis remains on reducing waste at the source through pollution prevention, responsibly managing those wastes that cannot be eliminated, and increasing the efficiency and competitiveness of Illinois business. Our goal within our new agency is to preserve our natural resources by working with others to efficiently use raw materials, better manage solid and hazardous waste, and minimize toxic releases to our air and water.

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List of Abbreviations

AAR	Association of American Railroads
ACC	Activated Carbon Cloths
ACPL	Alternative Chemical Processes Laboratory
ACTL	Alternative Cleaning Technologies Laboratory
AFS	American Foundryman's Association
ANL	Argonne National Laboratory
BNRC	Board of Natural Resources and Conservation
BTEX	Benzene, Toluene, Ethylene, and Xylene
CAAA	Clear Air Act Amendments
Center	WMRC
CERL	United States Army Corps of Engineers Construction Engineering Research Laboratory
CHASE	Citizens for a Healthy and Safe Environment
COMPETE	The Coalition for Manufacturing Performance Through Technology
CMC	Chicago Manufacturing Center
CMP	Clean Manufacturing Program
CRGCP	Central Regional Groundwater Protection Committee
DCCA	Department of Commerce and Community Affairs
DNR	Department of Natural Resources
ENR	Department of Energy and Natural Resources
FY	Fiscal Year
GCP ³	Greater Chicago Pollution Prevention Program
GIS	Geographical Information System
GLPPC	Great Lakes Pollution Prevention Clearinghouse
GLRPPR	Great Lakes Regional Pollution Prevention Roundtable
GRF	General Revenue Fund
HML	Hazardous Materials Laboratory
HWRF	Hazardous Waste Research Fund
HWRIC	Hazardous Waste Research and Information Center (now WMRC)
IEPA	Illinois Environmental Protection Agency
IDPH	Illinois Department of Public Health
IGIS	Illinois Geographic Information System
IMEC	Illinois Manufacturing Extension Center
IP	Illinois Power
ISP	Information Services Program
LAN	Local Area Network
LSP	Laboratory Services Program
MEC	Manufacturing Extension Center
MEP	Manufacturing Extension Program
MERTC	Manufacturing, Engineering, Research and Training Coalition
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NEWMOA	Northeast Waste Management Officials' Association
NIST	National Institute for Standards and Technology

NORBIC	North Business and Industrial Council
P2	Pollution Prevention
P ² AID	Pollution Prevention Assistance and Information Database
PI	Principal Investigator
PIE	Partnership for Industry and Ecology
PIII	Printing Industry of Illinois and Indiana
PIPP	Partners in Prevention Program
PNEAC	Printer's National Environmental Assistance Center
POTWs	Publicly Owned Treatment Works
RI/FS	Remedial Investigation/Feasibility Study
RO	Reverse Osmosis
RRT	Reduction and Recycling Techniques/Technologies
SHWEC	Solid And Hazardous Waste Education Center
TPPA	Toxic Pollution Prevention Act
TRI	Toxic Release Inventory
UIUC	University of Illinois at Urbana-Champaign
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WMI	Waste Management, Inc.
WMRC	Waste Management and Research Center (formerly HWRIC)



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Chapter 1: Introduction



The Center begins its second decade of service to the industries and citizens of Illinois as the Illinois Waste Management and Research Center (WMRC). Over the last eleven years we have grown in size and stature, and have achieved both national and international recognition. Our goal, however, is to grow slowly and purposefully, and to achieve many of our objectives through partnerships with others. Throughout this report we have attempted to express the integrated nature of our work, and the successes we have had through a variety of partnerships. It is obvious to us that the modern, complex environmental problems we face require the cooperation and coordination of specialists from many disciplines. We attempt to provide this integrated approach both within our Center, and by teaming with others outside the Center. This annual report describes the nature and extent of these collaborative efforts.

This report covers the period July 1995 through June 1996 (the Fiscal Year 1996). The focus is on the integrated nature of all of WMRC's programs to help meet our mandate of finding solutions to Illinois' waste problems.

Chapter 2 of the report presents a brief summary of each of the Center's programs and services offered. Descriptions of specific program activities can be found in previous annual reports available from WMRC's Clearinghouse (HWRIC 1994, 1995).

Chapter 3 summarizes the Center's technical assistance efforts to various groups within Illinois. The emphasis of this chapter is on WMRC's efforts to promote pollution prevention, and on the partnerships we have formed to help accomplish this.

Chapter 4 discusses our research program, both ongoing and completed projects sponsored by

the Center, as well as projects conducted by Center staff.

Chapter 5 presents information on the services and activities of the Center in northeastern Illinois, primarily in the Chicago area. WMRC's staff has continued to grow in the Chicago area, and the services we provide there have also expanded to meet the needs within this area.

Chapter 6 discusses future activities and priorities for WMRC designed to bring our state closer to the goal of a sustainable future. We have called this chapter "Sustainability Through Partnering," and we focus on how we are working with others to prevent pollution, enhance industrial productivity, and improve our environment for future generations.

The Illinois Waste Management and Research Center (WMRC) was formed within the Illinois Department of Energy and Natural Resources (ENR) as the Hazardous Waste Research and Information Center (HWRIC) in 1984. The Center became a division within ENR in 1990, and is affiliated with the University of Illinois, Urbana-Champaign (UIUC). WMRC's building, the Hazardous Materials Laboratory (HML), is owned and operated by UIUC. On July 1, 1995, WMRC became a Division of the Office of Scientific Research and Analysis within the newly formed Department of Natural Resources (DNR).

The Center was charged with a mission to combine research and education; information collection, analysis, and dissemination; and direct technical assistance to industry, agriculture, and communities. Working with industry to reduce waste at the source, and to recycle those wastes that could not be reduced, was an early priority of the Center. WMRC's programs have been multimedia, looking at all wastes and discharges to the air, land and water.

The Center's focus on waste reduction/pollution prevention was formalized in September 1989 by the state's Toxic Pollution Prevention Act (TPPA). This Act (Public Act 86-914), which was amended in 1990 by Senate Bill 2253, expanded the Center's five programs (Research, Information Services, Industrial and Technical Assistance, Data Management, and Laboratory Services) to include a . The included the activities of our initial Industrial and Technical Assistance program. WMRC's current organizational structure is illustrated in Figure 1. Table 1 lists FY96 WMRC staff.

The state-funded headcount for WMRC during FY96 was 26.2 on General Revenue Funds (GRF), 6.5 on Solid Waste Management Funds (SWMF), and 1 on Hazardous Waste Research Fund. Total staff at WMRC, including contract and part-time personnel, is about 60. The state budget for the Center is about \$2.7 million; \$100,000 of this are in funds where WMRC has to generate the revenue. A little over \$500,000 of our total budget is designated for sponsored research projects.

The Center answers to the Board of Natural Resources and Conservation (BNRC), which consists of scientist and technical experts in the areas of expertise of the Center and three scientific surveys. It is chaired by the Director of DNR. The Board was formed by legislation (PA80-1218) to approve personnel actions of the Scientific Surveys and WMRC, and to provide programmatic oversight. The Center also has a Program Advisory Panel (PAP), whose members provide an external source of advice on the Center's programs. The panel includes representatives from industry, other state agencies, universities, and environmental groups.

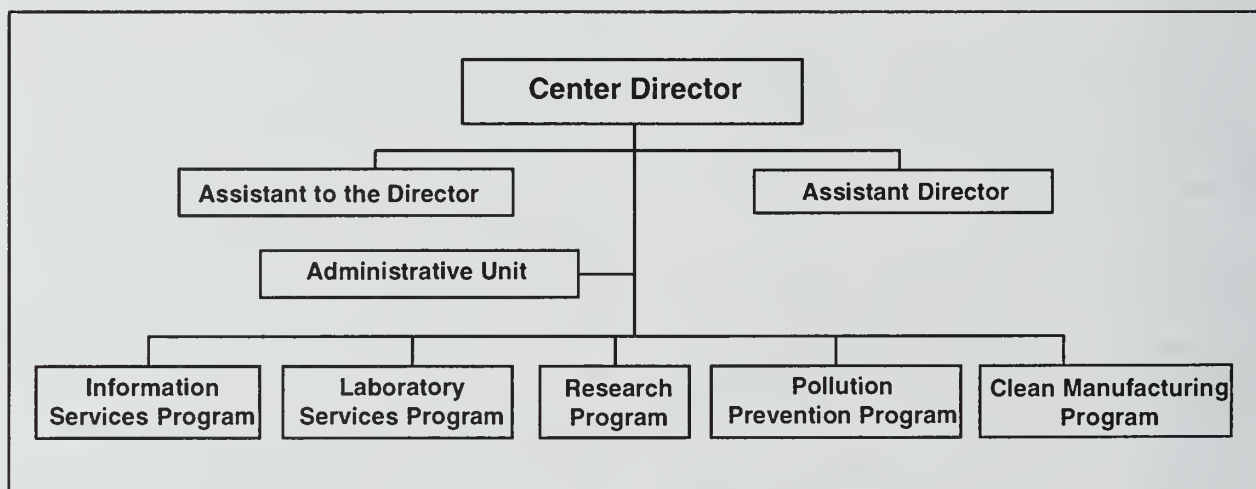


Figure 1. WMRC FY96 Organizational Chart

Table 1. WMRC Staff by Program

*(Note that funding sources vary)

Administration

David Thomas, Director
Gary Miller, Assistant Director
John Marlin, Assistant to the Director/Information Services Program Manager
Katherine Day, Human Resources and Administrative Services Manager
Christine Murphy-Lucas, Business and Finance Manager
Daniel Kraybill, Waste Management Assistance Specialist
Traci Klecz, Receptionist
Kaye Jones, Receptionist
Cynthia Melchi, Human Resources/Office Assistant
Betty Stites, Office Assistant
Cheryl Van Ness, Fiscal Assistant
June Wilhite, Laboratory Purchasing Agent

Laboratory Services Program

Marvin Piwoni, Laboratory Services Manager
Teresa Chow, Senior Analytical Chemist
Jack Cochran, Senior Organic/Analytical Chemist
Scott Dalbey, Facilities and Safety Coordinator
Bradley Daniels, Screening Laboratory Chemist
Gina Eversole, Organic Preparations Chemist
Amy Hughes, Inorganic Preparations Chemist
Daniel McGinness, Gas Chromatographer
Jonathan Talbott, Senior Analytical Metals Chemist
Luann Weidenmann, Inorganic Preparations Chemist
Monte Wilcoxon, Quality Assurance Officer

Pollution Prevention Program

Timothy Lindsey, Pollution Prevention Program Manager
Kenneth Barnes, Environmental Engineer
Christine Hayes, Pollution Prevention Technical Assistant
LeAnn Herren, Environmental Engineer
William Nelson, Process Evaluation Specialist
Joe Pickowitz, Pollution Prevention Technologist
Nandakishore Rajagopalan, Research Engineer

Research Program

Jacqueline Peden, Research Program Manager
Carla Blue, Outreach Specialist
Laurie Case, Project Officer
Christopher Harris, Outreach Assistant

Information Services Program

John Marlin, Information Services Program Manager
Laura Barnes, Librarian/Clearinghouse Specialist
Priscilla Smiley, Assistant Librarian
Jill Blanchar, Systems Administrator
David Green, Computer Systems Specialist
George Krumins, Database Management Assistant
Steve Warner, Technical Specialist
Sandra Broda, Information Specialist
Ester Burke, Information Specialist
Lisa Morrison, Information Specialist

Clean Manufacturing Program, Chicago

Malcolm Boyle, Senior Engineer/Office Manager
Jerry Brown, Manufacturing Process Engineer
Clifford Jahp, Environmental Engineer
Deb Kramer, Printing Waste Reduction Specialist
Caroline Pomeroy, Environmental Specialist
Margarita Cruz, Secretary

Chapter 2:

Programs and Services

Introduction _____

This chapter provides a brief overview of the Center's programs, services and priorities.

Pollution Prevention _____

In 1986, WMRC's Pollution Prevention (P2) Program was established as a long term approach to solving Illinois' waste management problems. It relies on direct technical assistance to industry, education programs, and research support to promote waste reduction. For waste that can't be reduced we look at recycling and improving waste management strategies.

WMRC's P2 Program encourages companies to closely examine how materials flow through their facilities, to pinpoint where and why wastes are generated, and to identify technologies, equipment, and/or new operating practices that reduce these wastes. Pollution prevention is a win-win program, wherein businesses cut costs and increase efficiency and competitiveness while concurrently protecting the environment.

The specific activities of WMRC's P2 Program are to:

- provide technical assistance to industry,
- develop and demonstrate clean technologies,
- recognize exemplary pollution prevention accomplishments through the annual Governor's Pollution Prevention Awards,
- educate and train in the pollution prevention area and transfer technology,
- answer regulatory questions and assist with permits, and
- provide assistance with economic justification of implementation strategies.

The most visible aspect of WMRC's Pollution Prevention Program is technical assistance. P2 staff provide information and services on solving

environmental problems to Illinois citizens, businesses, educational institutions, communities, and governmental units. Source reduction, recycling, and other methods of waste reduction are emphasized. Other services include: guidance on regulatory and permitting matters, recommendations on appropriate waste handling methods, and referrals to qualified service organizations.

Because WMRC is a nonregulatory organization, the assistance provided is advisory only; companies and individuals are not required to follow the recommendations and advice given by Center staff. WMRC does not report site-specific findings to state regulatory agencies.

WMRC continues to use its three well equipped clean technology laboratories to solve a variety of waste management problems. Testing innovative technologies to separate contaminants from process streams is the focus of our Pilot Laboratory. Technologies such as ultrafiltration, reverse osmosis, vacuum evaporation and centrifugation are evaluated for recovery and recycling of process stream components. WMRC's Alternative Cleaning Technology Laboratory has become a recognized test facility for the demonstration of safe cleaning techniques, employing aqueous cleaners where hazardous organic solvents were previously used. Alternative Chemical Processes Laboratory staff assist synthetic and process chemists who are trying to stem pollution at the ultimate source—the design stage.

Chicago Manufacturing Program _____

The growing demand for WMRC services provided the incentive for a new regional office, and on December 8, 1994, the Center's Clean Manufacturing Program (CMP) was established. Located in the historic Sears Administration

building at Homan Square, in association with the Chicago Manufacturing Center (CMC), the Center provides businesses and community groups in northern Illinois and Chicago area with technical assistance on regulatory compliance, pollution prevention/environmental assessments, safety assessments, and assistance with the implementation of pollution prevention and waste management programs. The overall response to the program has been exceptional and businesses are taking advantage of the available technical assistance to augment their environmental responsiveness.

The Center's CMP staff work with various service providers, such as CMC and the North Business and Industrial Council (NORBIC), to integrate pollution prevention and waste management services with the business development, modernization, and competitiveness programs already provided by these organizations. As businesses consider new technologies or modifying existing technologies, they will be encouraged to evaluate environmentally responsible options, including pollution prevention/waste minimization, into their corporate decision-making process.

The CMP staff coordinate closely with the Center's scientists and engineers in Champaign to provide the variety of services and information discussed above.

Research _____

Each year, WMRC receives an appropriation from the state to support research on various waste issues. The Center funds projects that:

- investigate the problems associated with historical and existing waste management practices,
- explore solutions to those problems, and
- develop ways to prevent those problems from occurring in the future.

The distribution of these funds and the monitoring of how they are used are the responsibility of the Center's Research Program. For FY96, the money appropriated to fund research was \$637,400. These funds are primarily available to investigators working in Illinois, although re-

searchers from other states have received limited support for projects of significance to Illinois.

Part of the research appropriation is used to support technology projects with industries as part of the Reduction and Recycling Technologies (RRT) program. The remainder of the funds support basic and applied research projects. These are selected from proposals submitted in response to the Center's general request for proposals. Full proposals are evaluated both by Center staff and external peer reviewers. Those projects that respond best to the most urgent problems and seem most likely to succeed or to have an immediate benefit to the state are selected for funding. Projects generally begin October 1.

Projects selected for funding during FY96 are discussed in Chapter 4. WMRC staff work with the investigators during the course of their projects, providing comments on the work as it progresses, serving as sources of information when needed, and often assisting with industrial process evaluations. Center staff have worked to supplement the funding allocated to the program by co-funding projects with other agencies and obtaining external funding to pursue additional topics of interest. These efforts will continue in FY97.

By managing the projects that the Center supports and conducting their own investigations, WMRC's staff have become familiar with a variety of industries, the wastes they produce, and the technologies or techniques that can reduce those wastes. Center-sponsored projects have addressed the severity of the contamination problems in the state, how contaminated sites can be restored, how current problems can be avoided, and how both the contaminants and their removal can effect human health.

Staff maintain an awareness of other hazardous waste research efforts being supported at a national level to avoid duplication, use a peer review system, and identify and take advantage of joint funding opportunities. Associations with individuals from other agencies/organizations that fund research are sought. Through these contacts, expert reviewers are found for proposals and final

reports. These experts are an added source of technical information and are essential to the selection of quality projects. Information from the research WMRC funds and conducts is combined with what is learned from publications, technical meeting participation, and personal/professional associations to respond to inquiries from the public, legislators, industries, and others. It serves as a basis for technical papers and presentations, and sometimes policy recommendations.

The results of Center-funded research, as well as Center-conducted research, are made available in a variety of ways. Articles in peer-reviewed and technical publications are encouraged, as are presentations at meetings, seminars and workshops. Factsheets and brochures describing research projects and/or their results are prepared and distributed to technical organizations and companies that might benefit from the information. Most research projects end in peer-reviewed research reports published by WMRC that are available through the Center's Clearinghouse.

Research staff provide technical and editorial reviews of documents, graphics for written and visual presentations, and a variety of other desktop publishing types of activities. Staff also serve as coordinators and participants for Center-sponsored workshops, meetings, and other events.

Laboratory Services _____

The Laboratory Services Program's (LSP) primary mission is to provide analytical and logistical support to researchers working on chemical waste problems. Sophisticated instrumentation and professional staff allow the Program to offer analytical and technical support to a broad range of clients. WMRC's building, the Hazardous Materials Laboratory, was constructed specifically to support such analytical resources and to provide a safe environment for the conduct of research projects addressing chemical waste questions.

The LSP supports pollution prevention, remediation and waste treatment research by providing chemical characterization of process and waste streams, both before and after applica-

tion of engineering technologies to these streams. Resulting data are used to make decisions on appropriate strategies for treating and/or reducing waste and increasing process efficiency.

The Program supports industrial projects, often in the form of analytical data on industrial process and waste stream composition. The Program's laboratory instrumentation permits identification and measurement of most organic and inorganic components likely to be present in industrial process and waste streams. While much of the work done for industrial clients involves measuring oil and grease and surfactant levels in cleaning solutions, more sophisticated services are provided as well. Refinement of analytical methodologies to identify and measure specific organic chemical additives in process streams allow P2 researchers to monitor the behavior of these components as a result of membrane testing. Metals analysis and characterization of precipitates enhanced researcher understanding of the chemical and physical processes occurring during treatment studies. Such data are critical to adjusting treatment approaches to best fit the industrial water or solvent stream being explored. The analytical experience gained from working with such complicated matrices prepares our chemists for future work on the wide variety of samples they will likely encounter. Specific analytical capabilities of the laboratory are summarized in the FY93 annual report (HWRIC 1993).

WMRC's work with a variety of industrial clients provides us access to samples of varied composition not generally available to vendors developing products for the analytical support industry. Such work has provided our staff with opportunities to explore the performance of some of these new products in our lab, and to share these results with the vendors. For example, we have worked with extraction disks from 3M Corporation to extract oil and grease from complex industrial samples. Such disks, if they work efficiently, have the potential to substantially reduce solvent use in analytical labs worldwide. By exposing such new products to a wide variety of industrial samples we can provide a more rigorous evaluation of the products, helping vendors assess product strengths and shortcom-

ings, and improve quality and usefulness. WMRC can provide that exposure without compromising the relationship it has with its industrial clients. WMRC benefits by identifying better, and often more environmentally friendly, ways to do its testing. Results of these investigations can occasionally be developed into presentations at national meetings, conveying our results to the larger analytical chemistry community while aiding the professional development of our chemists. This year several WMRC staff chemists presented their evaluations on new products/applications at analytical conferences.

The LSP also serves the research community by supporting a variety of researchers, both public and private, working with environmental problems. Researchers include those receiving

WMRC research funding, and researchers at the scientific surveys, the University of Illinois, the Civil Engineering Research Lab (CERL) or elsewhere who have research funding from other sources. Our support generally takes the form of chemical analyses that the researchers are not able to perform themselves or readily obtain in their own institutions. In some cases, the lab staff also help in experimental design or other aspects of research project development. As in previous years, the laboratory provided assistance on a wide variety of samples. Table 2 lists the industrial and research clients served during this fiscal year.

Laboratory space in the HML is accessible to researchers from outside of WMRC. CERL researchers have occupied two laboratories within

Table 2

FY96 Lab Services Program Clients	
<p>Industrial Clients (via technical assistance efforts) Ace Plating American Association of Railroads Burlington Northern Railroad Century Tools CP Hall Drum Beaters Eagle Wings Harris Corporation Highland Machine and Screw Co. JLM Chemical LCN Closures Linecraft Tool Company Marwi USA Mobile Power Wash Pierce Industries PQ Corporation Radio Flyer Safety-Kleen Witco Corporation</p>	<p>Research Program Funded Clients Cailis/UI-Chicago Dentistry School Davis/Fehr-Graham Freedman/UI Civil Engineering Department Halbrook/Southern Illinois University Kelly/State Water Survey Rayburn/UI Agronomy Department Thurston/UI General Engineering Department</p> <p>Direct LSP External Clients Adrian/CERL Boddu/CERL Buck/UI Natural Areas Cropek/CERL Gentry/UI ACES Jones/UI Agronomy Department Li/UI Beckman Institute Lillig/UI Material Sciences & Engineering Dept. Loebach/UI ACES Maloney/CERL Mangung/UI Material Sciences & Engineering Dept. Martel/UI Civil Engineering Dept. Nashold/Argonne National Lab Sipkins/Stanford University Skerlos/UI Industrial Engineering Department Stadleman/UI Forestry Department Steele/State Geological Survey Sweet/State Water Survey Webb/Illinois Department of Public Health Weiner/UI Beckman Institute</p>

the facility over the past year. These researchers, who are exploring problems of interest to the military, make use of our specially designed laboratories and avail themselves of analytical and other services. The Clean Technologies Laboratory is used by WMRC's P2 Program staff to evaluate the performance of various treatment technologies on process or waste stream samples from a variety of industrial clients. Similar services are provided by P2 staff in the Alternative Cleaning Technology Lab and Alternative Chemical Processes Laboratories. LSP staff provide coordination of laboratory use, logistical support, safety oversight, and often contribute technical guidance and analytical support to such projects.

Information Services _____

Fulfilling WMRC's legislative mandate to compile and disseminate waste-related information is the principal responsibility of the Clearinghouse and Library. A full-time librarian and half-time assistant librarian along with student staff are responsible for providing internal and external clients with information and materials. Table 3 provides outreach statistics for FY96.

WMRC's core information resources are contained in the Library and Clearinghouse. The WMRC Library contains over 12,000 items, including books, government reports, journals, maps, video and audio tapes, and articles. In FY96, library staff added 1,446 articles, 742 books, and 84 journals to the library's collection. Records for the library collection are maintained in two separate *db/Textworks* databases—catalog (books, audio/visual materials, magazines), and article citations. All staff can access the databases directly from their office computers through WMRC's Local Area Network (LAN). The Library collection does not circulate outside the Center, but interlibrary loan requests are honored.

The Clearinghouse includes two collections of materials. The first is the collection of WMRC-produced documents of over 100 items. Most of these are final reports on research projects sponsored by the Center. Also included are pollution prevention factsheets as well as technical and

administrative reports. The second Clearinghouse collection of over 200 items includes brochures, pamphlets, and other brief publications produced by WMRC, the US and Illinois Environmental Protection Agencies (USEPA, IEPA) and other agencies, covering 23 topical areas. The Clearinghouse database is also in INMAGIC format, and is used for inventory as well as holdings purposes. Clearinghouse reports are available to all clients—businesses, citizens, schools, etc. located in Illinois or elsewhere. WMRC generally charges a nominal fee for reports to recover some of the reproduction costs.

WMRC is increasingly involved in regional and national efforts to network pollution prevention assistance providers and/or clearinghouses. Several grant applications have been submitted to build on prior efforts which identified needs for coordinating the dissemination of information in hard copy and electronic form.

The ISP also serves the research, information and outreach goals of the Center by maintaining a toxics and waste database for Illinois, responding to requests for information from this database, and managing WMRC's computer resources. The database manager utilizes the Center's Geographic Information System (GIS) and accesses many state-wide geographic data resources through the IGIS (Illinois Geographic Information System) within our main agency, the Illinois Department of Natural Resources.

WMRC's hazardous waste database is comprised of information from many different sources, including USEPA, IEPA and research conducted or sponsored by the Center. Much of these data, such as the Toxic Release Inventory (TRI) and Annual Hazardous Waste Reports, exist as a result of federal or state mandates that require reporting for the purpose of monitoring and regulating industrial waste activities. Some data, such as the Historical Hazards GIS database, provide a glimpse of prior industrial hazardous waste activities. The Center's hazardous waste database currently contains many types of hazardous waste-related files, ranging from TRI data to state business patterns data. The Center's GIS capabilities provide access to the database and

Information Outreach	Services Statistics	Program for FY96
Library Reference Queries Answered for General Public		330
Library Items Lent Via Interlibrary Loans		28
Requests Made to Clearinghouse		540
WMRC Publications Distributed		3622
Non-WMRC Publications Distributed		2880

Table 3. Information Services Program Outreach Statistics for FY96

allow hazardous waste data to be analyzed spatially. New information is added to WMRC's database every year.

One of the most visible uses of the database is to identify hazardous waste sites at or near properties that are being sold. Reports and maps are prepared to assist individuals conducting preliminary site assessments. For FY96, 211 requests for this information were received and distributed. In addition to property transfer searches, the database has been used to define and characterize various hazardous waste activities for the purpose of developing policies for the management of these wastes.

WMRC's computer resources, including the LAN and Sun/Unix environment, are managed by a system administrator and computer systems specialist. A database management specialist provides support for the Center's computing resources including software and hardware evaluation, applications programming, and staff training.

WMRC's data management staff added two home pages to the World Wide Web this year. A new DNR GIS home page can now be accessed through the uniform resource locator (URL) <http://denr1.igis.uiuc.edu/gis/igishome.html>. This home page contains GIS data originally available (since April 1994) through the Department of

Energy and Natural Resources on CD-ROM. Some of the data available on this GIS home page include: floodzones, landfills, streams, administrative boundaries, 1990 census, nature preserves, and natural areas. The data which are in Arc/Info export format can be downloaded from the Web.

The second home page is for WMRC. This Web page is under construction and will be periodically updated. The site presently contains general information about the Center, its services and resources. Additions will be made to provide more detail about each of the Center's programs. When completed, the WMRC home page will allow downloading of some Center-produced materials such as fact sheets and case studies. WMRC's home page can be accessed with URL <http://www.hazard.uiuc.edu/WMRC/>.

Chapter 3: Pollution Prevention Assistance

Introduction

During its ninth year, WMRC's Pollution Prevention Program continues to work with Illinois industry with the goal of reducing waste at the source. WMRC's technical assistance outreach increased significantly for the second year in a row in FY96. Site visits to various types of industrial and municipal operations in need of pollution prevention assistance increased by 33% over the previous year. Table 4 provides a breakdown of the types of facilities visited in FY96. Fabricated metals, electroplating and food processing facilities continued to be important targets of technical assistance. Printing facilities also were important customer of technical assistance in FY96 when compared to previous years. This increase in assistance to printers is due in part to the new pollution prevention printing projects WMRC acquired in FY96. Chapter 4 provides a summary of WMRC's printing assistance projects.

Expansion of WMRC's Pollution Prevention Network

Manufacturing Extension Programs

One of the most interactive partnerships developed by WMRC is the one with CMC, one of NIST's Manufacturing Extension Programs (MEPs). CMC offers business and technological services to manufacturers in the Chicago area and has subcontracted with WMRC to add environmental and pollution prevention assistance to those services. The CMP staff participates in CMC manufacturing assessments by adding an environmental component to their modernization recommendations. The partnership between CMC and WMRC has benefited many companies during FY96 and will continue to do so in the future. See Chapter 5 for more details on Center efforts in the Greater Chicago area.

One example of what can be achieved through partnering is the assistance provided to Agri-Fine Corporation of Chicago. The company was concerned about expansion planning, employee training, information processing, and waste disposal and was working to address all of these issues. The company introduced some new waste reduction practices and had modified their manufacturing processes, but still needed to reduce their aqueous wastes and the costs associated with their wastewater discharge. They first contacted CMC, who included WMRC in the initial assessment. Several options for wastewater reduction were proposed by WMRC engineers and were considered by Agri-Fine. One option has been selected for pilot testing in WMRC's Clean Technology Laboratory. Center staff will use a combination of ultrafiltration and evaporation to remove and concentrate contaminants and reduce the volume of water being discharged.

Referrals from Publicly Owned Treatment Works (POTWs)

Responses to WMRC's load reduction program with POTWs continue to increase. Typical requests are related to reduction of some contaminant in the company's wastewater. While this has generally been wastewater that results from some aspect of a manufacturing process, several companies requesting assistance were focused on cleaning operations. One company cleans food grade pails for reuse in roofing and painting operations while the other cleans the insides of tankers that carry a variety of items from milk to chemicals so they can be used to transport other substances.

Other companies seeking to reduce the amount of metals being discharged in their waste water were referred to WMRC by POTWs. One machine shop with a phosphatizing operation was visited and presented with possible options to

reduce the metal content of their discharge. Center staff are waiting for a decision by the company about the technique they would like to explore, then will progress with waste stream analyses and pilot testing at our facility, the Hazardous Materials Lab (HML). It is probable that ultrafiltration will be used for the metals removal and waste stream concentration.

Several other companies were referred to WMRC by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). WMRC and the MWRDGC have had a long and mutually beneficial partnership. A WMRC pollution prevention engineer is located at the District's offices and assists their inspectors with clients needing help meeting compliance requirements or needing pollution prevention assistance. One of the companies recently referred to WMRC was an electroplater who wanted to reduce both the

metal content and the volume of the company's waste water discharge. WMRC engineers and chemists have been working on this problem since last May and the company has been adopting their recommendations. Some of the recommendations that are now a part of their electroplating operations included adding a transfer pump to improve counter current rinsing, a level controller to reduce the quantity of water being discharged, and using rinse water from static rinsing tanks as process water. Other options being explored at WMRC include the evaluation of reverse osmosis and electrocoagulation technologies that will facilitate additional recycling of the waste water and its constituents.

Farm Implements Manufacturer

WMRC was asked to assist a manufacturer of farm implements to lower its discharge of iron to the local sanitary sewer system. The company

Table 4: Comparison of Site Visits by P2 Personnel During FY94 through FY96

Business Type	Site Visits		
	FY94	FY95	FY96
Fabricated Metals	16	57	60
Electroplaters	8	39	20
Auto Repair and Body Shops	5	0	13
Machine and Welding Shops	3	8	20
Railroads	2	3	3
Coil Coaters	2	0	0
Pharmaceutical Manufacturers	3	3	2
Research Labs	3	6	1
Foundries	2	9	5
Oil Refineries	2	7	2
Chemical Processing	0	5	9
Food Processing	0	21	26
Printing	0	8	31
POTWs	0	17	3
Printed Circuit Boards	0	0	10
Jewelry Manufacturing	0	0	5
Plastics	0	0	4
Drycleaners	0	0	15
Automotive	0	0	6
Textiles	0	0	5
Waste Treatment	0	0	8
Construction Supplies	0	0	3
Other ¹	6	21	20
Total	52	204	271

¹ Includes agricultural products, churches, computer manufacturing, energy processors, industrial services, packaging, schools, fiberglass, and drum reconditioning

generated approximately 260,000 gallons of water contaminated with high levels of iron from their iron phosphate metal cleaning bath. WMRC evaluated the root causes of the high iron levels and made recommendations to the company. These recommendations included: better housekeeping, decreased water usage, optimizing chemical controls, and membrane filtration technology to remove the iron, and a modernized wastewater treatment system. After working with the company for one year, a decision to use polymer flocculating agents to precipitate the iron out of the cleaning bath and the use of a diatomaceous earth filter system to polish the resulting sludge proved effective. Implementation of this technology allowed the company to continue operating in compliance with regulations.

Tanker Truck Washing Facility

At the request of the local POTW, WMRC engineers and scientists provided technical assistance to a tractor-trailer truck washing facility. The facility was exceeding its wastewater discharge limits with respect to metals and was being heavily fined by the POTW. WMRC engineers reviewed the facilities operational process and provided several suggestions on how to reduce compliance problems. Better housekeeping to remove cadmium-coated bolts soaking in the hydrofluoric and sulfuric acid wash solution in the facilities floor troughs was suggested to decrease cadmium discharge. A recommendation to substitute the use of hydrofluoric acid for a hydrochloric acid was also made to decrease etching on the aluminum tanks of the tractor-trailers. The company has switched to a new cleaner and has installed a wastewater recycling system.

Referrals from Illinois Power

Eight requests for technical assistance came from customers of Illinois Power. These included a cooking vessel manufacturer, a corrugated box maker, two chemical processors, a juice manufacturer, a dry cleaner, and a public drinking water utility. The manufacturer of cooking vessels was experiencing problems with their waste water. A preliminary visit has been made to the vessel manufacturer, and Center engineers will return in October for a complete assessment to locate the problem and identify one or more solutions.

Bench scale evaluation of membrane filtration to enhance product recovery was conducted for one of the chemical processors and pilot scale tests are being planned for the future. A proposal was also submitted to the juice manufacturer to evaluate membrane filtration to improve product recovery. A detailed assessment and materials balance evaluation was conducted for the dry cleaner which was used to justify the purchase of a recycling system.

A project proposal is being developed in conjunction with the University of Illinois' Department of Environmental Engineering to evaluate membrane filtration for removing nitrates from drinking water at the public drinking water facility. The box manufacturer had been recycling waste water back into the manufacturing process, but is now having problems with box production which is possibly caused from reusing the waste water. WMRC is currently analyzing the waste and process waters to fully determine the cause of the problem. The ultimate goal is to restart wastewater recycling once the problem has been isolated and eliminated.

Referrals from the American Foundryman's Society

Center staff have been working with the American Foundryman's Society (AFS) for more than six years to explore pollution prevention alternatives for foundries. WMRC engineers are working with a foundry in northern Illinois referred to the Center by AFS. The foundry produces brass, bronze, and aluminum and is interested in analysis of its spent sand to determine if it could be recycled in some other process and if it should be classified as a hazardous waste. An assessment of the foundry operations was completed. Once analysis of the sand has been performed, Center staff will use the analytical data and their knowledge of the plant operations to determine whether the sand can be recycled.

Workshops _____

One of WMRC's business association partners is the North Business and Industrial Council (NORBIC). This group serves businesses on the north side of Chicago, including more than 120 printing companies. On September 21, 1995,

WMRC joined with NORBIC to sponsor a half-day workshop for printers, which was held at NORBIC's offices. The workshop topics included: environmental regulatory requirements for printers for the control of toxic air pollutants, solid wastes, and liquid discharges; opportunities for government financing to undertake environmental projects; and case study examples of pollution prevention techniques that have been adopted by printers. The workshop provided NORBIC's members with the opportunity to learn more about existing and pending regulations, meet assistance providers who can help them comply with these regulations, and be introduced to proven methods to reduce the wastes from their processes. Attendees were encouraged to contact NORBIC and WMRC for further help with both regulatory questions as well as pollution prevention assessments.

Environmental Management Workshop

Making Pollution Prevention Work for You was the title of a workshop presented by WMRC, Illinois Valley Community College, and the Central Illinois Manufacturing Innovation Consortium. Held August 24 in Ogelsby at the community college, the goals of the workshop were to discuss:

- using pollution prevention to avoid regulatory exposure and liability,
- improving plant efficiency by implementing the newest waste minimization and source reduction technologies,
- reducing compliance and disposal costs by minimizing use of toxic materials, and
- making process improvements to help achieve regulatory compliance.

The seminar was attended by personnel from a variety of small businesses. WMRC's staff spoke on the topics *Pollution Prevention Principles*, *Total Quality Management*, and *Using Pollution Prevention to Reduce Regulatory Exposure*. Those attending the workshop thought they had received practical information that they could use in their companies. Several attendees requested additional workshops to discuss regulatory issues.

National Teleconference on Pollution Prevention for Lithographic Printers

As a partner in the Printer's National Environmental Assistance Center (PNEAC), WMRC participated in a nationally broadcast teleconference for lithographic printers. Video clips of various printers implementing pollution prevention techniques were presented and an on-air panel of experts was available to answer audience questions. DCCA coordinated the marketing efforts as well as the five downlink sites for Illinois. IEPA also co-sponsored this event.

Pollution Prevention Projects _____

During FY96, WMRC scientists and engineers undertook a number of projects to evaluate process changes that could potentially reduce waste generation. Some of these projects involved implementing relatively simple process modifications while others involved the evaluation of innovative technologies. Brief summaries of these projects are provided below.

COMPETE Project Update

Project COMPETE (Coalition for Manufacturing Performance through Technology), a one year project funded through the Illinois Department of Commerce and Community Affairs' Technology Challenge Program Grant, was developed to provide small and medium sized enterprises (SMEs) with specialized assistance with environmental issues. Project COMPETE worked with the seven Illinois Manufacturing Extension Centers to provide environmental training, outreach, and technical assistance to MEC field agents and their business clients. Key tasks of the project included:

- Technical support of Illinois manufacturers regarding pollution prevention,
- Providing environmental regulatory solutions, inspections, and references,
- Developing controls and technologies to reduce or eliminate pollution,

- Incorporating modernization concepts into planning for regulatory compliance, and
- Developing pollution prevention strategies for manufacturers.

Project COMPETE provided environmental technical assistance to 158 Illinois businesses in 27 SIC codes; conducted 49 workshop/training events reaching approximately 800 people; and, eight pollution prevention projects were developed and implemented.

Project COMPETE's success was not only in its goal to help Illinois' manufactures with environmental problems but also in its establishment of a viable network of assistance providers with a wide range of experiences who are available to answer manufacturer's questions.

Machine Manufacturer

A machine manufacturer operates a five stage alkaline cleaning/phosphating system to degrease parts prior to powder coating. During the degreasing process, the alkaline cleaner collects oil and grease, and other suspended solids. As the amount of contaminants increase, the efficiency of cleaning decreases. Some of this loss in cleaning ability is compensated for by adding more chemicals. However, a point is reached when the cleaning efficiency can no longer be maintained by chemical addition, and the cleaner solution is drained to the city sewer.

Though no ordinances are currently in place limiting oil and grease discharges, this company voluntarily tries to minimize and regulate the amount of effluent to avoid overloading their POTW. The company contracted WMRC to carry out pilot trials using microfiltration to separate and concentrate the oil and grease in the alkaline cleaning solution. The trial successfully separated and concentrated the oil and grease making recycling of the cleaner possible.

PQ Corporation

An inorganic chemical manufacturer was looking for ways to treat and reuse an inky-colored alkaline groundwater. Though the water itself was not hazardous, it was being drained into a creek, creating an aesthetic problem. The inky color was

determined to be caused by iron and high amounts of humic substances in the soil. WMRC engineers were successful in demonstrating the use of a new membrane separation process, nanofiltration, to successfully decolorize the water. Calcium and magnesium were also highly reduced in the decolorized water allowing its use in product formulation.

Association of American Railroads (AAR)

Railroads across the United States and Canada clean railcars, engines, motors and other such components with large volumes of alkaline cleaning chemicals. This results in very high volumes of oily wastewater that needs expensive pretreatment before discharge. Under contract from the AAR, WMRC surveyed the use of alkaline cleaners across a number of railroad facilities. The survey resulted in identifying a few broad classes of alkaline cleaners that represented the numerous brands currently being used. Further research was completed to identify the type of ultrafiltration membranes best suited for each alkaline cleaner class identified by the survey. A highly successful pilot trial using these membranes is in progress at a railroad facility in Iowa.

Apparel Manufacturer

WMRC assisted a major supplier of graduation gowns and uniforms to academic institutions across the United States. The company manufactures, rents, cleans, and repairs gowns on a somewhat seasonal basis. As part of their operation, the facility operates an industrial scale dry cleaning plant which uses mineral spirits as its cleaning solvent.

The use of this solvent has become an issue because of the need for the company to obtain a new air permit pursuant to the provisions of the Clean Air Act Amendments (CAAA). Solvent emissions from their dry cleaning need to be limited to less than 100 tons per year, and there is a concern that this could limit the company's growth. As part of a cooperative effort with the local electric utility, WMRC personnel are assisting with an evaluation of source reduction methods to reduce solvent emissions.

Total solvent emissions from the CC & G facility are roughly 84.5 tons per year. This quantity of lost solvent has a value of approximately \$24,000. By performing a detailed process evaluation, WMRC personnel determined that the losses from one of the plant's seven dryers account for 75 tons per year, or 89% of the total plant solvent losses.

WMRC, the company, and electric utility personnel are currently investigating methods of using this solvent more efficiently, thereby reducing plant emissions and saving the plant money.

Metal Surface Treatment Facility

An industrial metal surface treatment facility which cleans, phosphatizes, and paints metal parts have been exceeding the regulatory limits for iron in their discharge. Their POTW suggested they contact WMRC for assistance in correcting that problem. The company had met the POTW discharge limits in the past by discharging weekly and diluting the discharge. Since this was no longer possible, the company had explored other possibilities with limited success, including the purchase of a wastewater treatment plant for the facility, and precipitation and filtration of the iron from the discharge.

An assessment by WMRC technical staff resulted in several other recommendations to reduce the iron and also to extend the life of their cleaning process baths. One recommendation was that precipitation and removal of iron should continue. In addition, the removal of oil, grease, and soils from the process baths should be explored. This would extend the cleaning bath life and reduce discharge. A proposal was submitted to the company describing the equipment required, its costs, how it would be evaluated by WMRC and a timeline for the project. The company was in the process of installing another process line in the facility and will incorporate the suggestions made by the Center's P2 staff in that line. Testing of the P2 modifications will be made as soon as the line is in operation.

Chemical Manufacturer

The goal of the partnership between WMRC and the chemical manufacturer is to develop a

pollution prevention program that includes implementing a continuous improvement strategy to minimize all waste generated at the facility. Specific procedures for prioritizing and systematically reducing these wastes are under development. The contract includes the development of a detailed pollution prevention plan which will serve as a guide to chart the progress of the program.

Specific items in the plan included the importance of management support, a listing of reasons for the program, identification of the pollution prevention team, description of how waste will be characterized, provision of a strategy and schedule for pollution prevention assessments, a cost allocation system, description of technology transfer, training needs, and program and project evaluation and implementation.

The goals for this partnership are both specific and general. Simultaneously, the company would like to optimize its production of long oil alkyds, thereby reducing its waste production, increasing its bottom-line profit, and improving the quality of its production process. More general goals include improving worker health and safety in the facility and improving the company image and attractiveness to investors.

Characterization of the General Process

Since the focus of this pollution prevention plan has been the long oil alkyds, the pollution prevention team represented the general process by a flow diagram, showing the movement of raw material through the process as well as the generation of final product and waste. The diagram showed, in addition to the raw material, final product, and waste flows, other inputs such as lubrication fluids, cleaning agents, cooling water, etc. This provided an understanding of the overall process and the associated wastes.

The complete understanding of the production of the alkyd included a better understanding of the efficiency of the process and the cost of the waste streams. From these data, it was decided to focus on the plant-scale production of the alkyd as the point where significant pollution prevention could occur. The means to achieve this would be

through slight process modification or engineering changes.

Assessing Wastes and Identifying Pollution Prevention Opportunities

Through regular meetings at the company's manufacturing facility, the P2 team has studied and outlined the life-cycle states of the alkyd. The first step was to examine the entire production of the long oil alkyd product line. The flow diagram prepared earlier provides a good starting point for prioritization as it shows all of the input and output streams for the product line.

A productive way to generate ideas was found to be informal meetings with employees (scientists, engineers, safety personnel, etc) who work in the production of this alkyd. During this time team members were encouraged to "brainstorm" and discuss options. All options were recorded and given serious consideration. Some options may be easily identified, but more difficult ones involve source reduction and in-process recycling.

Future Directions

WMRC scientists will be working side-by-side with company engineers in both the laboratory and in the plant to determine P2 opportunities. Non-disclosure agreements ensure that the information exchange during these times are candid.

In tandem with this process evaluation work will be cost-accounting of any changes resulting in pollution prevention. The benefits to be gained by implementing a pollution prevention project should be identified. Along with reduced waste generation (and associated costs), these benefits may include improved worker safety/morale, better community relations, reduced liability, reduced regulatory concerns, and improved relations with regulatory agencies.

Alternative Cleaning Technology Laboratory (ACTL) _____

The growing number of regulations on waste effluents from manufacturing facilities has increased the need for industries to develop a systematic approach to meet the new limits. Many industries in Illinois would like to explore alterna-

tive cleaning technologies but lack the information and/or resources to accomplish this task. With its Alternative Cleaning Technology Laboratory, WMRC is trying to help companies address this problem.

Potential clients learn of WMRC's expertise through channels ranging from phone inquiries to references from state and federal regulatory agencies. Initial discussions determine the nature of the problem, which may range from a simple solvent substitution to reevaluation of the entire cleaning operation. More importantly, the stage is set for ongoing communication, during which the exact nature of the problem is defined and a systematic plan is developed.

The focus of these discussions include potential financial savings, improved public image, a safer and healthier workplace, enhancement of the company's competitive edge, and overall continuous improvement.

The current projects being studied in the alternative cleaning technology laboratory exemplify the approach described above.

Bellows Manufacturer

WMRC worked with a manufacturer of bellows used in machines, ranging from medical devices to automobiles. A component of their process had involved the use of chlorinated solvents (perchloroethane and trichloroethylene). After their appearance on the IL Toxic Release Inventory for 1993, the management asked WMRC to assist them in switching to an alternative cleaning system. The ACTL provided assistance by: performing bench testing of potential cleaners on oils contaminating their metal substrates, doing pilot scale tests under conditions similar to those in their facility, and inspecting the progress of the plant-wide implementation of the new cleaning technology. The target goal is to no longer be using the chlorinated solvents after December 31, 1996.

Chemical Manufacturer

A large chemical manufacturer contracted WMRC to do cleaning studies on some of their products. The results of these studies expand the information database at WMRC regarding com-

mercial cleaners, provides more experience for WMRC's scientists in achieving cleaning goals and provides valuable information to manufacturers of cleaners. This interaction has the added benefit of improving WMRC partnerships with Illinois businesses.

Alternative Chemical Processes Laboratory (ACPL)

The Alternative Chemical Processes Laboratory seeks to achieve pollution prevention by the study and modification of existing chemical manufacturing processes. Utilizing expertise in mechanistic organic chemistry, ACPL technical staff assist industries in achieving waste minimization. ACPL data will be used to recommend direct modifications of existing processes to recover more marketable chemicals from their final reaction product; to provide life-cycle assessments; to review the company's entire production process and identify sources of waste; and to design ways of performing chemical reactions using less toxic raw materials.

Chemical Manufacturer

WMRC staff began working with a manufacturer of phenol which uses a chemical process involving cumene. This process generates an excess of 8 million pounds per year of still bottom residue. The residue has been classified as hazardous waste, preventing the material from being blended for fuel. Two chemicals with market value comprise part of the residue. The project initially involved the detailed characterization of the waste stream, which led to a plan to selectively separate the two chemicals. The ACPL has been developing a chemical technique to separate these two chemicals, which comprise almost 60 percent of the current wastestream, from the residue.

If successful, this project could reduce the volume of the company's waste by 60 percent or more, provide reductions in hauling and disposal fees, and generate additional revenue. This represents the first hands-on research effort for the Center's ACPL.

Ninth Annual Governor's Pollution Prevention Awards Presentation

The Ninth Annual Governor's Pollution Prevention Awards Ceremony was held September 20, 1995 at the Radisson Suites Hotel in Chicago. These awards honor businesses and other organizations in Illinois that have successfully reduced the generation of wastes and the use of toxic chemicals. Over 130 people attended the ceremony including representatives from the award winning companies, DNR, IEPA, USEPA, DCCA, and other state and federal agencies. Lt. Governor Bob Kustra presented the four awards and 13 certificates of merit (Table 5). This year's winners and their award winning activities are presented in Appendix B.

In 1996, WMRC established an award for continuous improvement. This award acknowledges the efforts of companies that have won awards and/or certificates in the past and who have continued to develop and sustain significant pollution prevention programs. Winners in this category were Caterpillar Inc. (East Peoria Facility), Homeshield Fabricated Products, Motorola Lighting, Inc., and Tellabs Operations, Inc. Although their pollution prevention projects may not have been significant enough to deserve an award this year, their efforts to continuously improve their operations over several years deserve this recognition.

Ninth Governor's Awards Categories

Category	Award	Certificate
Large Industrial	2	2
Medium Industrial	1	4
Small Industrial	1	1
Educational Institution		2
Continuous Improvement		4
Total	4	13

Table 5.

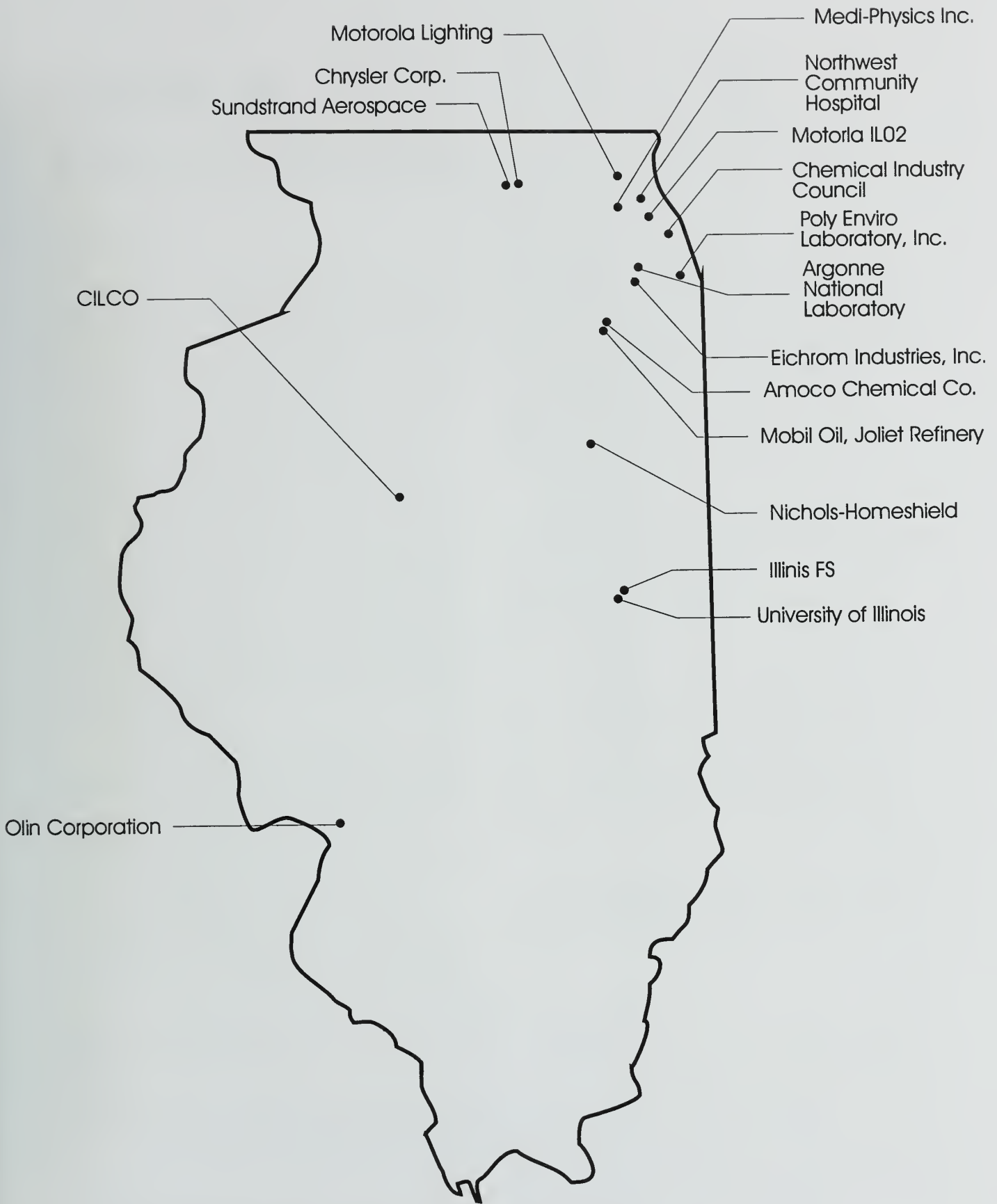


Figure 2: Locations of the 1995 Governor's Pollution Prevention Awards winners.

Chapter 4: Research Directions



Introduction _____

An essential component of WMRC's mission is research into the nature and extent of Illinois' environmental problems, particularly those associated with waste and chemical releases. Four main types of research projects occur at WMRC.

The first type of project involves the Center funding scientists at other institutions through a competitive proposal process. WMRC has sponsored research on a variety of waste issues since its inception in 1984. In FY96, WMRC used \$150,000 of state funds to begin new research projects, while \$377,720 was used for continuing projects. The new projects are highlighted in this chapter and continuing projects can be found in Appendix D. Center-funded projects are managed by WMRC Research Program staff and result in published technical reports. Publications in FY96 are listed in Table 6.

A second type of research project involves a collaboration between Center Pollution Prevention staff and an industrial client. The Reduction and Recycling Techniques/Technologies (RRT) Program funds clean technology development and demonstration projects. The RRT Program promotes pollution prevention in Illinois by providing up to \$50,000 per year for applied research projects. Most project awards, however, are in the \$5,000 to \$20,000 range. Awards can

be obtained for development or demonstration of waste reduction techniques and technologies, or for testing new applications of existing methods. An RRT award must be equally matched by the contractor with either funding from other sources or in-kind services. Projects generally focus on: modifying industrial processes to eliminate, reduce, or replace toxic materials; or, testing the process capabilities of equipment for reducing, detoxifying, or recycling waste streams.

Under the RRT program, Center staff may provide technical support to Illinois businesses and industries to conceive and implement workable projects. WMRC engineers and scientists are available to provide "hands on" assistance with project development, initiation, and management.

The third type of research project uses the skills of WMRC's analytical laboratory staff. They conduct analysis for research projects funded by WMRC, analyze wastestreams for industrial clients, and do methods development work. The Lab Services Program also does contract work for other research groups outside the Center.

The fourth type of research involves projects for which WMRC has received funding from an outside agency through a competitive grant process.

Table 6. FY96 Published Reports and Technical Documents

Report Number and Title	Author	Publication Date
RR-077 Remediation of Pesticide-Contaminated Soil by a Combination of Compost Addition and Planting	Michael Cole	July 1995
TR-020 Treatment of Spent COD Solutions for Safe Disposal	Thomas Holm	April 1996

Research Program Funds New Projects _____

Several research projects selected to receive FY96 funding from the Center were delayed because of uncertainty in the amount of FY96 revenues being added into the Hazardous Waste Research Fund (HWRF), the major source of our research funds. Money going into HWRF comes from a tipping fee on hazardous waste. Recently, one of the two existing hazardous waste disposal sites in Illinois, Waste Management's SID Landfill in Chicago, was closed. While the remaining operation, the Peoria Disposal Company's landfill, can take some of the wastes that would have been disposed at SID, most of those wastes will be sent out of the state. Tipping fees will be reduced as will revenues into HWRF. As a result, WMRC's total research budget has been reduced by approximately 10 percent. The FY96 funds remaining for projects were released in February. Four new projects have formally begun. Brief summaries of these projects follow.

Development of a Sensitive Bioassay to Detect Exposure to Environmental Estrogens

Elizabeth Jeffery and Paul Vancutsem; University of Illinois at Urbana-Champaign

Many Illinois waste sites contain a variety of environmental estrogens, most of which are lipophilic and can therefore be expected to accumulate in the food chain. There is evidence that estrogenic pollutants cause serious adverse effects, including eggshell thinning in birds and liver cancer in humans. These pollutants are hypothesized to disrupt reproduction and threaten species' survival. An assessment of the impact of these chemicals on people and wildlife is needed to make judicious risk management decisions. To evaluate risks of environmental estrogens more accurately, a new type of bioassay will be developed using molecular biology techniques already available. Once verified and established, this assay can be simplified to rely on routine serum analysis techniques commonly available at diagnostic laboratories. Project objectives are: 1) develop a

sensitive bioassay to detect estrogenic and proestrogenic environmental contaminants, 2) develop a set of sensitive biomarkers to detect exposure of wildlife and humans to estrogenic and proestrogenic environmental contaminants, and 3) test the bioassay and biomarkers on samples from Crab Orchard National Wildlife Refuge.

A Critical and Statistical Evaluation of Characterization Methods for Sites Contaminated through Multiple, Discrete Spills

Michael Barnhardt and Donald Keefer, Illinois State Geological Survey

This study will use existing data from two agrichemical facilities to determine the optimum number of samples and their location to assess the occurrence of soil contamination. Analysis of these data will provide the basis for modeling the distribution of the contamination at the site. This study will develop a document that provides guidance in site characterization given complex contaminant distributions like those found at agrichemical facilities. The site characterization method is expected to both decrease the costs of sampling and analysis, and give greater assurance that the extent of contamination is determined.

Activated Carbon Adsorption/Regeneration System: Recovery and Reuse of Toxic Organic Compounds

Dr. Mark Rood, University of Illinois at Urbana-Champaign

This project will continue to develop a new adsorption technology coupled with cryogenic vapor recovery with a goal of reducing air pollutant emissions and providing for reuse of toxic materials. Activated carbon cloths (ACCs) will be further studied in a laboratory-scale fixed bed configuration to measure breakthrough times of the bed for realistic gas stream conditions that contain chlorinated organic compounds. Low cost micro-engineered carbon adsorbents will also be evaluated with this research project.

NORBIC

A joint project between WMRC and NORBIC (North Business and Industrial Council) has recently begun. NORBIC serves over 1,200 companies, mostly manufacturers, that employ over 70,000 workers on the north side of Chicago. Its goal is to preserve the industrial climate in this area by promoting it as a good place to own and operate a manufacturing company. Through NORBIC, businesses can gain access to financial assistance, workforce training, job training programs, and international trade and relocation options.

In this project, NORBIC and WMRC will conduct an industry specific survey to collect data on waste management practices, pollution prevention concerns, and compliance issues. The results of the survey will be used to develop workshops for the specific industrial sector. An additional deliverable will be a list of contacts interested in WMRC and NORBIC services.

New RRT Projects _____

In FY96, as part of our RRT program, WMRC provided \$20,000 in matching funds and approximately 600 hours of technical assistance to three firms. These projects included optimization of an electroplating operation, recycling of pickling bath solution, and removal of ammonia from a chemical processing facility's fatty amine and quaternary surfactant stream.

Ace Plating

Ace Plating has operated a decorative finishing business in Chicago for over 30 years. In the wake of changing environmental regulations and proposed changes by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), Ace requested assistance from WMRC to identify opportunities for reducing metals and cyanide in their wastewater discharges.

WMRC's initial efforts included minor process modifications and better housekeeping practices which helped the company reduce the metal content in their discharge and comply with MWRDGC limits.

After the initial recommendations were implemented, WMRC staff members made additional suggestions to enhance pollution prevention efforts. These included limiting rinse water flow rates and recycling the rinse waters. Previous water usage of 20,000 gallons per day has been reduced to less than 5,000 gallons per day—a 75 percent reduction. Approximately 60 percent of the rinse water being used at the company is presently being recycled. Total metals discharged were reduced from 176 pounds to 38 pounds. This is a 78 percent reduction in metals discharged to the environment. Total metal concentrations were reduced from an average of over 4 ppm to an average of slightly above 2 ppm.

Vacuum evaporation was tested by seeking to reduce fresh water usage to a minimum. Fresh water was reduced to one gallon per minute (about 500 gallons per day) for a three-week period. A problem was noted with product quality, but only on one product. This electroplater is a job shop and about 200 different products are run through the plating line in a week. WMRC continues to assist the company in finding the appropriate vendor and evaporator for their process.

Reverse osmosis was tested at a bench scale size. The test proved that reverse osmosis will provide clean water suitable for recycling and reuse in the process. However, a retentate stream of 20 to 25 percent would have to be handled in another manner. Knowing the projected capital cost and operating expense of the reverse osmosis system, it was decided to pursue other technologies that would not require a second technology to achieve a closed loop for the electroplating process.

Current plans are to continue reducing the amount of water used. Initial tests indicate that the water usage can be reduced to 3,000 gallons per day with no effect on product quality. After carefully reducing the water usage as much as possible, plans are to proceed with the next step in attempting to "close loop" the process water. The two current methods that have the most promise are ion exchange and electrocoagulation. Ion exchange is the more proven method, but it is also more costly to install and to operate. If

electrocoagulation works for this company, its benefits and low capital and operating costs would make it an ideal technology to be transferred to other electroplaters. A pilot scale AC electrocoagulation unit has been leased and testing is scheduled for late October 1996.

If neither of these technologies proves acceptable, other technologies will be tested. However, the one known option to assist electroplaters with implementation of zero discharge is to return to evaporation, which is proven, but costly.

Witco, Inc.

Witco, Inc., located in Mapleton, Illinois is a premier manufacturer of quaternary ammonium surfactants and other fatty amines. The manufacturing process involves the reaction of fatty acids with ammonium to form nitriles which are further processed to fatty amines and quaternary surfactants. An excess of ammonia is used to increase conversion efficiency. The use of such excess, while beneficial from a conversion perspective, also results in an aqueous ammonia stream containing fatty material. The recovery of ammonia for reuse in the process is expected to result in substantial by-product reduction as well as increased process efficiency.

In FY96, Witco and WMRC research personnel initiated a project to remove fatty materials from the ammonia stream using microfiltration/ultrafiltration. Results of this project will be presented in future WMRC reports.

Arid Technologies, Inc.

Arid Technologies, Chicago, is a company specializing in developing membrane technology systems for their clients. Their RRT project with WMRC tested reverse osmosis (RO), a membrane filtration technology, to remove metal contaminants and regenerate and recycle sulfuric acid from a galvanizing metal process line.

The prototype RO unit for this pilot study was designed by Arid to withstand the high pressure, temperature, and acidity of their client's pickling waste stream. The test will take place on site at the manufacturing facility over a three week period.

If the test is successful, a full-scale RO unit will be constructed and put into operation in this facility. Currently, the manufacturing facility generates 5,000 gallons of spent sulfuric acid per week, paying \$0.40/gallon for transport and disposal. Raw material costs for the 94% sulfuric acid used by the company are approximately \$0.50/gallon.

Arid Technologies estimates the RO system will save the company \$100,000 annually in reduced disposal costs and acid purchases.

Center-Conducted Projects _____

Completed Projects FY96

The Class V Well Project was initiated to help protect groundwater from contamination by Class V underground injection wells. During the period October 1993 through July 1995, WMRC received funds from USEPA Region 5 to assist businesses in identifying and closing Class V wells and providing information on alternative means of dealing with their wastes.

Class V wells include a variety of liquid disposal methods discharging into the ground. Common examples include septic systems and drains which are not connected to an appropriate treatment system. Industrial and process wastes entering these wells can contaminate groundwater. Peoria and Tazewell counties were identified by the IEPA as vulnerable to groundwater contamination, and were selected to be part of an enforcement initiative.

Pollution prevention is the preferred means of reducing hazards to public health and the environment associated with industrial pollution because it minimizes the need to recycle, treat or dispose of wastes. It was expected that companies providing economically and environmentally sound pollution prevention solutions would be more cooperative in closing wells. It was also thought that WMRC as a non-regulatory state agency would be better able to achieve rapport with local interests than the enforcement branch of the USEPA.

Throughout the project, WMRC maintained a close working relationship with several local

organizations including the Central Regional Groundwater Protection Committee (CRGPC) and the City of Peoria. The CRGPC was organized pursuant to the Illinois Groundwater Protection Act and is composed of representatives of county and municipal officials from four counties including Peoria and Tazewell. The mandate of the CRGPC fit well with the goals of the project, and committee members assisted greatly in helping the project gain credibility with local organizations. The committee found WMRC's efforts useful and asked that the project be expanded into two other counties within its jurisdiction.

Information packets were sent to 5,300 businesses in the area. They contained information on wells, groundwater protection and pollution prevention specific to various industry types. The packets provided enough information for most businesses to correct problems without assistance.

An 800 number was maintained throughout the project for people from the project area to call for information or technical assistance. WMRC received a total of 131 calls. People called most frequently to report that they were no longer in business, to object to being on the list, or to ask basic questions about the mailings and Class V wells. The calls resulted in four site visits which identified three potential Class V wells and confirmed that six others were properly capped. Although there were many efforts to reach companies and help them find alternatives to Class V wells, few companies accepted the offer. The investigators believe this is because of business' reluctance to seek help from government agencies.

The project concluded with a half-day workshop in Peoria titled *Regulatory Peace of Mind* on June 13, 1995. The workshop was aimed at businesses in the two county area with questions regarding environmental issues. Presenters included WMRC engineers discussing practical methods for reducing waste and improving process efficiency, a local environmental attorney on compliance issues, and the Peoria County Solid Waste District on the industrial recycling ordinance. The workshop was attended by 42 people

and was sponsored by nine local businesses and agencies. This workshop lead to two requests for pollution prevention site assessments and several phone inquiries. Additionally, one of the cosponsors, Central Illinois Manufacturing Innovation Consortium (CIMIC), requested a similar half-day event be held in the LaSalle-Peru area.

Laboratory Research Support Activities

Analytical support for research is one important component of the Center's Laboratory Services Program (LSP). Laboratory staff receive requests for analysis of a variety of materials from investigators working across the United States (see client list in Table 2). On many projects, Center staff simply provide analytical data back to the project scientists/engineers, but frequently, laboratory staff are more active participants in projects. They work with investigators to collect the samples, develop new methods to characterize samples, analyze the samples and the data, and assist in the preparation of the project report. These projects help to develop the professional competence of our staff and often lead to opportunities to present papers and posters at national meetings. Some of the research-oriented projects we worked on over the past year are featured below.

Gas Sampling at Greene Valley Landfill

At the end of 1994, WMRC's laboratory manager was contacted by Citizens for a Healthy and Safe Environment (CHASE) of DuPage County who were looking for an independent laboratory to analyze the gases coming from the Greene Valley Landfill in Darien, Illinois. CHASE had earlier data from an analysis of the landfill gases indicating the presence of vinyl chloride and other hazardous air pollutants. They were interested in obtaining data from a source with no connection to the landfill operator.

The landfill has the required gas collection system that removes gases from throughout the complex and sends them to a pair of high temperature flares for combustion and decomposition. The gases are routinely sampled from ports located below the flares and analyzed as required by current regulations. Data from these analyses

had, on several occasions, been provided to CHASE by Waste Management, Inc. (WMI), the landfill operator.

WMRC staff took preliminary samples and performed some semiquantitative analyses, but could not provide a rigorous sampling and analysis of the landfill gases CHASE wanted. The Center offered to work with CHASE to find an analytical laboratory that was certified by USEPA to perform these analyses and to arrange for more samples to be taken and analyzed. Samples were collected on September 18 and analyzed by Air Toxics Limited. WMRC provided funding for the sampling and analysis, worked with CHASE to develop the data collection plan, and coordinated and oversaw the sampling effort. Analytical data were received and reviewed by WMRC and provided to CHASE, IEPA, WMI, and several area legislators' offices. The contaminant concentrations revealed in this data report were similar to those found in previously reported data. Hopefully, our report laid to rest citizen concerns about the risks the landfill gas system presented to area residents.

Pink Water Analysis

WMRC and the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL) have been working cooperatively for a number of years on a variety of environmental problems of interest to the Department of Defense. Many of the projects focus on pollution that results from the manufacture and/or use of munitions. One project recently completed investigated the contamination problems that result from the packing of trinitrotoluene and similar propellants into shell casings. The spillage during these packing operations is rinsed away with water, creating a waste that is commonly referred to as "pink water" because of the distinctive color imparted by the propellants. At the start of the project, WMRC chemists developed a method using capillary electrophoresis to analyze the various constituents of the pink water. This work led to the presentation of a poster describing the methodology at a national conference. CERL researchers working in the Hazardous Materials Laboratory (HML) evaluated the usefulness of membrane separation technologies to treat this

wastewater and reclaim the water for reuse. WMRC laboratory staff provided analytical support that allowed interpretation of the encouraging membrane results.

East St. Louis Metals Exposure Study

The Illinois Department of Public Health (IDPH) received a contract from USEPA to do a correlative study of the levels of arsenic, cadmium, and lead in the bloodstreams of residents of East St. Louis compared to the levels of the same metals in environmental samples collected in and around their homes. IDPH subcontracted with WMRC to provide the environmental sample analyses. Drinking water, yard soils, and household dust samples were collected and analyzed. Ambient air samples were taken weekly at five sites and the sample filters analyzed. In total, WMRC provided data on 500-600 samples for the three metals of interest at concentrations into the parts per billion range. As anticipated, some of the air filter, dust and soil samples showed elevated levels of the metals, probably originating from nearby industrial activity and automobile exhausts, both past and present. Analytical work on the project was completed in January 1996, and the final data report was submitted to IDPH. These results are being analyzed with blood level concentration data received from the Centers for Disease Control, and a project report is imminent.

Plant Analysis Used to Pinpoint Areas of Contamination

One of the more interesting projects for which WMRC's technical and analytical help was requested has been carried out over the past three years with researchers from Argonne National Laboratory, in work sponsored by the Commodity Credit-Corporation of the US Department of Agriculture. Carbon tetrachloride is a contaminant of concern at former government grain storage facilities where the chemical was used as a component of a commercial grain fumigant. The storage program ended in the 1960s, but soil had become contaminated at some bin sites, leading eventually to contamination of drinking water supplies. Argonne scientists have been investigating whether plants growing over contaminated sites can be used to help pinpoint areas of elevated

concentrations of persistent organic contaminants. Soil and vegetation (leaf, stem, and root tissue) samples were collected from former grain storage sites in Kansas and Nebraska and sent to WMRC for analysis. WMRC's organics group has developed methods to screen these tissue samples for the organic compounds of interest. This past year's fall sampling season was cut short by the late September frost in the Great Plains, but a spring sampling was successful. Data reports for each sampling period were submitted to Argonne, and prospects are good for continuing the work into FY97.

Arcola Sludge Ponds

The University of Illinois Committee on Natural Areas manages a number of sites in east central Illinois that preserve some special environment and/or are especially useful for student research. UIUC was offered title to land surrounding and including several ponds just south of Arcola, IL, and were particularly interested in the site because it would represent the first wetlands area they would manage under the Natural Areas program. But the site had been used in an experimental project over 20 years ago during which traincar loads of sludge from Chicago municipal wastewater treatment plants were transported to and deposited in the ponds and adjacent ditches. The university was concerned about the legacy of the earlier sludge disposal project conducted at the site.

WMRC lab staff were asked to assist in some preliminary sampling of sediments in and around the ponds. These samples were screened for organic contaminants and heavy metals. Based on the report generated from these screening analyses, the University decided that they did not wish to incur the potential liabilities associated with this site. DNR is now considering ownership of the site.

DOD Incinerator Emissions

New rules curtailing open burning of munition and other wastes of importance to the army have forced Corps of Engineers researchers to seek other methods for waste disposal. Controlled incineration has emerged as one alternative for destroying these wastes, but little information is

available on the completeness of destruction and the emissions released by this technology. One of WMRC's senior chemists accompanied a CERL researcher to the Radford, VA, Army Ammunition Plant to assist in the sampling of stack gases emitted from Radford's incinerator. The project focused on collection and analysis of stack gases from trial burns of three different military wastes. Emission gases were analyzed for a variety of inorganic and organic constituents as part of the Army's feasibility studies. Samples collected during the trial burns were returned here for analysis and we provided a data report to CERL for this work. Unfortunately, problems with incinerator operations and with sample collection (by a consulting firm) compromised the research effort. The testing will be repeated during FY97.

Addressing Industrial Air Emissions

With partial support through WMRC's Research Program, the UIUC General Engineering Program spent the last two years working with an industrial client in the Kankakee area to determine if minor modifications to their manufacturing processes could favorably impact air emissions from the facility. WMRC staff assisted this project by training students in the use of sampling gear, accompanying students to the industrial facility to guide them through the sampling process, and analyzing the samples that were collected. This support effort yielded information on toxic components of the industry's air emissions that the company was unaware existed. Armed with this information, the company went to its suppliers to identify and eliminate the source of this compound. The air emissions data provided by WMRC is being correlated with process modifications implemented at the plant. The General Engineering students and staff hope, as a result of their evaluation, to make suggestions to the facility on improving workplace air quality and reducing overall emissions.

Environmental Movement of Atrazine

Atrazine is a herbicide that is heavily used by Illinois agriculture to control weeds in corn. UIUC produces many acres of corn each year and has traditionally used Atrazine in its weed control arsenal. Recent toxicological information on this

herbicide suggests that it may be a human carcinogen and University researchers have become concerned about the fate of the compound applied to their fields.

WMRC lab staff worked with UIUC scientists to define a sampling plan for collecting water samples in tiles draining University agricultural fields to which Atrazine was applied. Coordinating sampling with rainfall events, these scientists collected several sets of samples from early Spring into Summer. These samples were returned to WMRC where they were analyzed for Atrazine and its environmental breakdown products. Based on the results of this preliminary investigation, the research team has received funding for a two-year study on Atrazine behavior; WMRC will continue to provide analytical support.

Externally Funded Projects _____

In FY96, external contracts continued to support a variety of WMRC activities. Several of the industrial pollution prevention projects discussed in Chapter 3 received support from federal or state agencies, or from the companies being assisted. The Alternative Cleaning Technology Laboratory (ACTL), for example, was started with a combination of state and federal funding. Financial support from USEPA resulted in the hiring of the chemist for the ACTL who has worked with many Illinois companies to replace their chlorinated organic solvent cleaning systems with less toxic alternatives.

Additional federal support continues the development of information resources that were described in WMRC's report for FY95 (HWRIC 1996). Considerable progress has been made on these efforts to develop, collect, compile, and distribute pollution prevention information to technical assistance providers and businesses in Illinois and nationally. WMRC's good working relationship with other pollution prevention programs in the Great Lakes and northeastern states has increased the efficiency of data collection and distribution. This network of technical assistance organizations contributing information

continues to expand and will include groups from southern and western states in the coming year.

The information projects can be divided into those that concentrate on resources for use with printers and those that are more general, covering more than one industry sector. The majority of projects dealing with the printing industry are described in Chapters 5 and 6. The more general projects focus on gathering information and developing materials for technical assistance providers to use with different industries. These projects also examine different mechanisms for sharing information such as meetings, newsletters, listservers, and clearinghouses. Their focus may be regional and/or national.

Great Lakes Regional Pollution Prevention Roundtable (GLRPPR)

This regional group of representatives from government, industry, academic institutions, trade associations, and other groups meet twice a year to exchange information and learn from each other. These annual interactions of the GLRPPR's ~ 350 members from over 160 organizations were coordinated by volunteers until 1994 when the group worked to obtain funding for a director. Funding for a newsletter and to develop a clearinghouse had been obtained by WMRC in 1993. Since 1994, the director was housed at the Cleveland Advanced Manufacturing Program (CAMP) and the newsletter and clearinghouse were housed at WMRC. GLRPPR Steering Committee members intended to seek long term funding to continue employing the director and supporting the other services, and in 1995 decided this would be easier to achieve if all parts of the operation were housed under one host organization. WMRC responded to the GLRPPR's Request for Proposals for a single host in November 1995 and was selected in February 1996.

Funding is being provided by USEPA Region 5 to support a half-time Executive Director for the GLRPPR; continue producing the newsletter, *LINK*; and continue the development of the regional clearinghouse for pollution prevention information. During FY96, WMRC has been working with CAMP to insure a smooth transition. To date, Jackie Peden has been named

Executive Director, some changes have been instituted in the newsletter production, and the clearinghouse materials have increased.

In October 1996, the new GLRPPR Executive Director assumes full responsibility for coordinating the two annual meetings and between meeting interactions of the steering committee and the subcommittees. Tasks include organizing conference calls; arranging for meeting accommodations, speakers, tours, etc.; maintaining the mailing list; and representing the GLRPPR at various meetings. The Executive Director will work with the steering committee to find sources of long term funding for the position and prepare proposals to obtain that financial support.

The GLRPPR newsletter, *LINK*, is a quarterly publication compiled from contributions made by organizations from throughout the Great Lakes states and the Canadian provinces. The newsletter's purpose is to improve communication about pollution prevention activities and accomplishments in the region. It has proven to be a highly valued information resource. Beginning in June, an Editorial Board composed of members of the GLRPPR Steering Committee has helped guide the managing editor in maintaining a high quality content to the newsletter.

GLRPPR Clearinghouse information is contained in two databases, VendInfo and TechnInfo, described below. These databases can be downloaded from the Internet. WMRC also provide the databases on disk to those organizations without Internet access. Both databases were initially developed at the Solid and Hazardous Waste Education Center (SHWEC) in Madison, Wisconsin. WMRC became responsible for their continued development and maintenance in March 1996.

The VendInfo database contains over 1400 vendors and service providers from the US and Canada who manufacture equipment that can be used for pollution prevention. The database can be searched by process (e.g. cleaning or metal finishing) or by equipment type (e.g. acid recovery equipment or air filters). Records for each vendor include company name, address, phone

number, type of equipment, and applicable industrial process. New funding from USEPA's Office of Research and Development and the Department of Energy will fund the updating and restructuring of the database. This will include more detailed descriptions of the vendors and their products, as well as programmatic changes to make locating information easier. To access VendInfo through the Internet use <http://es.inel.gov/cgi-bin/vendinfo.pl>.

TechInfo is a bibliographic database that lists over 14,000 pollution prevention references. The database compiles materials from the libraries and clearinghouses of states represented by the Northeast Waste Management Officials Association (NEWMOA), the Waste Reduction Resource Center (WRRC) in North Carolina, and the states and Canadian provinces in the Great Lakes region. This compilation provides one comprehensive, easy-to-access source of pollution prevention literature. It is searchable by subject, title or author. Each record provides a citation including a brief abstract and the organization holding the work. The Internet address for TechInfo is <http://es.inel.gov/cgi-bin/techninfo.pl>.

Developing a Pilot Inter-Regional Information System

WMRC, NEWMOA, and SHWEC are being funded by USEPA's Office of Pollution Prevention and Technology to explore the available options for sharing information among regional groups. The options include both print and electronic resource guides for technical assistance providers to use with specific industries, listservers, and a national clearinghouse.

Two resource guides have been produced and will be made available in Fall 1996. These guides are to aid technical assistance providers in their pollution prevention efforts with printers and metal finishing operations. Information on pollution prevention options available in each industry were gathered and evaluated for these information packets. The documents present the most effective pollution prevention information and provides additional sources of information and assistance. Two more information packets are being prepared and should be available in the Fall

of 1997. These will follow the same format and be for use with foundries and metal coating operations.

Listservers are also being evaluated as part of this study for their effectiveness as information exchange mechanisms. Two listservers, P2Tech and P2Reg, were originally started at SHWEC to facilitate quick exchange of information among individuals working in the area of pollution prevention. Of the two, only P2Tech is currently active. P2Reg has seen almost no activity and has been de-activated. In March 1996, WMRC assumed full responsibility for maintaining the P2Tech listserver and its archives. This listserver has proven to be a very good and active mechanism to address problems. Information exchange is quick and beneficial. To learn just how useful it has been, follow up with the listserver participants is beginning and the results of this evaluation will be used to make recommendations regarding continuing this service.

Also being evaluated is the use of the databases comprising the clearinghouse for the GLRPPR, NEWMOA, and others. Initial recommendations are that the development of expertise in specific areas by the different groups participating in the project should continue. This expertise and information should be shared as is being done already with VendInfo and TechInfo. Participants should include state clearinghouses from the other USEPA regions. There should be one coordinating agency to update and maintain the databases and distribute the updates. Additional information on the acceptance of this type of mechanism is being gathered through surveys and interviews. The final recommendations will be presented in the project's final report which will be available in Fall 1997.

Pollution Prevention Assistance and Information Database

Over the past four years NIST has established manufacturing modernization programs in all 50 states. In Illinois the Chicago Manufacturing Center (CMC) was established in 1994 and the Illinois Manufacturing Extension Center (IMEC) for the downstate areas is being established in the fall of 1996. The services provided by these

manufacturing assistance centers now include environmental compliance and pollution prevention assistance. In 1995, NIST provided funding to WMRC and three other partners to develop customized information resources and evaluation tools to support the modernization services offered by these programs under a project called Pollution Prevention Assistance and Information Database (P²AID). Staff in these programs have expertise in various business practices and engineering but they are not typically trained in environmental issues or P2 technologies. Thus, existing environmental regulatory and pollution prevention information has to be provided to these staff with suitable background information, explanations, and sources of additional contacts.

By the fall of 1996 a prototype database will be delivered for evaluation by the NIST programs. This first database will include computer software and a manual on the subject of printing. It will be suitable for taking into facilities for on-site assessments and assistance. During the second and third years of this project the prototype version will be revised and expanded based on the needs of the NIST programs and information on four or five additional manufacturing sectors will be added. The tentative manufacturing types to be addressed include foundries, wood products, manufacturing, and coating technologies. In addition to the hardcopy and PC versions of P²AID, the information may be made available and updated by establishing a site on the World Wide Web.

Chapter 5: Activities in the Chicago Area

Introduction _____

There are an estimated 60,000 manufacturers located in northeastern Illinois. In addition there are over 100,000 other businesses. This is about two-thirds of all businesses in the state. WMRC staff provide environmental assistance for all types and sizes of companies as described in Chapter 3. During the past several years emphasis has been given to assisting printers, electroplaters, food processors, and metal finishers because of WMRC's staff expertise and the large numbers of these industries in the state.

To better serve businesses and the public in the northern part of Illinois, WMRC has established the Clean Manufacturing Program (CMP) (see Chapter 2) and a presence at the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). Increasingly the Center is working with the staff of Argonne National Laboratory (ANL) to develop and test new technologies and explore ways to better serve businesses in the area. Two staff are now located there as visiting scientists.

Staff in the Chicago offices have daily responsibility to implement several key Center initiatives. The main initiatives, described in this chapter, are the City of Chicago's Brownfield Forum, Greater Chicago Pollution Prevention Program, Printers' National Environmental Assistance Center, and the Illinois Great Printers Project. In addition, several research projects were sponsored in the Chicago area (see Chapter 4) and WMRC operates information clearing-houses at the main offices on Homan Square and in cooperation with the North Business and Industries Council (NORBIC).

The Chicago offices, in close coordination with the Champaign staff, have been providing assistance with regulatory compliance, pollution

prevention/ environmental and safety assessments, and assistance with the implementation of pollution prevention (P2) programs and projects. The Chicago offices initially had three engineers at CMP and one at MWRDGC to provide technical assistance. The offices have grown to a staff of six full time engineers, one part-time engineer, and a part-time secretary. This increase in personnel was possible through funding from a National Institute of Standards and Technology (NIST) grant plus continued funding from the U.S. EPA Region 5.

The Clean Manufacturing Program has been well received. Chicago area businesses are taking advantage of the technical assistance to increase process efficiencies, to increase marketplace competitiveness, reduce waste generation, and reduce their environmental liabilities. The assistance provided to integrate conservation of natural resources and pollution prevention into the development and application of business policy and management practices is reaping dividends for Illinois. The education of Illinois businesses on the environmental impact of their business decisions, along with economic ramifications, has been part of the training provided by the Center. Most companies readily understand that what is good for the bottom line is good for business. And pollution prevention is good for the bottom line.

Compliance and Pollution Prevention Technical Assistance _____

The Chicago offices have used a number of means to contact companies and market the services provided by the Center. Companies have been referred to the Center by local organizations (community groups, local business development groups, the CMC, POTWs) or have heard of the Center through presentations, workshops, or

mailings. Often the initial request for services is for evaluation of environmental compliance and/or safety issues. Many of these contacts have culminated in pollution prevention/environmental and safety assessments. During the assessments, pollution prevention/waste reduction opportunities, when appropriate, are identified at the facility.

Outreach and Marketing of Services

During FY96, 12 major outreach presentations were given in the Chicago area. These included technical presentations on pollution prevention to local community groups, educational institutions, businesses and trade associations. Presentations were given at Earth Day in Chicago on pollution prevention; at the Chicago Manufacturing Center on Total Quality Environmental Management (TQEM) and again on how to identify pollution prevention/waste reduction opportunities; on a waste reduction case study at an IEPA workshop in Peoria; on pollution prevention for a graduate class at the Illinois Institute of Technology (IIT); on safety at Jane Addams, a local community association; on total cost accounting for waste reduction and process improvement at an American Society of Mechanical Engineers (ASME) seminar; and on pollution prevention and Center services at a MWRDGC workshop, to name a few.

The Chicago offices have been active in disseminating information on the services available from WMRC to the business community, local governmental entities, and local groups. We have taken our message to county fairs, school science days, university lecture rooms, and business luncheons in an effort to educate people about pollution prevention. We never know where or when one of these encounters will pay off. Recently a lawyer for a company called us to request assistance. He had heard one of our presentations, knew we were a non-regulatory service center, and realized his client could use our services. These types of referrals require blanketing the community with our message. To be more efficient, we have established partnerships to better market our services as described below.

Pollution Prevention/Environmental Assessments

In most instances environmental compliance and safety assessments have led companies to improve their waste management and/or safety programs. In several instances they have led to pollution prevention technology development and safety projects. The environmental and cost benefits of these projects are evaluated by Center staff. Usually it is found that the project will result in cost savings, improved quality of product, better working conditions for the employees, and a more environmentally responsive company. Over the last year the Chicago offices, in close collaboration with the Champaign staff, have done the following:

P2/environmental and safety assessments	80
Technical assistance services provided	70
Pollution prevention projects	12

Assessments include facility tours to become familiar with company operations, and process flow diagramming. Technical assistance includes addressing regulatory questions, providing compliance information, assisting with permitting, and return visits to follow up on pollution prevention project implementation.

Along with the above, numerous telephone calls were handled where information or technical assistance has been given or referrals made to other state agencies including DCCA for general business assistance, IEPA for compliance assistance and pollution prevention, and the State Fire Marshall's for underground storage tank issues.

A large number of the assessments have been in industries which historically have generated large amounts of wastes. Sometimes these companies are the easiest to assist with reducing the waste generated. Typically they have heard about P2 and know it is a good thing, but they do not know how to take the first steps. Sometimes they simply need some help getting their programs going. WMRC staff play an important role in getting companies going, and the assessment is a key factor. In the assessment it is determined what wastes are generated, their origin, and why

they are being generated. Out of this assessment WMRC staff use their expertise and the various information resources that the Center has developed to identify and select the most promising pollution prevention options.

Safety Assistance

Safety is a very important issue among small businesses. In many cases these businesses did not know where to obtain answers to their safety concerns, such as training, use of safety equipment, need for safety equipment, safety guarding of equipment, written safety programs, and miscellaneous questions. Providing information to these companies has reduced their liabilities and increased worker safety.

Of the 80 P2/environmental assessments conducted during FY96, 43 also involved safety assessments of the facilities. These safety assessments have led to cost savings for the companies, better working conditions for the employees, safer facilities, training of employees in safe work procedures, and the proper use of personal protection equipment. The assessments usually consist of the review of existing safety programs, a tour of the facility to evaluate the status of existing safety programs, identification of safety equipment, and employee understanding of the safety program. Many of the smaller companies are not aware of the OSHA requirements which apply to them, such as a written safety program, employee training, and documentation.

Technical assistance was given to 17 additional companies by providing copies of Occupational Safety and Health Administration (OSHA) regulations, model safety programs, safety equipment and vendor information, asbestos abatement information, and hazardous chemical information. Through NORBIC we provided safety information and two safety educational seminars to small businesses belonging to this Small Business Development Center. This allowed NORBIC to provide a service they had trouble providing previously.

Pollution Prevention Projects

When a company is committed to the idea of reducing waste, saving money, improving pro-

cesses, and improving quality we can often work with them to achieve these goals through a specific pollution prevention project. Examples of these projects can be found in Chapter 3. Most companies find that they have improved their processes, reduced their waste and waste disposal costs, and are more competitive. The environment benefits since less waste and less toxic waste is being generated.

Partnerships

Chicago Manufacturing Center (CMC) - Integration of Pollution Prevention With Manufacturing Modernization Technical Assistance Project

The staff in the Chicago office have been working with the CMC staff to identify pollution prevention, waste reduction, and process efficiency opportunities at CMC client companies. In addition, WMRC staff look for business assistance needs of companies seeking environmental help that can be referred to CMC. WMRC staff members often accompany the CMC field agents during their facility assessments. This partnership allows WMRC, as a non-regulatory environmental assistance agency, to evaluate a facility with CMC and assist the company with any compliance, waste, or safety issue identified. The benefit of the partnership to CMC is the ability to better assist the client and generate revenues from the various projects identified by WMRC. Initially this project ran from September 1, 1994 to August 31, 1995. Funding was obtained from the U.S. Department of Commerce, National Institute for Standards and Technology (NIST) to continue this effort.

This new project is one of several others funded by NIST aimed at integrating environmental and business modernization services in their Manufacturing Extension Partnership (MEP) program. This endeavor will integrate environmentally focused technical assistance for small and mid-size manufacturers into the efforts of MEPs interested in providing these services. This will be accomplished by training the MEP staff to identify waste reduction opportunities, developing

assessment tools to assist MEP staff, evaluating MEP assessment methodology, assisting MEP staff on assessments to identify project opportunities related to environmental and safety areas, and working with the MEP to develop group projects for specific industrial sectors. The assessment tools will be developed to help promote environmental responsibility, pollution prevention awareness, and cost benefit analysis. The overall goal is to train the MEP staff to recognize and identify pollution prevention/process efficiency opportunities for their clients and be able to convey the benefits to the client. This is a two year project which runs from September 1, 1995 through August 31, 1997. To date eight training modules have been prepared and viewed by MEP staff, two pollution prevention cost benefit analysis training sessions/workshops have been held, three MEP assessments have been evaluated, a pollution prevention opportunities demonstration was held at an MEP client facility, and various industrial sector focus groups have been held to determine industry needs.

NORBIC

A collaborative partnership of WMRC and NORBIC was formed for outreach to the businesses in the NORBIC service area. NORBIC is a highly successful economic development organization assisting in the retention, expansion, and development of business and industry, primarily on Chicago's north side. NORBIC serves over 1,700 manufacturing companies, representing over 300,000 jobs in the Chicago area. Businesses in the area have come to trust NORBIC's services. The partnership between NORBIC and WMRC focuses on providing environmental compliance and pollution prevention assistance to businesses in the NORBIC area. WMRC staff answer questions about environmental regulations, compliance issues, safety concerns, and implementation of pollution prevention technologies and programs. This technical assistance is being provided by referrals from NORBIC, by accompanying NORBIC's staff to facilities in their area, by the establishment of a satellite pollution prevention clearinghouse at the NORBIC office, and meeting twice a month at NORBIC with clients to discuss specific environmental issues. This

partnership has proven to be an effective way for WMRC to work with a trusted and credible business organization to reach their members.

Argonne National Laboratory (ANL)

A new partnership with ANL is underway to establish a means to bring technology and scientific expertise from the research laboratory to businesses. Argonne's research in pollution prevention and environmental remediation could be of great benefit to Illinois companies. Often these companies are unaware of or do not understand some of the more advanced technologies and require assistance in order to utilize the technology effectively at their facility. We are presently proposing a pilot demonstration of an ANL remediation technology at a facility which has a small oil spill. ANL is interested in using a remediation technology using a foam injected into the soil below the oil spill. The foam will rise to the surface carrying with it some of the oil. The foam being injected will also contain microorganisms which will digest the oil, so that the oil which is left behind in the soil will be food for the microorganisms. Clean-up efficiency at the laboratory scale is over 90%. This is an ideal opportunity to apply laboratory successes in a real world setting. Though the company does not have the funds to remediate the spill, ANL may be able to use the facility as a field demonstration of the remediation technology. In this instance, all parties should benefit.

Commonwealth Edison

The Champaign and Chicago offices recently began working with Commonwealth Edison, the main electric utility of northern Illinois, to develop a partnership to provide technical assistance and energy conservation assistance to companies in and outside of the ComEd service area. So far, one company with an environmental concern has been visited by WMRC and ComEd. While WMRC addressed the environmental issues, ComEd evaluated the state of the facility's production equipment. From their evaluation, ComEd presented the company with various options in energy usage and equipment maintenance for a more efficient operation. ComEd brings a knowledge of energy consumption and process equip-

ment energy requirements to companies still operating under the premise that energy is cheap. Any waste of a resource is inefficient and effects a companies bottom line. This partnership is another avenue to reach companies not readily willing to have a state agency touring their facility.

Graymills

Graymills is a manufacturer of industrial (from counter top to shop floor) automatic parts cleaners. They have been proactive in working with the Center to provide environmentally safe, yet effective cleaning agents for their clients to use in their parts cleaners. This partnership will involve evaluating various aqueous and semi-aqueous cleaners and how well they clean in various real world environments. Many companies in the Chicago area, because of its ozone non-attainment status, are switching from organic solvent parts cleaning to aqueous systems.

Brownfields

Chicago acquires abandoned, tax delinquent properties on a regular basis. Some sites are contaminated and must be remediated. This leaves the city responsible for cleaning up the contamination and putting the property back on the tax rolls. The City's Brownfields Forum has been identifying issues impeding the return of these properties to productive use. WMRC has participated in the forums and our role would be to assist companies interested in a brownfield property with evaluating the companies pollution prevention program. This would involve (1) characterizing waste generating sources within the facility; (2) identifying ways to change or modify materials, processes, practices or products contributing to waste generation; (3) implementing pollution prevention measures that are determined to be technically and economically feasible; and (4) periodically re-evaluating individual pollution prevention options and redefining waste management goals where necessary. The benefit to Illinois is that companies moving into brownfields would be aware of best waste management practices and would increase their ability to operate more efficiently and competitively. This would

also mitigate the chances of the site becoming a brownfield again.

A Final Report and Action Plan was issued by the Brownfields Forum on December 7, 1995. The plan lays out a strategy to enhance business development, job creation, an increased tax base, community revitalization, and environmental remediation which otherwise might not have occurred. In November, 1993, the City of Chicago launched a pilot program to remediate five abandoned properties over a two year period for private development. Work is nearing completion and new sites will be identified.

Greater Chicago Pollution Prevention Program

The Greater Chicago Pollution Prevention Program is a cooperative effort between the MWRDGC, the City of Chicago, IEPA, USEPA, Citizens for a Better Environment and the Chicago Legal Clinic. This cooperative effort was begun about four years ago. The objectives of this program are for the participating organizations to work together to assist companies in the Chicago area to reduce the generation of pollution at the source and to educate companies on the multimedia impacts of waste generation.

During FY96, WMRC undertook four main tasks: to provide information on pollution prevention, conduct training to MWRDGC and City of Chicago staff on pollution prevention techniques, make presentations to promote pollution prevention concepts, and conduct on-site assessments at industrial facilities of compliance issues and pollution prevention opportunities. During the year WMRC staff involved in this project made 41 site visits to 23 companies. In addition, over 130 company and individual requests for information and assistance were fielded. In several cases these assessments resulted in pollution prevention research and demonstration projects which were supported by WMRC staff and facilities in Champaign. These projects are described in more detail in Chapter 3. Presentations on pollution prevention were made to 11 organizations including the Industrial Pretreatment/Hazardous Waste

Committee of the Illinois Water Environment Association, the Industrial Waste Annual Meeting of the MWRDGC, the Automotive Parts Rebuilders Association Annual Clinic, an accounting consultant, Commonwealth Edison, and the Northern Illinois Water Analysts.

Great Printers Project_____

WMRC began working with others in the Great Lakes Region on this project in 1993. This regional project has been led by the Council of Great Lakes Governors, the Environmental Defense Fund and the Printing Industries of America. Emphasis during FY96 was on developing a manual for lithographic printers on environmental compliance requirements in Illinois, agreeing on criteria for designating a company as a "Great Printer," and providing technical assistance to printers on both compliance questions and pollution prevention.

The environmental compliance manual has been a joint effort with technical experts from WMRC and the printing industry, regulatory experts from the Illinois EPA, and environmental experts from the Center for Neighborhood Technology. The draft manual not only will provide a detailed description of all the regulatory requirements that affect printers, but it will also include information on how pollution prevention options can be used to meet those regulations. This manual is expected to be published in the fall of 1996.

Criteria for being designated a "Great Printer" include pledging to work with suppliers, employees and customers to improve the environment through waste reduction; committing to the Great Printer Principles and agreeing to comply with current environmental practices; and implementing pollution prevention efforts and providing an annual progress report. WMRC will help companies implement pollution prevention efforts and will help evaluate their progress.

Many printers in Illinois have requested compliance and pollution prevention information and assistance from WMRC during the past year. The primary responsibility for responding to these

requests has been our Chicago-area staff because most printers are located in that area and two of our Chicago staff have this specific expertise. Often these requests resulted in invitations to conduct on-site compliance reviews and pollution prevention opportunity assessments. In the future these activities will be continued and expanded as described in Chapter 6.

Printers' National Environmental Assistance Center_____

The Printers' National Environmental Assistance Center (PNEAC) is one of four small business compliance assistance centers funded by USEPA to fulfill commitments by President Clinton and Administrator Browner. PNEAC is a unique partnership between pollution prevention technical assistance organizations and printing trade associations. The Center began working with these groups in July 1995. PNEAC is designed to complement existing service providers by increasing access to the best information and expertise available. The intent is to be a one-stop-shopping source for printing related information for printers, technical assistance providers, regulators (both state and federal), and pollution prevention assistance providers.

A service of PNEAC is developing and operating two listservs: PRINTECH and PRINTREG. Printech focuses on pollution prevention technical issues and Printreg focuses on regulatory issues.

PNEAC identified through various focus groups that printers are concerned about anonymity. Because the internet could compromise anonymity, questions are posted for printers and provide them with the annotated responses. PNEAC team members also monitor the listserv to prevent advertising of commercial vendors and prevent controversial topics such as seeking opinions on companies.

PNEAC also attempts to link these listservs with other relevant listservs. Specific team members assume responsibility for monitoring P2 TECH and the Small Business Ombudsman listserv. The team member forwards printing

related and other relevant e-mails to Printech and Printreg.

PNEAC has also developed a World Wide Web Home Page. The home page contains information about conferences, regulatory initiatives, hot news, and previously asked questions as well as links to other related web pages and contact people. PNEAC also has various case studies and fact sheets available on this web site.

Research _____

Three applied pollution prevention research projects in the Chicago area were funded by WMRC under our Reduction and Recycling Techniques/Technologies (RRT) Program. These projects as described in Chapter 4. In total, WMRC provided \$20,000 in matching funds to support these studies. In addition to funding these studies, WMRC's laboratory staff were involved in a research study of potential air emission from a landfill located in the Chicago area, also described in Chapter 4.

Chapter 6: Sustainability Through Partnering



Introduction

The Illinois Waste Management and Research Center has begun its second decade of service to industry and the citizens of the state in a new Department and with a new name. Both of these events have encouraged the Center to expand its focus and to look more broadly at the issues of resource conservation, pollution prevention, advanced waste management, and sustainable development. As we did in our last annual report (HWRIC 1996), we focus our discussion here on ways we anticipate we will partner with others to address the remediation and restoration of contaminated sites, and to prevent future waste problems by assisting industry with pollution prevention techniques and technologies.

The mission of the Illinois DNR is to promote an appreciation of the state's natural resources and work with the people of Illinois to protect, manage and enhance those resources to ensure a high quality of life for present and future generations. WMRC has a significant role to play in this regard. Through its pollution prevention activities the Center works to help prevent releases of contaminants to the environment, and to more responsibly manage those wastes that are produced. Through its research and technical assistance efforts it is identifying the nature and extent of contamination at specific sites in Illinois, and exploring ways that these sites can be remediated. Within DNR we have the opportunity to define and help remediate contamination on state lands, and help assure that these lands will be protective of wildlife and humans.

The Center also realizes that the complexity of today's waste management problems means that a variety of organizations and expertise are needed to help solve these problems. The cooperation of many different elements of our society is required to achieve sustainability. Each citizen has a role

to play in extending the life of valuable natural resources and in protecting the environment which we all share and enjoy. WMRC's role is to provide innovative ideas and reliable information, to identify research areas needing further definition, and to work with others to help solve past problems and prevent future ones.

In this chapter, we discuss partnering activities within our own agency. We then address ways we are working together with other agencies and organizations within the state. Our discussion of a specific proposed industrial ecology project provides a model for partnering between state agencies, industry and private groups to enhance our state's natural resources. We conclude this chapter with a discussion of regional Great Lakes partnerships that are important to sustainability for the state and region, and with emerging partnerships that we believe will take on greater importance in the future.

This chapter reflects our present and projected efforts to reduce and better manage waste, to enhance industrial productivity, and to preserve and improve Illinois' environment for future generations. We consider these partnerships important components of a longer term sustainability program for Illinois. It will take a variety of people and organizations working together to sustain and improve our environment and natural resources into the future. We welcome your ideas, suggestions, and interest in partnering to help accomplish these goals.

Partnering within DNR

DNR senior management is aggressively seeking to foster communication and cooperation between divisions in the new Department. As part of this effort, DNR celebrated its first anniversary this summer with a series of orientation events where staffers and senior managers from different

divisions could meet. The Region 3 event was held at the Natural Resources Building in Champaign and was chaired by WMRC's John Marlin. The half-day event included exhibits, facility tours, a cookout, and a two-hour seminar on the Department with emphasis on Region 3's resources. Presentations included: the DNR video, updates on the Midewin Tall Grass Prairie, the low level radioactive waste facility siting process, climate change, and the functions of WMRC.

This event in combination with others such as the regional managers meetings, leadership workshops and strategic positioning workshops will lead to a greater overall understanding of resources and expertise available within the Department. This in turn will facilitate cooperative efforts between divisions for enhancement and protection of natural resources. Some areas where WMRC might significantly contribute to Department-wide problems are highlighted below.

The DePue Contamination Site

Background

In the early 1980s sediment from Lake DePue was dredged and disposed in a diked area on DNR land. These sediments exhibited metal contamination from nearly 80 years of exposure to wastes emanating from a zinc smelting facility in the town. The Illinois Environmental Protection Agency (IEPA) recently entered into agreement with the owners of the industrial smelting site (the Responsible Parties, or RPs) to define environmental risks associated with that site and begin to mitigate these risks. The dredged material disposal site on Department land has remained an unresolved issue in this agreement, but DNR has engaged in discussions with IEPA to explore mechanisms for the resolution of site problems.

Preliminary surveys of the dredged sediments have revealed that concentrations of zinc and cadmium are elevated well above background levels. These high concentrations of metals are distributed both horizontally and vertically through the approximately 500,000 cubic yards of sediment residing within the diked area. DNR will be required to characterize the site in detail and identify potential risks from the contaminated

sediments to the surrounding environment and to the human population using or living in the vicinity of the site.

If DNR secures funding and agrees to accept responsibility for characterizing the site, to identify potential environmental risks associated with that site, and to explore options to mitigate those risks, the Department will have immersed itself in the complex Remedial Investigation/Field Study (RI/FS) process that has its roots in national Superfund legislation. This process begins with the issuance by the regulatory agency (IEPA) of a Statement of Work. The Department received a draft of this document from IEPA in late May 1996. A response to that draft is in preparation and may be presented to IEPA during Fall 1996, depending on the outcome of further discussions with the Agency. Once a consensus Statement of Work is in place, the Department will be responsible for developing first a Site Assessment Plan, and then an RI/FS Work Plan, that address in detail the Department's site study plans for the next several years.

WMRC, in conjunction with DNR legal staff, has taken the early lead on defining probable field survey activities and the cost implications of that work. A DePue Working Group, with representation from the three scientific surveys, DNR legal staff, and WMRC has been formed to serve as a coordinating body to begin planning for work that will likely be required and to identify technical expertise within the Surveys which might address that work. The Work Group has also been involved in developing some cost estimates for use by the Department as they pursue funds from the state to fulfill DNR obligations to the RI/FS process.

Opportunities

Efforts at DePue represent an exceptional opportunity to apply the technical expertise available at the Surveys and Center to a Departmental problem. Most of the technical issues involved in characterizing the site and its associated risk, and some of the issues surrounding potential remediation at the site, can be addressed by existing staff of these organizations. The Center is presently working with DNR manage-

ment to hire an experienced remediation engineer to serve as the project manager for this site. This Remediation Specialist will be assigned to WMRC and will report to its Director. The Remediation Specialist will be charged with effectively utilizing Department resources, including Survey/Center expertise, in order to define and seek resolution to problems at DePue.

Ideally, the Remediation Specialist would be hired in time to assist development of the planning documents required in the RI/FS process. The Remediation Specialist will define project needs to the Department and work with Department staff to secure the funding necessary to take the RI/FS process through to completion.

WMRC is exploring ways in which its research funds can be used to build on the RI/FS work in the DePue area, with a goal of improving our scientific understanding of the behavior and impact on the environment of these metals. Project ideas will be solicited through the Research Program's solicitation process and one or more applicable projects will be funded. WMRC will also explore, in coordination with IEPA, opportunities to gain additional research funding from the DePue site RPs.

WMRC staff will have direct involvement in the RI/FS process. Engineering expertise on staff will be called upon to help guide activities at the site, review planning documents and data reports, and interpret results in terms of needed corrective actions. Staff engineers may also assist in defining remediation alternatives and in securing and overseeing outside contractors to provide the remediation effort. WMRC analytical staff will analyze samples for metals and other contaminants in support of site characterization efforts. They will also play an important role in providing quality assurance oversight for all site activities and in assisting the Remediation Specialist's interactions with other Office of Scientific Research and Analysis scientists.

Natural Resources Damages Assessments

An additional aspect of this site investigation involves recovering Natural Resources Damages from the smelting site owners. IEPA is urging

DNR (both agencies are stewards of the state's natural resources) to become involved in a damage assessment at DePue. Additional funding support will be needed if the Department agrees to conduct the studies needed to establish the magnitude of these damages in the greater DePue area.

WMRC's Remediation Specialist will also play a role in the Natural Resources Damages issue. DePue represents a potential test site for the state to develop a viable program in this area. The problems at this site will allow the Department to begin to define what constitutes a Natural Resources Damages claim and to explore the legal processes leading to a settlement at DePue.

GIS Support

WMRC's Information Services Program provides detailed information on potential contamination at existing DNR sites and those the Department is interested in buying or managing. The information includes Geographic Information System (GIS) maps showing the location of known factories, smelters, and other facilities which used hazardous materials or processes. Also included is information on landfills, superfund sites and other areas of potential concern. The information is useful in defining, prior to purchase or construction, the potential for contaminated water, soil or sediments existing at a site.

Over the rest of the year WMRC will work with other DNR staff, especially in the Office of Realty and Environmental Planning, to determine what mix of information will best meet Departmental needs. The goal will be to update existing databases and develop others that will help in the management and acquisition of land. Future efforts may involve visits by WMRC engineers with pollution prevention and remediation experience to existing and potential DNR sites. Such visits may help identify problem sites and will facilitate the adoption of improved housekeeping practices to prevent spills and avoid contamination.

Addressing Issues at Contaminated State Lands

DNR manages many parks, trails, and wildlife management areas throughout the state. Over the

last year, WMRC has been involved in providing assistance on a number of waste and contamination issues at existing sites, and on the acquisition of new lands. In the latter case, WMRC data management staff have utilized GIS data on contaminated sites, and our historical hazards database to determine the potential for existing contamination on properties of interest to the Department. Such data are also used to define potential hazards at construction sites on Departmental lands. Of particular concern are dredging operations where sediments may contain sufficient concentrations of contaminants to require special handling and disposal.

WMRC is working with others at DNR to expand our activities in this area. In particular, we are formalizing our process for review of activities related to the purchase of new lands and construction activities at existing lands. WMRC will provide the review and GIS data searches at each of these sites. WMRC's new Remediation Specialist, based in Springfield, will be the agency's lead person to address contaminant issues on state lands. In cases where cleanup may be necessary, the Remediation Specialist will take the lead to work with other DNR divisions and offices to bring the necessary resources together to address RI/FS type issues, will interface with IEPA and other agencies, and will be responsible for the preparation of necessary documents.

Livestock Waste Management Facilities Act

Among the more controversial environmental legislative issues this session was a bill to regulate management and design of large livestock facilities. An increase in the number of facilities planning to raise thousands of hogs at one site precipitated the legislation. The legislation seeks to protect the environment from spills, groundwater contamination, and odors while allowing Illinois livestock producers to remain competitive.

The legislation established a Livestock Management Advisory Committee representing the Departments of Agriculture, Natural Resources, Public Health and the Environmental Protection Agency to recommend rules for implementation of the law. WMRC's John Marlin is representing

DNR on this committee and chairing the Department's internal livestock waste team. The internal team consists of representatives of a number of Departmental units including Fisheries, Water Resources, Mines and Minerals, Scientific Research and Analysis, and Realty and Environmental Planning.

Participation in this process is bringing WMRC into contact with a number of potential partners within the Department, state government, and the agricultural and environmental communities who share a common interest in agricultural waste issues. This participation is another example of the expanding services that WMRC can provide to our Department and the state.

Partnering with IEPA _____

P2 and State Government

WMRC continues to explore ways to further partner with IEPA, particularly in the area of pollution prevention. One activity this past year was our mutual participation on the state's Pollution Prevention Advisory Committee. This legislatively formed committee is exploring a variety of ways in which pollution prevention can be further supported and promoted in the state. DCCA joins IEPA and WMRC as the third government agency participating on this council.

In FY96, IEPA, with assistance from WMRC, initiated a state government pollution prevention project. The project objectives are to determine recent pollution prevention and recycling activities ongoing in state agencies, to determine where real success stories are occurring, and to look for ways to further promote pollution prevention within state agencies. This effort also includes beginning to determine the present waste management needs of some of these agencies. It is hoped that some agencies and/or their specific facilities will seek WMRC or IEPA help in doing facility audits and in developing pollution prevention plans. A workshop is planned to review preliminary data collected from a survey and to highlight needs and successes. A final report with recommendations for future actions will be submitted to the Pollution Prevention Advisory Council and to the Governor's Office.

Accounting Project

IEPA has received a federal grant to pursue pollution prevention training for public accountants. WMRC worked with IEPA staff to help secure this funding and is assisting with selection of a contractor. A contractor will be retained to research, design, develop, and pilot a training course for certified public accountants. This course will focus on P2 principles/benefits and environmental accounting programs, tools, and techniques relevant to environmental management activities for advisors of small to medium-sized businesses. WMRC and IEPA have been working with Illinois professional accounting associations who have indicated a strong interest in providing this course to their members. P2 programs and accounting associations in several other Great Lakes states have also indicated an interest in this course. One long-term benefit envisioned from this project is that small business managers will be able to obtain economic evaluations of P2 options from a trusted service provider. Currently most accountants do not have the expertise to convey this information which, in our experience, is often a significant impediment to businesses implementing P2 projects.

Partnering with Manufacturing Extension Centers _____

CMC

The Chicago Manufacturing Center (CMC) is a not-for-profit corporation funded in part by the National Institute of Standards and Technology (NIST), a division of the U.S. Department of Commerce. The goal of CMC is to help small to medium-sized manufacturing companies upgrade their equipment, improve their processes, and strengthen their business performance. WMRC has been co-located with CMC for the last several years to help integrate pollution prevention and environmental concerns into various business practices. WMRC assists CMC in evaluating environmental concerns of businesses requesting assistance and strives to integrate pollution prevention considerations into business modernization projects. A NIST contract on environmental integration, received by CMC in September,

1995, which has WMRC as CMC's major subcontractor, is allowing the Center to expand its pollution prevention activities in the Chicago area. The contract will continue through this year.

Illinois Manufacturing Extension Center

NIST has awarded a contract for a new Manufacturing Extension Partnership for downstate Illinois. Current plans will place this new Illinois Manufacturing Extension Center (IMEC) in Peoria on the Bradley University campus. WMRC played a part in the drafting of this proposal and plans to develop a partnership with IMEC modeled upon the relationship already established with the Chicago Manufacturing Center. WMRC technical assistance personnel will work closely with IMEC field agents to help client companies modernize their operations with respect to environmental issues and improved operating efficiency. The partnership with IMEC will provide WMRC with access to a new set of potential industrial clients in downstate Illinois.

Industrial Ecology—The PIE Effort

According to Graedel and Allenby (1995) of AT&T, industrial ecology can be defined as “the means by which humanity can *deliberately and rationally* approach and maintain a *desirable* carrying capacity, given continued economic, cultural, and technological evolution.” The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal.

WMRC is interested in working with a cluster of companies to develop a joint industrial ecology project. Under the project umbrella, mutual regulatory issues (and areas of regulatory relief) might be addressed, as well as ways that companies collectively could work to enhance the environment in which they operate. A goal would be to help all the companies operate more efficiently and better utilize resources, while cooperating in environmental improvement efforts.

The Center is just beginning to explore one such opportunity, the PIE (Partnership for Industry and Ecology) initiative. This initiative would foster a partnership between the state (DNR, IEPA), industry and other groups in the area of the old Joliet Arsenal and the newly designated Midewin National Tallgrass Prairie (part of the state's Prairie Parkland Macrosite). The goal is for these partners to create and cooperatively implement a sustainable development program that would enhance the natural resources of the area and promote local industrial and economic development.

It is hoped that the PIE program will become a cornerstone for future environmental protection and enhancement strategies for Illinois and the nation. It will illustrate how industry and the state can work cooperatively to enhance economic development, industrial viability and the environment. The Prairie Parkland Macrosite will be a national showcase, not only for its unique prairie, but for its industrial ecology initiative that assures sustainability for the area.

Regional Efforts _____

Great Printers

For the past 3 years WMRC has been working with other agencies, environmental organizations and printers in the Great Lakes region to promote pollution prevention practices in the printing industry. In the fall of 1996 the Council of Great Lakes Governors, including Illinois' Gov. Edgar, signed a commitment to this project. Gov. Edgar pledged that the participating agencies in Illinois would work to enroll 125 printers in this program by the summer of 1997, review printing practices in state government to determine if they are consistent with Great Printers' recommendations, and streamline the regulatory reporting system.

Over the next year WMRC staff will work with the other project partners to provide compliance and pollution prevention assistance to printers, present a series of workshops for printers, and identify ways to improve the regulatory permitting and reporting system in Illinois.

Great Lakes Regional Pollution Prevention Roundtable (GLRPPR)

For many years, the GLRPPR has provided a forum for environmental professionals from states in the Great Lakes region to share information about the pollution prevention activities of their organizations. Members of GLRPPR come from regulatory and non-regulatory state agencies, federal agencies, universities, regional groups, private and other organizations. All share a common goal of helping each other and others in the region to learn more about successful pollution prevention programs and options and how to modify these concepts and implement them into their operations (and the operations of the businesses in their communities) to achieve reductions in waste generation.

Staff from WMRC were among the founding members of this originally all-volunteer organization. An executive director was appointed in 1994 to coordinate meetings and other Roundtable activities, which included a newsletter, and a clearinghouse. WMRC played a large role in the early development of the clearinghouse and now maintains its databases and printed materials. Center staff produce the regional newsletter with the aid of a journalism graduate student who solicits contributions from member organizations.

Beginning in September 1996, WMRC staff assumed the responsibilities of the executive directorship of the Roundtable. This new involvement for the Center has already resulted in the organization of an editorial committee to contribute to and review the newsletter. The new director will coordinate the services that the Center provides to the Roundtable in addition to providing oversight to committee meetings and two semi-annual all-member meetings (see Chapter 4). Services will be expanded to include training on how to obtain clearinghouse information and to use clearinghouse resources.

WMRC has been a strong proponent of pollution prevention and has been a long-term, active participant in the GLRPPR and other groups interested in promoting waste reduction at its source. The Center is currently working with other regional and national organizations to

explore information resources and how their contents are used and distributed (see Chapter 4). These efforts will compliment and expand the services that WMRC can provide not only to the GLRPPR members but also to its own staff and those of other Illinois agencies, communities, businesses, and citizens.

Emerging Partnerships _____

Expanding Existing P2 Partnerships

WMRC technical assistance personnel continue to build strong partnerships with Illinois utilities. Efforts to work with state POTWs to help their industrial users reduce waste discharges have continued to reap significant rewards. Additionally, WMRC personnel have worked closely with power utilities to assist them in their efforts to help power customers identify and exploit technology opportunities that can improve efficiency and reduce waste. It is anticipated that the coming year will bring many opportunities for collaboration with various power utilities.

Greater Chicago Pollution Prevention Project

Both the MWRDGC and USEPA Region 5 have provided additional funding to continue this project through September 1997 (see Chapter 5 for further description). New tasks to be undertaken include continuing to provide P2 and compliance assistance, establishing a P2 award program with the District, and assisting USEPA with promoting the Wa\$teWi\$e program. The Wa\$teWi\$e program is a voluntary initiative with businesses to focus on reducing and recycling industrial solid waste. WMRC staff will also work with the City of Chicago, Cook County and IEPA to train their inspectors in P2.

A major new effort in the project involves project partners working with the North Business and Industries Council (NORBIC) to identify ways to streamline the environmental regulatory system in Chicago and to improve delivery of assistance services. A focus group of business volunteers is being formed to help address these issues.

Argonne National Laboratory

At the end of FY96, two WMRC Chicago office staff were accepted as Visiting Scientists and located at Argonne National Laboratory (ANL) in the southwest Chicago area. The Center's Office Manager for Chicago also spends at least one to two days a week at ANL. The goal of this partnership is for our staff to gain familiarity with ANL's staff expertise and unique technical resources. WMRC will identify practical environmental issues of businesses for the team of WMRC and ANL staff to address. For example, a proposal from a company is being considered that would establish an aqueous cleaning research and demonstration laboratory at ANL and provide a commercial-sized unit at the company. Different commercial cleaning products would be evaluated using the cleaning equipment and the information garnered would be made available to other industries seeking cleaning assistance. This and other technologies will be explored over the next year, with the goal of establishing a joint research and testing program with ANL.

WMRC staff have collaborated with staff at ANL in a variety of ways over many years. One recent effort has been the Manufacturing Engineering, Research and Training Coalition (MERTC) project which was spearheaded by ANL. MERTC provides access to manufacturing information from a number of academic and research institutions to interested users via the Internet. Among other features, MERTC provides direct links to the homepages of participating partners and the ability to search for information on a variety of technical topics of interest to Illinois manufacturers. The MERTC homepage address is <http://www.anl.gov/MERTC/>.

Summary _____

The Center is still in the early stages of developing a Sustainable Illinois program that connects state agencies, business and environmental groups, municipalities, and other players who must be involved in such a far-reaching effort. The partnerships and working relationships developed to date with a variety of organizations are important in this effort. Within the limits of the Center's resources and staff we will: (1) build

on our direct pollution prevention assistance by exploring new partnerships and relationships that will help us gain increased access to Illinois companies; (2) play an active role in education and information dissemination; and, (3) explore opportunities to enlighten and bring together others who might be able to play a larger role in defining and creating a sustainable future for our state.

References

Graedel, T.E. and B.R. Allenby 1995,
Industrial Ecology, Englewood Cliffs, NJ:
Prentice Hall.

HWRIC 1993, Illinois Hazardous Waste
Research and Information Center, Annual Report
Fiscal Year 1993, HWRIC Report AD94-024.

HWRIC 1994, Illinois Hazardous Waste
Research and Information Center, Annual Report
Fiscal Year 1994, HWRIC Report AD95-025.

HWRIC 1995, Illinois Hazardous Waste
Research and Information Center, Annual Report
Fiscal Year 1995, HWRIC Report AD96-026.

Electronic References

WMRC Homepage:

<http://www.hazard.uiuc.edu/wmrc>

DNR GIS Homepage

<http://denr1.igis.edu/gis/igishome.html>

VendInfo Access

<http://es.inel.gov/cgi-bin/vendinfo.pl>

TechInfo Access

<http://es.inel.gov/cgi-bin/techinfo.pl>

PNEAC Homepage

<http://www.hazard.uiuc.edu/pneac/pneac.html>

MERTC Homepage

<http://www.anl.gov/MERTC/>

Appendix A: Staff Publications and Presentations

Barnes, Kenneth M. 1995. "Pollution Prevention and Current Regulatory Issues Pertaining to the Commercial Painting Industry." Illinois-Michigan-Indiana Paint and Decorators Association Convention (Rockford, IL, July 7, 1995).

Barnes, Kenneth M. 1995. "Using Pollution Prevention to Reduce Regulatory Exposure (Case Studies)." Illinois Valley Community College (Ogelsby, IL, August 24, 1995).

Barnes, Kenneth M. 1995. "HWRIC Pollution Prevention Services." *Pollution Prevention and Waste Minimization Workshop*, sponsored by the Water Environment Federation (Rosemont, IL, August 30, 1995).

Barnes, Kenneth M. 1995. "Pollution Prevention and Current Regulatory Issues Pertaining to the Small Business Paint and Decorators Association." Presented to Lewis & Clark Chapter, Paint and Decorating Contractors of America (Belleville, IL, October 16, 1995).

Barnes, Kenneth M. 1995. "An Introduction to Pollution Prevention for Manufacturing Extension Center Field Agents." Presented at the Western Illinois Manufacturing Technology Extension Center (Moline, IL, November 21, 1995).

Barnes, Kenneth M. 1995. "An Introduction to Pollution Prevention for Manufacturing Extension Center Field Agents." Presented to the Central Illinois Manufacturing Extension Program (Peoria, IL, November 22, 1995).

Barnes, Kenneth M. 1995. "An Introduction to Pollution Prevention for Manufacturing Extension Center Field Agents." Presented at the Joliet Junior College Manufacturing Extension Center (Joliet, IL, November 28, 1995).

Barnes, Kenneth M. 1995. "An Introduction to Pollution Prevention for Manufacturing Extension Center Field Agents." Presented at the North Central Illinois Manufacturing Extension Center (Crystal Lake, IL, November 30, 1995).

Barnes, Kenneth M. 1996. "Harris Corporation: The Road to Continuous Improvement." Presented at the *Southern Illinois Environmental Managers Association Conference*; (Carterville, IL, March 11, 1996).

Barnes, Kenneth M. 1996. "ISO 14001, International Environmental Management Standards," 16th Annual Illinois Recycling Associations Convention (Pollution Prevention Assistance and Information Database, (Rockford, IL, May 8-9, 1996).

Barnes, Kenneth M. 1996. "Household Hazardous Waste and Pollution Prevention." Presented to the Cerro Gordo Women's Club (Cerro Gordo, IL, April 23, 1996).

Barnes, Laura L. 1996. "Pollution Prevention Information Distribution in the Great Lakes Region." Presented at the *Great Lakes Information Network Conference* (Lansing, MI, April 8, 1996).

Beatty, Christopher D., T.M. Chow, G.M. Eversole and J. W. Cochran. 1996. "Extraction of Quaternary Ammonium Compounds from Water Using a Cation Exchange Disk." Presented at the *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* (Chicago, IL, March 3-8, 1996).

Chow, T.M., B.D. Daniels, V.M. Boddu, and S.W. Maloney. 1995. "Rapid Analysis of Nitroaromatic and Nitramine Explosives in Pink Water by Capillary Electrophoresis." Presented at the *International Ion Chromatography Conference—95* (Dallas, TX, October 1-5, 1995).

Chow, T.M., B.D. Daniels, J. Liu and N. Adrian. 1996. "Analysis of the Transformation of

Nitroaromatic Compounds in Waste Water by Bacteria Using Micellar Electrokinetic Capillary Chromatography." Presented at the *EnviroAnalysis '96 Conference* (Ottawa, Canada, May 13-16, 1996).

Cochran, Jack W. and Eric W. Hoglund. 1996. "Evaluation of USEPA Method 1664 and a Solid Phase Extraction Disk Method for Determining Oil and Grease in Surfactant Laden Wastewaters." Presented at the *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* (Chicago, IL, March 3-8, 1996).

Cochran, Jack W., Gina M. Eversole, David Green, Dan McGinness, Val R. Beasley, and Martin G. Greenwell. 1996. "Analysis of Fish Tissue for Amines and an Alkyl Tin Using the MS-MS Capability of an Ion Trap Mass Spectrometer." Presented at the *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* (Chicago, IL, March 3-8, 1996).

Eversole, Gina M., Jack W. Cochran and Christopher D. Beatty. 1996. "Purge and Trap Grade Water from a New Carbon Extraction Disk." Presented at the *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* (Chicago, IL, March 3-8, 1996).

Eversole, Gina M., Jack W. Cochran, George M. Frame, and Mitch Hastings. 1996. "Congener-Specific PCB Analysis Using a New, Low Bleed, GC Stationary Phase with Ion Trap Detection." Presented at the *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* (Chicago, IL, March 3-8, 1996).

Frame, George, J.W. Cochran, and S. S. Bowadt. 1996. "Capillary GC Systems Optimized for Determination of Complete PCB Congener Distributions in Aroclor Mixtures." Presented at the *American Chemical Society National Meeting* (New Orleans, LA, March 27, 1996).

Freeman, H. and D.L. Thomas. 1996. "Evaluation of the Environmental Pollution Prevention Project (EP3) - Cairo, Egypt." Unpublished report to USAID, Washington, DC, based on a site visit and review (January 12-20, 1996).

Lindsey, T., S. Neese, and D. Thomas. 1996. "Implications of Pollution Prevention for Water Pollution Control." Water Quality International, March/April 1996, Oxford, UK, p.32-36.

Lindsey, T.C. 1995. "Utilization of Membrane Separation to Extend the Life of Various Industrial Process Solutions." Presented at the Electric Power Research Institute Conference for Food Processors (Oakbrook, IL, July 13, 1995).

Lindsey, T.C. 1995. "Pollution Prevention Principles and Examples." Presented at the HWRIC Regulatory Peace of Mind Conference (LaSalle-Peru, IL, August 24, 1995).

Lindsey, T.C. 1995. "Pollution Prevention Implementation as a Continuous Improvement Process." Presented to the Three Rivers Manufacturing Association (Joliet, IL, September 14, 1995).

Lindsey, T.C. 1995. "Pollution Prevention Techniques for Manufacturing Technical Assistance Providers." Presented to the Chicago Manufacturing Center (Chicago, IL, November 20, 1995).

Lindsey, T.C. 1995. "Pollution Prevention Concepts for Accounting Professionals." Presented to FERS Accounting Firm (Chicago, IL, November 20, 1995).

Lindsey, T.C. 1995. "Pollution Prevention Opportunities in the Chemical Processing Industry." Presented to Amoco Chemicals (Joliet, IL, December 6, 1996).

Lindsey, T.C. 1995. "Utilization of Membrane Filtration to Recycle Degreasing Solutions in Railroad Facilities." Presented to the Association of American Railroads (Washington, DC, December 20, 1995).

Lindsey, T.C. 1996. "Pollution Prevention Capabilities of the Hazardous Waste Research and Information Center." Presented to Officials of the Electric Power Research Institute and Illinois Power (Champaign, IL, February 20, 1996).

Lindsey, T.C. 1996. "Pollution Prevention Approaches to Solving Industrial Waste Problems." Presented at Illinois Power's Environmen-

tal Solutions Training Program (Champaign, IL, March 8, 1996).

Lindsey, T.C. 1996. "Pollution Prevention Opportunities in the Environmental Consulting Business." Presented at staff training for Philip Environmental, Inc. (Columbia, IL, March 18, 1996).

Lindsey, T.C. 1996. "Utilization of Aqueous Cleaning Processes in Fabricated Metals Operations." Presented at staff training for Viking Pumps, Inc. (Chicago, IL, March 22, 1996).

Miller, Gary D. "Pollution Prevention Career Opportunities." U.S. Environmental Protection Agency (Chicago, IL, July 12, 1995).

Miller, Gary D. "Pollution Prevention Case Studies for Small and Large Printers." Presented at the North Business and Industrial Council workshop (Chicago, IL, September 21, 1995).

Miller, Gary D. "Pollution Prevention: An Overview of Issues, Technologies, and Methodologies." University of Illinois at Chicago, Principles of Environmental and Occupational Health Sciences (EOHS 400) (Chicago, IL, September 25, 1995).

Miller, Gary D. "Opportunities and Services of HWRIC for Pollution Prevention in Electroplating." Jane Adams Corporation (Chicago, IL, July 12, 1995).

Miller, Gary D. 1996. "Pollution Prevention Case Studies and Technical Assistance Services from HWRIC." University of Illinois (Springfield, IL, March 11, 1996).

Miller, Gary D. 1996. "Compliance and Technical Assistance—The Illinois Experience." (Chicago, IL, March 20, 1996).

Miller, Gary. 1996. "Providing Access to Environmental Tools and Information for Manufacturers through a National Database and Technical Assistance Network," at 89th Annual Meeting of the Air and Waste Management Association, Nashville, TN.

Morrow, Debra A., Peter Gintautas, Aaron D. Weiss, Marvin D. Piwoni, and Mark Bricka.

1996. "Metals Speciation in Soils: A Review of Methodologies." US Army Corps of Engineers, Waterways Experiment Station, Technical Report IRRP-96-5. 99p + app.

Nelson, William M. 1995. "Chemistry and Pollution Prevention Opportunities in Industrial Processes." Presented to McWhorter Technologies Inc. (Carpentersville, IL, November 1, 1995).

Nelson, William M. 1996. "Pollution Prevention for Process Engineers" Presented to McWhorter Technologies Inc. (Carpentersville, IL, February 26, 1996)

Nelson, William M. 1996. "Pollution Prevention Case Studies in Metal Cleaning and Possibilities for Closing the Loop." Presented at the *Metal Cleaning and Coating and Pollution Prevention Workshop* sponsored by the Illinois Environmental Protection Agency (IEPA) (Springfield, IL, March 28, 1996.)

Nelson, William. 1996. *The Key to Successful Aqueous Cleaning is... Water*. Precision Cleaning Vol. IV, No. 4.

Peden, Jacqueline M. and Timothy Lindsey. 1995. "Membrane Filtration Technology for the Metals Fabrication Industry." Presented at *Emerging Technologies in Hazardous Waste Management VI*, sponsored by the American Chemical Society (Atlanta, GA, September 17-20, 1995).

Piwoni, Marvin D. and Jack W. Keeley. 1996. "Basic Concepts of Contaminant Sorption at Hazardous Waste Sites." in *EPA Environmental Assessment Sourcebook*, pp. 9-18. J. Russel Boulding, ed. Ann Arbor Press, Inc., Chelsea, MI.

Rajagopalan, Nanadakishore and M.Cheryan. 1995. "Pervaporation of grape juice aroma." *Journal of Membrane Science*, 104, 1995, 243-250.

Rajagopalan, Nanadakishore, Lakshminarayanan Pattabiraman and Munir Cheryan. 1996. "Solvent Recovery and Partial Deacidification of Vegetable Oils by Membrane Technology." *Fett/Lipid*, 98.

Rajagopalan, Nanadakishore, L.P.Raman and M.Cheryan. 1996. "Deacidification of Soybean Oil by Membrane Technology." *Journal of the American Oil Chemists Society*, 73, 2, 1996

Thomas, David L. 1995. "A Look to the Future of Environmental Protection." Keynote speech for the Environmental Technology Forum, 20th Annual Governor's Conference on the Environment (Lexington, KY, October 26, 1995).

Thomas, David L. 1995. "What is Pollution Prevention - State's View." Speech representing the National Pollution Prevention Roundtable to the Aluminum Association's Conference on Pollution Prevention in the Aluminum Industry. (Nashville, TN, November 1, 1995).

Thomas, David L. 1995. "Pollution Prevention and Sustainable Development." Lecture to University of Illinois Honors Program, Scholars Adventures Series (Champaign, IL, December 5, 1995).

Thomas, David L. 1995. National Metal Finishers Center, Advisory Panel Meeting, National Pollution Prevention Roundtable (Miami Beach, FL, December 5, 1995).

Thomas, David L. 1996. "Environmental Programs for a Sustainable Future." presentation to Environmental Committee, First Presbyterian Church (Champaign, IL, February 27, 1996).

Thomas, David L. 1996. "Pollution Prevention and Sustainable Development." Presentation to CERL (Champaign, IL, March 19, 1996).

Wiedenmann, Luann 1995. "Analysis of Precipitation Samples by FI-Inductively Coupled Plasma-Mass Spectrometry." Presented at the *Federation of Analytical Chemistry and Spectroscopy Society Conference* (Cincinnati, OH, October 18, 1995).

Appendix B: Governor's Pollution Prevention Awards

Educational Category

University of Illinois at Chicago (UIC)— Certificate

The University of Illinois at Chicago employs 10,000 staff and faculty members. The UIC has continued its successful Chemical Redistribution Program through its Environmental Health and Safety office. The program is an exchange service which allows UIC chemical users to receive or donate high quality chemicals that otherwise become a waste. Since 1991 this program has saved the UIC over \$42,000 in chemical and waste disposal costs. UIC has shared its success with other college campuses throughout the nation and has provided Chicagoland private schools and companies with information about the redistribution program.

Elgin Community College (ECC)—Certificate

Elgin Community College is a northeast Illinois college with a full time student enrollment of 5,358 students and 678 employees. ECC has an award winning recycling program that has exceeded its goal of 60% waste reduction by the year 2000. ECC's waste reduction plan has saved the college over \$13,000 a year in waste avoidance costs and netted ECC \$2,500 in savings from selling aluminum cans. ECC has also eliminated the use of its incinerator by recycling cardboard in lieu of burning it. ECC is also in the process of converting their centrifugal chiller to a CFC-123 refrigerant to eliminate the need to use R-11 freon. ECC's recycling program has been of great benefit to the environment by diverting 78 tons of waste per year from the landfill. This equates to 1,255 cubic yards per year or a savings of approximately 1,326 trees. ECC credits their waste hauler as being instrumental in their waste reduction plan.

Small Industrial Category

Amoco Chemical Company —Award *Willow Springs*

The Willow Springs Plant is a polystyrene manufacturing facility, producing approximately 62 million pounds of polystyrene in 1994. Amoco eliminated 83,204 pounds of hazardous waste generated at this plant through segregation, reuse, and product elimination. A change in operating procedures segregated styrene from used oil which was producing 10,500 gallons of hazardous waste per year. The used oil, shipped to another Amoco plant, is now fuel blended in an industrial boiler. The styrene condensate which was mixed with the oil is now managed with the rest of the styrene from the plant. The 215,000 pounds of styrene condensate from the plant is collected and sent to another Amoco facility for use as a raw material where it produces a pound of gasoline for every pound of styrene. The operation reduces Amoco's hazardous waste production by 215,000 pounds and returns approximately \$20,000 per year in high value components converted from the styrene condensate. New equipment was installed in the plants laboratory to eliminated the use of solvents in testing procedures. Amoco also switched parts washing equipment vendors and now uses a vendor that sells the used solvent from the parts washer to another company that uses the solvent as a substitute for a raw material. Amoco has also expanded its recycling program and achieved a 33% reduction in solid waste collection. Of note in Amoco's arsenal in its fight against pollution is Amoco's use of employee teams to develop plans to minimize waste streams within their area of responsibility. Amoco awards employees for their best environmental ideas or projects.

Central Illinois Light Company (CILCO)— Certificate

CILCO is a producer of electrical power servicing numerous central Illinois communities. CILCO utilizes coal fired boilers and natural gas to supply the energy needs of its customers. CILCO has successfully established the Gas Desulfurization Material Reuse Program to eliminate one of its waste streams from its Lincoln Gas Storage Field. Through this program and a process known as the Stretford process, CILCO strips natural gas stored underground of absorbed hydrogen sulfide which is collected as a sulfur sludge material. After a feasibility study, CILCO determined that the sulfur sludge from Lincoln could be mixed with a limestone slurry used at CILCO's Duck Creek Power Plant to scrub oxides of sulfur (SO_x) emissions from the Power Plant's smoke stack. As a result CILCO eliminated 36,000 gallons per year of an Illinois Special Waste and prevented 30 cubic yards of special waste from entering the landfill annually. Recognizing the competitive edge pollution prevention can provide, CILCO's management philosophy emphasizes the reduction and elimination of pollutants and waste through employee programs such as "Bravo Bucks," which gets employees to monetarily recognize co-workers for their efforts and innovative ideas. By successfully communicating their Pollution Prevention values to the local community, CILCO has contributed to increased environmental awareness in several Illinois counties.

Medium Industrial Category

3M Cordova—Award

3M Cordova is a specialty adhesive chemical manufacturer. The Cordova Plant manufactures adhesive backing and magnetic oxide. 3M Cordova significantly reduced their discharge to the Mississippi River of ammonium sulfate, an aquatic toxin, from their production of magnetic oxide. 3M totally eliminated their use of ammonium hydroxide in their process by reformulating their magnetic oxide, a by-product of which was the ammonium sulfate. 3M Cordova's reformula-

tion using sodium hydroxide was the result of a total effort on the part of 3M's R&D laboratories, pilot plants, manufacturing, design engineering, and the facility that coats the magnetic oxide. The new formulation produces a by-product, sodium sulfate, which is less toxic to fish and other aquatic life in the Mississippi River. Additionally, 3M reduced their ammonia gas emissions by approximately 17,000 pounds per year. 3M's outstanding management policy considers the environment one of its four corporate values. Through 3M's Pollution Prevention Pays (3P) Program employees have developed and implemented numerous projects. The above project is a reflection of the high environmental awareness that 3M employees have. Although the payback period for the magnetic oxide project was high, 3M did achieve a cost avoidance of \$12 million for the installation of an ammonia concentration removal system and saved an additional \$2 million in yearly operating expenses.

Stepan Company—Certificate

The Stepan Company is a manufacturer of polymers and surfactants. Stepan Company implemented a pollution prevention project that modified their process for the distillation of crude phthalic anhydride. Their previous process generated phthalic anhydride lite-ends, a listed hazardous waste. Stepan's new process combines the waste phthalic anhydride lite-ends with pure phthalic anhydride, as a feed stock, to produce crude polyol. After the reaction process is complete the crude polyol is shipped as a polyester polyol which is used in the manufacturing of wallboard. Stepan Company's new process has eliminated 52% of their hazardous wastestream. The reuse of this chemical waste coupled with the savings in raw material purchases has saved Stepan Company \$68,000 in 1994. Stepan plans to reuse 100% of their waste phthalic anhydride in 1995 and projects a savings to the company of \$130,000 per year. It was through management commitment and employee quality work groups that Stepan Company was able to eliminate a hazardous wastestream. In the future, Stepan Company plans to work with other producers of

distillation light-ends to reuse their waste to produce a usable product.

UOP McCook Plant—Certificate

The UOP McCook Plant manufactures a variety of anti-ozonants and anti-oxidants for the petroleum and rubber industries. UOP has successfully upgraded their manufacturing process through continuous improvement. UOP sought and found a more suitable catalyst for their chemical reaction process and coupled the material substitution with a better process control system. The new control system allowed plant operators to better monitor the process and control the temperature of the reactor. Tighter process control improved product quality, decreased production of waste, and segregated the waste from the recyclable materials. Including the profits generated, UOP saved approximately \$44,000 from the additional product manufactured and from waste disposal costs. A project payback period of 3 years was established, including a reduction in maintenance costs, lower labor costs, quicker product turn around times, and fuel savings as justification. UOP also eliminated a RCRA waste by changing their vendor of p-nitroaniline (PNA) to a vendor who supplied PNA in drums that did not use an inner liner. This change saved UOP \$6,700 and eliminated about 1,000 pounds of drum liners required to be disposed of as hazardous waste. Future UOP management plans include expanding the waste cost allocation system and investigating reduction in water usage.

Amoco Chemical Company—Certificate

Joliet Plant

The Joliet Plant is an organic chemical manufacturing facility. The plant produces purified isophthalic acid (PIA), maleic anhydride (MAN), trimellitic anhydride (TMA), and polystyrene. Amoco Chemical's management goal to reduce wastes and emissions was highly successful in 1994. Amoco implemented several process changes in the isophthalic acid (IPA) unit that cut their disposal of benzene and moisture contaminated activated alumina used to dry the IPA gas stream by 50%. The Amoco polystyrene produc-

tion unit uses a Condensate Recovery Unit (CRU) to condense styrene for reuse within the polystyrene unit. About 16% of the total styrene condensate from the plant is collected and sent to another Amoco facility for use as a raw material where it is processed into a pound of gasoline for every pound of styrene. The CRU operation has saved Amoco about \$150,000 per year in waste disposal and \$150,000 per year by converting from the styrene condensate into high value components. Amoco also switched parts washing equipment vendors and uses a vendor that sells the used solvent from the parts washers to another company as a substitute for a raw material. This change reduced Amoco's hazardous waste generation by 61%. Additionally, Amoco has reduced its Volatile Organic Matter (VOM) generation by 70 tons per year through retrofitting of one of their thermal oxidizers by installing two catalyst modules to destroy pollutants emitted to the air. Amoco has also implemented numerous programs that add great value to their pollution prevention activities such as a flex-time work option to reduce auto emissions, use of recyclable metal containers, recycling of polyethylene shrink wrap and unusable polystyrene material, and education of their employees. The economic benefits of all these projects and programs has earned Amoco, through either cost reduction, cost avoidance, or profit, a total of approximately \$570,000 in 1994. Amoco hopes to increase this savings in 1995 by totally eliminating some of the wastes described above.

Eaton Corporation—Certificate

The Eaton Corporation is a fabricator of automobile and appliance controls and automobile components. Eaton Corporation progressively converted or improved their overall elimination of solvent degreasing operations, culminating in 1994 with the final installation of new parts cleaners and washers. Through the following equipment change-outs Eaton achieved its goal of source reduction in chlorinated solvents. A study of part types, oils, contaminants, and levels of cleanliness was implemented and from that study several techniques and machines were developed. A 10 cubic foot barrel type machine, a 0.5 cubic

foot small basket type machine, and a 0.2 cubic foot capacity ultrasonic cleaner were selected. The replacement alkaline wash solution produced no emissions and after neutralization was discharged to the sanitary sewer. Eaton realized a 57% decrease in their Volatile Organic Compounds (VOC) emissions in 1994 and a 65% reduction in their solvent wastestream. Eaton Corporation has an outstanding commitment to pollution prevention and maintains as their ultimate goal the replacement of all chlorinated solvents with alternative cleaners. Eaton's program of parts washer replacement has been evolutionary in nature and has provided hands-on experience which can be directly transferred to similar manufacturing operations.

Large Industrial Category

Chrysler Corporation, Belvidere—Award

Chrysler Corporation Belvidere Assembly Plant produces the Dodge and Plymouth Neon Automobiles. Plant operations include assembly, painting, stamping, fascia molding, and steam generation. Chrysler's Pollution Prevention Program is a cooperative effort between suppliers, after market users (recyclers), and production hourly and management teams. It was through the Small Car Platform Team and Chrysler's rag supplier, PPG, that results were achieved in eliminating solvents (Xylene, Toluene, Acetone, and Methyl Isobutyl Ketone) used to wipe down the automobiles at various points within the facility. Chrysler reduced its solvent emissions from 1.6 pounds per car to 0.85 pounds per car. Chrysler also reduced their disposal of hazardous waste contaminated rags by 50%, saving over \$66,000 per year. In another area of the Plant, Chrysler disposes of 7,000 pounds of broken windshields annually as lead contaminated (D008) hazardous waste. Chrysler worked through two of its suppliers to successfully eliminate the use of a window tinting compound that used a lead-base primer to tint the rear windshield. Chrysler's front windshield supplier was not able to fully eliminate the lead-based primer due to the critical nature of a seal on the front windshield. The vendor, however, was able to formulate a reduced

lead content primer that would pass a Toxic Characteristic Leaching Procedure (TCLP) test for hazardous lead (D008) content. Chrysler no longer uses windshields that may be classified as hazardous waste and has saved over \$8,000 annually in hazardous waste disposal costs. Chrysler also reuses and recycles plastic covers used by suppliers and has eliminated the landfilling of over 1.3 million pounds of plastic annually. Chrysler management believes that without overall team cooperation, programs such as the three noted above would not have been successful or even implemented.

Honeywell Micro Switch Division—Award

Micro Switch is a forward thinking division of the Honeywell Corporation. Micro Switch manufactures electrical and electronic switches and sensors. Micro Switch has an evolving pollution prevention program that has implemented numerous changes through their facility. These include, cadmium plating alternatives, nickel recovery from plating, mercury/glass separation, and painting waste reductions. Two other projects of note were Micro Switch's Coolant Recycling Program and the Halogenated Solvent Elimination Program. In the coolant Recycling Program, Micro Switch utilizes a Cimcool Full Cycle Module to increase the consistency of the coolant quality. Micro Switch's coolant recycling program has reduced their volume of hazardous waste by 87% and saved \$27,135 in reduced waste disposal and raw material costs annually. The Halogenated Solvent Elimination Program eliminated vapor degreasing operations using freon 113 and methylene chloride typically use to remove oils, waxes, and other soils. Elimination is being achieved through aqueous cleaning alternatives, no-clean, non-halogenated solvent, and component material changes. Halogenated solvent use has been reduced by 20% with total elimination of halogenated solvent use projected by August 31, 1995. Approximately \$5,000 in disposal costs have been saved and \$100,000 in raw material costs has been avoided. Micro Switch has an excellent management commitment to reduce pollutants at their source through material substitution, product

reformulation, process modification, and improved housekeeping. Through Micro Switch's Pollution Prevention Task Team (P2T2) employees evaluate and select alternative processes for implementation into the manufacturing process.

Commonwealth Edison Company—Certificate

Commonwealth Edison (ComEd) is a major supplier of electrical energy in northern Illinois. ComEd has expanded its Waste Minimization Program into an aggressive Life Cycle Management Program. The new program includes final disposal considerations in the procurement process to help prevent the purchase of materials that may appear to be less expensive at first, but will ultimately result in more costly environmental impacts (such as hazardous waste generation). Through the Life Cycle Management Program, ComEd has reduced its waste generation by nearly 88% from 1992 levels. Waste oil generation was reduced over 60% in one year - from more than 2 million gallons in 1993 to 822,000 gallons in 1994. ComEd changed out their naphtha solvent parts washers with mineral spirits parts washers. Due to the use of hazardous solvents, 32 of ComEd's facilities were large quantity generators. Today, only 13 facilities are large quantity generators - ComEd's goal is to reduce this number to six by 1996. In 1994, ComEd recycled 549,000 tons or 71 % of the coal ash created as a by-product of the company's fossil plants. The recycled coal ash can be used as a concrete additive for buildings or in highway construction. ComEd also recycled 17.3 million pounds of scrap metal from obsolete equipment and transmission system renovations, equipment replacement and demolition. The scrap metal is sent to the company's scrap house for processing and reuse in the metal fabrication industry. Additionally, ComEd has put back into service over 15% of electrical transformers earmarked for reclamation. ComEd has an outstanding management commitment and full employee support for all its waste minimization opportunities, making "Life Cycle Management" an integral part of every employee's vocabulary. Implementation of this new program has saved ComEd over \$61,000 this year, however; ComEd expects the program to

save them over \$2 million dollars in the coming year.

Caterpillar Inc., Mossville Engine Center—Certificate

The Caterpillar Mossville Engine Center machines, assembles, paints, and tests Caterpillar engines. The Mossville Center has eliminated its use of vapor degreasing using trichlorethylene (TCE). Caterpillar implemented a project to modify their production process to utilize a water based wash solution followed by a steam blow off to clean finished parts. The new washer system has eliminated over 25,000 pounds of TCE and saved Caterpillar \$30,000 in disposal costs, chemicals purchased and man-hours spent in maintenance. Additionally, Caterpillar estimates that it saved \$3.5 million dollars through their current Waste Minimization Program, an increase of 25% over 1993. Through management commitment and employee teams Caterpillar Mossville encourages their employees to get involved in recycling/environmental projects and programs. The elimination of vapor degreasing by Caterpillar is an outstanding example of a solvent substitution project that works and pays back, not only in profit but also in employee health and welfare.

Continuous Improvement Category

This is the first year that HWRIC has established this new category of recognition. It is designed to acknowledge the continuous improvement efforts of companies that have won awards and/or certificates in the past and who continued to develop and sustain significant Pollution Prevention Programs. This Award will note pollution prevention programs or projects that surpass initial efforts to reduce waste or "pick low hanging fruit" which produces significant waste reductions quantities and large monetary savings. Although their projects over the last year may not have been significant enough in and of themselves to deserve an award, their efforts to continuously

improve their operations are recognized by this award.

Caterpillar Inc., East Peoria Facility— Continuous Improvement Certificate

The East Peoria Caterpillar facility is a manufacturer of track type tractors, pipe layers and power shift transmissions. Caterpillar has implemented a continuous improvement element to its Waste Minimization Program. Caterpillar's methodology and approach to continuous improvement in waste minimization was several fold. The primary task was full evaluation of all processes in the facility. This involved breaking down the facility into 12 manufacturing commodities. Staff of each commodity then conducted their own review of chemicals, processes, and techniques used and reported them to an environmental impact committee. The committee compiled the reports and issued a Facility Waste Minimization Plan. The Plan details a list of action items along with specific goals that can be measured. Some of the action items that were addressed included reduction in waste oil through implementation of an oil sampling program; elimination of mineral spirits usage throughout the plant; and a metal working fluids management program to maximize the functional life of the fluids. Caterpillar management is fully committed and supportive of this program and employee support is solicited through interviews that incorporate employee knowledge and ideas into the Facility Waste Minimization Plan. Economically, Caterpillar's new program has implemented Total Cost Assessment (TCA) into environmental programs. TCA looks not only at the cost of a material but at the life cycle cost which includes initial purchase price, disposal cost, and many other related costs.

Homeshield Fabricated Products—Continuous Improvement Certificate

Homeshield Fabricated Products manufactures fabricated metal into pre-engineered shapes for customers nationwide. Homeshield Products' Pollution Prevention Program encompassed numerous examples of environmental process efficiency. By designing an automated chemical conductivity sensor and fluid level controller this

company was able to successfully control their chromate conversion bath chemicals and de-ionized make-up water levels and save \$5,000 per year in waste disposal and non-productive downtime. Homeshield also reduced their storage of 55 gallon drums of roll forming coolant by converting to 330 gallon bulk containers realizing a cost savings of \$1,000 in the first year. Additionally, Homeshield improved the design of their packaging vehicle for Thermal Window spacers by using a reusable shipping container and eliminating the use of cardboard cartons. The new design will save Homeshield 62,700 pounds annually in solid waste. Homeshield also substituted a concentrated aqueous-based cleaner for their newly purchased parts washer and will save \$105 annually over the cost of a vendor supplied parts washing system. An additional chemical substitution will lower Homeshield's Hazardous Air Pollutant emissions by 98%. Homeshield substituted Methyl Propyl Ketone (MPK) for Methyl Ethel Ketone (MEK) for use in their laboratory to test the relative degree of paint cure of their baked on enamel finished process. Homeshield's management philosophy, goals, and strategies enable the company to remain competitive, environmentally conscious, and responsive to market trends.

Motorola Lighting Inc.—Continuous Improvement Certificate

Motorola Lighting Inc. is a manufacturer of electronic ballasts. In 1994, Motorola undertook an initiative to integrate economic and environmental goals into their process to ensure sustainable development. The elimination of Volatile Organic Compounds (VOC) from their entire ballast soldering process was implemented in two steps. Motorola was able to eliminate their use of an Isopropanol (IPA) based flux after investigating and testing an approved water based flux agent to use on their printed circuit boards. Motorola also eliminated their use of IPA, which had been used to clean their conveyor which moved circuit boards to a cleaning station. At the cleaning station Motorola substituted deionized water for IPA to clean the parts. As a result of these changes Motorola reduced their VOC emissions from the factory by 95.5%, a reduction of 78.9

tons per year. Motorola's outstanding management and employee participation enabled their Total Process Improvement (TPI) Team to identify reachable goals and then complete the projects in a timely manner. This kind of team work is an example of Motorola's belief in employee and management participation working together to solve a problem.

Tellabs Operations, Inc.—Continuous Improvement Certificate

Tellabs Operations, Inc. is a Global design manufacturer and supplier of voice, data, and digital telecommunications equipment. Tellabs has done an outstanding job eliminating liquid hazardous waste from their new flux application project the "Waveline Enhancement Project." Tellabs reduced their generation of liquid hazardous waste from 3,960 gallons per year to ZERO gallons per year by installing spray fluxers on all their waveline equipment. Tellabs also introduced the use of nitrogen into their waveline operations which reduced their soldering consumption by 75% and saved them \$25,000 annually. The new process also reduced Tellabs' production of "dross," the lead oxide residue removed as a maintenance function, by 70%, from 27,000 pounds to 8,000 pounds per year. The overall savings from the "Waveline Enhancement Project" is \$76,140 in reduced raw material usage and waste disposal costs. Additionally, Tellabs saved \$7,280 through their Solid Waste Reduction Program. Tellabs outstanding effort was successful because of the total support of employees and management. Tellabs' commitment to the environment goes beyond the reduction of waste and recycling. They have included natural prairie landscaping at their newest facility in Bolingbrook and make available to the community a "jogging path" through the facility grounds for residents to enjoy.

Appendix C: Continuing and Completed Research Projects



Table C-1. Projects Continuing in FY97

Title	PI/Affiliation
Waste Management Options	
Accelerated Aging of Stabilized Hazardous Wastes	Max Taylor and Robert Fuessle, Bradley University
Remediation Technologies	
Biodegradation of Dichloromethane	David Freedman, University of Illinois at Urbana-Champaign
Innovative Evaluation Methods for Bioremediation	Bruce Rittmann, Northwestern University
Remediation of Petroleum Contaminated Soils: Composting, A Better Way	Perino Technical Service, Inc.
Pollution Prevention Technologies/Techniques	
Characterization and Treatment of the Dental Waste Water Stream	Michael Cailas and James Drummond, University of Illinois at Chicago; William Roddy, Naval Dental Research Institute
Pollution Prevention Through Innovative Supplier Contracts: Strategies for Small Business	Thomas J. Bierma and Francis L. Waterstraat, Illinois State University
Risk Assessment	
Starlings as Avian Models and Monitors of Remedial Effects at Crab Orchard National Wildlife Refuge	Richard S. Halbrook and Alan Woolf, Southern Illinois University at Carbondale

Table C-2. Projects Completed in FY96

Title	PI/Affiliation
Effect of Chemical Immersion on Interface Strengths of Hazardous Waste Landfill Liner Systems	Timothy Stark, University of Illinois
Air Sparging at Mattison Machine Works	Quentin Davis, Fehr-Graham & Associates
Enhancement of BTEX Biodegradation Rates Under Iron-Reducing Conditions	Walton R. Kelly and Michael Machesky, Illinois State Water Survey
Waste Management Survey of Illinois Higher Education Institutions	Diane O'Rourke, University of Illinois at Chicago
Toxic Heavy Metals in Biodegradation and Bioremediation Technologies	Eric Niederhoffer and John Koropchak, Southern Illinois University at Carbondale

Synthetic Studies of a WaterSoluble and Recyclable Organotin Reagent	Rick Gaston, Southern Illinois University at Carbondale
Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois	Allan White and Deborah Savage, Tellus Institute
Product and Process Design Tradeoffs for Pollution Prevention	Deborah L. Thurston, University of Illinois at Urbana-Champaign
Galvanizing Bath Life Extension	Tedmund Tibieri, Arid Technologies, Inc.
Household Pets as Sentinels of Lead Exposure Phase II: A Study of Lead Exposure	William Buck, University of Illinois at Urbana-Champaign
Determination of Animal Hazards from Air and Soil Samples from Crab Orchard	Larry Hansen, University of Illinois at Urbana-Champaign
The Effects of Chronic Oral Dosing of Bismuth Alloy, Iron, or Lead Shot on the Reproduction of Game-Farm Mallards	William Buck and Karen Duncan, University of Illinois at Urbana-Champaign
East St. Louis Urban Ecology Project	Kenneth Reardon, University of Illinois at Urbana-Champaign
Development of an Activated Carbon Fiber Adsorption/Regeneration System to Recover and Reuse Toxic Organic Compounds	Mark J. Rood and Susan M. Larson, University of Illinois at Urbana-Champaign

Table C-3. New Projects in FY97

Title	PI/Affiliation
Creation of an Interactive On-Line Pollution Prevention Manual	Scott Butner, Battelle Memorial Institute, Seattle, WA
Novel Treatments for Resource Recovery and Waste Treatment in Printed Circuit Board Manufacturing	Michael Gula, Eichrom Industries, Inc., Darien, IL
A Critical and Statistical Evaluation of Characterization Methods for Sites Contaminated through Multiple, Discrete Spills	Michael Barnhardt and Donald Keefer, Illinois State Geological Survey

Appendix D: Research Project Summaries

Research Projects Continuing in FY97

Accelerated Aging of Stabilized Hazardous Wastes

Max Taylor and Robert Fuessle, Bradley University

Every year in Illinois about 40 million gallons of hazardous waste are treated before being shipped to land disposal. Stabilization is a widely-used, EPA-approved treatment for certain wastes. Stabilization often involves adding cement to waste to capture or immobilize contaminants within a solid matrix. The implicit assumption is that stabilized forms do not degrade upon long-term curing.

Some stabilization designs improve with curing age, and others, because of continuing chemical changes, may become ineffective in the long term. This research focuses on development of an accelerated curing method that will provide a testing procedure for early detection of stabilizations subject to long-term failure. Physical and chemical measurements of stabilized forms during curing have been performed to understand the reliability of the acceleration method. Apparent age is characterized by degree of silicate polymerization, infrared spectroscopy, x-ray diffraction, calorimetry, and expansion coefficients. These measurements are correlated with toxicity characteristic leaching procedure results to develop a model for predicting stabilization effectiveness into longer time frames.

The project is co-funded by WMRC and the Portland Cement Association.

Biodegradation of Dichloromethane

David Freedman, University of Illinois at Urbana-Champaign

This two-year research project examined biodegradation of dichloromethane (DCM), a chlorinated solvent. Methods for controlling discharges of DCM, a solvent used in paint stripping, plastics manufacturing, and pharmaceuticals, were needed as the search for nonchlorinated solvents continued. The overall objective of the project was to develop a high rate biological method for treating DCM-contaminated waste streams using denitrifying bacteria. Laboratory work, now completed, indicates this is possible, at least at the experimental laboratory scale. The results of this project will be usable by industries in Illinois that treat DCM-contaminated wastes. A final project report is being completed and will be available in early 1997.

Innovative Evaluation Methods for Bioremediation

Bruce Rittmann, Northwestern University

Bioremediation is a potentially powerful technique for remediating petroleum hydrocarbons, solvents, and other hazardous organic chemicals contaminating the environment. Nevertheless, it is a technique whose success is difficult to evaluate in the field, particularly in the case of in situ bioremediation. This is largely due to the inherent uncertainty created by matrix and contaminant heterogeneity, inaccessibility to observation, expense of sampling, and limitations of some measurements. In response to this difficulty, the National Research Council (NRC) recently released the report *In Situ Bioremediation: When Does It Work?* (NRC, 1993), which aims to provide rational and scientifically based guidelines from which detailed bioremediation evaluation protocols can be developed.

The overall objective of the research is to provide a prototype for conversion of the NRC guidelines into practical protocols for evaluating the success of bioremediation projects. This objective is being accomplished by integrating routine chemical analyses with several innovative techniques from molecular biology and geochemistry into a scientifically rational evaluation strategy. Application of the evaluation protocols for measurements of field samples are being demonstrated using laboratory-scale mesocosms containing contaminated soils or aquifer materials and simulating representative in situ and ex situ bioremediation systems.

During the initial phase of the study, the researchers concentrated on preparing a synthetic waste for the experiment and designing the mesocosms to be used. Over the second year, the mesocosms were constructed, allowing experimental determination of key analytical measurements from the proposed evaluation strategy. In addition, the researchers have completed designs for experimental "in situ" remediation experiments to field tests the method.

A draft final report for the project is expected in the spring of 1997 and the final report should be available fall of 1997.

Remediation of Petroleum Contaminated Soils: Composting, A Better Way

Janice Perino, Perino Technical Services, Inc.

This study will provide a basic outline for using bagged-composting remediation (BCR) to make it more accessible to a wider variety of users. BCR uses existing, relatively simple technology in an efficient manner without huge costs, space, permitting, and other prohibitive requirements.

Composting for leaking underground storage tank (LUST) sites is usually conducted in open or static "windrows". Structurally firm material and water are often added to the contaminated soils to improve handling and biodegradability. The drawbacks to conventional methods of composting include: large land requirements, high operating and maintenance costs, weather related control

problems and permitting requirements. Containment systems for composting have potential for remediation of impacted soils at LUST sites at costs significantly less than landfilling or other technologies while avoiding the limitations of conventional composting.

A landfill in the Taylorville area is the site for testing BCR using five bags with both gasoline and diesel-contaminated soil. The end date for this project is June 1997.

Characterization and Treatment of the Dental Waste Water Stream

Michael Cailas and James Drummond, University of Illinois at Chicago

William Roddy, Naval Dental Research Institute

The objective of this project is to establish the physical and chemical properties of dental waste streams and to assess and quantify the recycling potentials of their components. To accomplish this objective, the mercury content of the colloidal particles of the waste stream have been identified. Mercury and silver determination, particle size distribution and pH profile analyses, zeta potential measurements, and electron microscopy are the main experimental techniques which are being applied in the study. This project also examines treatment alternatives for this waste stream and establishes baseline performance characteristics with the use of pilot scale settling column and centrifuge experiments. The performance characteristics of more advanced treatment techniques based on sediment, reverse osmosis, ultrafiltration and centrifuge systems will be assessed as well. In addition, this project will yield the required background to evaluate existing treatment devices and sufficient quantitative information for identifying, assessing, and/or designing an optimum system for treating this waste at the source.

This is part of a larger project to explore waste recovery and disposal options for dental wastes. Additional financial support is being provided by the Department of the Navy. This project continues through FY97.

Pollution Prevention through Innovative Supplier Contracts: Strategies for Small Businesses

Thomas Bierma and Francis Waterstraat, Illinois State University

Illinois State University researchers Tom Bierma and Frank Waterstraat have been awarded funding to continue their innovative work on understanding how companies adopt pollution prevention and on developing strategies to encourage them to do so. The two year project seeks to develop contractual strategies between suppliers and small manufacturers which will provide financial incentives to both parties for continuous waste reductions. Innovative contractual arrangements between a few large manufacturers such as General Motors and their chemical suppliers have produced dramatic reductions in chemical waste. They are currently working with several companies in applying these contracts to a real-world situation. Thanks to initial funding by WMRC, the researchers were awarded a large grant by US EPA to broaden the depth and scope of their innovative research. A final project report will be available in early 1997.

Starlings as Avian Models and Monitors of Remedial Effects at Crab Orchard National Wildlife Refuge

Richard S. Halbrook and Alan Woolf, Southern Illinois University at Carbondale

The 1988 Remedial Investigation of Crab Orchard National Wildlife Refuge (CONWR) identified seven contaminated areas within the refuge that posed a potential risk to wildlife and recommended remediation of these sites. Exposure and effects data for avian (bird) species in these areas are limited. Preliminary studies revealed significant accumulations of contaminants and harmful effects in starlings nesting at one of the identified sites. The project goal is to determine pre-remediation baseline exposure and effects data on an avian model (the starling) and to provide a benchmark for assessing the effectiveness of remediation.

For this project, the investigators constructed starling nest boxes in the contaminated and

reference sites. From those boxes, nesting starlings were monitored, collected, and necropsied. Tissues appropriate for contaminant analysis were collected. Additional starlings from non-contaminated sites were collected for use in laboratory QA/QC. Some of the birds were lost to predation and preventative measures have been taken to guard against further predation. There has been no starling activity at one of the landfill sites. Contaminant analysis of collected tissues is being performed, and behavioral and statistical analysis will be conducted. Based on the progress and findings of the initial research, WMRC extended the funding for a second year. The study is proceeding along similar lines, allowing for a much greater data set from which to draw conclusions and make evaluations.

Research Projects Completed in FY96

Toxic Heavy Metals in Biodegradation and Bioremediation Technologies

Eric Niederhoffer and John Koropchak, Southern Illinois University at Carbondale

The Crab Orchard National Wildlife Refuge (CONWR) faces severe problems associated with contamination from a combination of toxic heavy metal ions (THMs) and toxic organic compounds. It is necessary to gain a molecular-level understanding of how anaerobic microorganisms cope with THMs, and whether they spread them, in order to understand how THMs impact the biodegradation and bioremediation technologies used to clean up organic pollutants. The goal of the project is to develop THM-resistant microorganisms that are useful for THM pollution abatement, particularly for organic pollutants such as polychlorinated biphenyls (PCBs) and chlorofluorocarbons (CFCs).

The researchers are working to isolate THM-resistant mutants of extremely thermophilic (heat-loving) methanogens (bacteria that synthesize methane from hydrogen and carbon dioxide) and other anaerobic bacteria. The work involves studying the binding and uptake of THMs to wild-

type methanogens and addressing the effects of THMs on the detoxification pathways common to anaerobic bacteria.

During the past year they have characterized THM-resistant mutants of *Methanobacterium thermoautotrophicum* Marburg and have begun to assess the ability of this strain to activate aromatic hydrocarbon and halogenated organic molecules in the presence of THMs. Part of this work involves isolating and characterizing outer membrane proteins from these strains. In the upcoming year they will return to efforts to isolate the THM mutants, and studies of culture supernatants and biodegradation pathways.

The project is completed and the report is undergoing external review. The results suggest that metals play an important role in the production of, or non-production of, cellular proteins, some of which may be involved in specific metabolic pathways. Because these proteins have specific utility in the general physiology of microorganisms, we need to pay particular attention to the metabolic pathways that form the basis of biodegradation technologies. The presence of THM's can indeed impact the success of normally effective techniques.

The final report will be published in the spring of 1997.

Effect of Chemical Immersion on Interface Strengths of Hazardous Waste Landfill Liner Systems

Timothy Stark, University of Illinois

Landfills still receive the majority of the hazardous and solid wastes generated in Illinois and will probably continue to do so for many years. As a result, new landfills must be sited and built to accommodate new wastes, and old landfills need to be covered.

Recognizing that leachates from industrial and municipal solid wastes may be as damaging as those from hazardous wastes, the USEPA proposed Subtitle D regulations that recommend the use of soil-geosynthetic liner systems for solid waste landfills. The integrity of these liners can be compromised by physical and chemical factors.

This study will test the effect of chemical immersion on the peak and residual strengths of both soil-geosynthetic and geosynthetic-geosynthetic liners.

Progress to date includes completion of torsion ring shear tests on textured high density polyethylene (HDPE) geomembrane/non-woven textile, geocomposite, and cohesive soil interfaces.

These tests reveal that the textured geomembrane/non-woven geotextile and drainage geocomposite interfaces exhibit a large post-peak strength loss at small shear displacements. This strength loss is attributed to shear displacement pulling out and/or tearing the filaments of the non-woven geotextile. Additional shear displacement combs orient these unattached fibers parallel to the direction of shear. To prevent this strength loss from occurring in the field, it is recommended that a separation layer, consisting of visqueen be placed on top of the textured geomembrane prior to adding the geotextile layer. After placing the geotextile, the separation layer is removed to prevent slope instability.

Results have also shown that the type of clay used for the compacted clay liner significantly effects the interface strength. Increasing the plasticity of the clay increases the interface strength.

This investigation is part of a larger study evaluating liners that has been funded by the Office of Solid Waste Research. The final project report will be available in February 1997.

Air Sparging Investigation at Mattison Machine Works

Quentin Davis, Fehr-Graham & Associates

Air sparging (aerating water to clean it) is a technology which uses simple estimates instead of solid guidelines for establishing design criteria. Its success and its economic accessibility to smaller businesses, however, make it a technology that deserves exploration. The goal of this research is to determine the quantitative relationships which can be used when designing an air sparging system. The effectiveness of air sparging at

varying distances from the injection point and at differing depths of injection have been measured. The optimum design for a sparging system has been obtained for the Rock River alluvium and similar aquifers. The primary objective is to determine an empirical relationship that will allow remedial system designs to be optimized under a wide range of site conditions.

Wells were installed and samples taken from the site were analyzed by WMRC's laboratory to measure the contaminant removal rate. The final report is in preparation and should be available in the spring of 1997.

Enhancement of BTEX Biodegradation Rates Under Iron-Reducing Conditions

Walton R. Kelly and Michael L. Machesky, Illinois State Water Survey

Some of the most common organic pollutants found in groundwater are the monoaromatic hydrocarbons, such as benzene, toluene, ethylbenzene, and xylene (BTEX). Because these compounds are biodegradable under a variety of environmental conditions, in situ bioreclamation is a viable strategy for cleaning contaminated aquifers. BTEX are known to rapidly biodegrade under aerobic (oxygen-rich) conditions. Unfortunately, oxygen is almost always absent in aquifers contaminated with significant amounts of these compounds. Using samples from a contaminated aquifer, this study examines the value of stimulating iron-reducing bacteria in anaerobic environments to biodegrade BTEX.

The completed research drew a number of conclusions. Primary among them was that BTEX can biodegrade rapidly under anaerobic, iron-reducing conditions, with toluene being particularly receptive to the process.

Illinois has a large number of BTEX-contaminated sites (gasoline spills, leaking underground storage tanks, etc.) and once these compounds enter the ground water, they can be very difficult to treat. If this method proves viable in the field, many of these sites could be at least partially remediated by simply enhancing iron-reducing conditions. This project succeeded in presenting a possible alternative remediation method and

establishing some baseline data about the process and the rate of the involved reactions.

This report will be published in November 1996.

Development of an Activated Carbon Fiber Adsorption/Regeneration System to Recover and Reuse Toxic Organic Compounds

Mark J. Rood and Susan M. Larson, University of Illinois at Urbana-Champaign

Toxic chemical releases into the environment from facilities within Illinois have been estimated at 100×10^6 kilograms during 1990 (IEPA, 1992). Releases into the atmosphere account for 38% of the toxic emissions. This research project is developing a new technology of activated carbon adsorption coupled with cryogenic (cold) vapor recovery that will reduce emissions and provide for reuse of toxic wastes.

Activated carbon fibers (ACF) have been studied in a laboratory-scale packed bed configuration to measure breakthrough times of the bed for realistic gas stream conditions. The packed bed will be designed to optimize the bed life. Saturated ACF have been regenerated using a nitrogen carrier gas and electrical resistance heating. The nitrogen gas stream containing the concentrated toxic gas was then treated cryogenically with liquid nitrogen. Cryogenic treatment of the gas stream condenses the toxic materials from its carrier gas, making these materials available for reuse in the original process.

This research was performed in collaboration with Liquid Carbonic, Inc., an Illinois-based company that developed and manufactures the cryogenic air quality control device. This collaboration has resulted in a better overall design of the system, a more rapid distribution of this innovative technology into the industrial market, an exchange of information between the University of Illinois and industry, and a broadening of adsorption and cryogenic applications.

The preliminary design of the fixed bed ACF was tested and the system modified to withstand the stress of heat and pressure needed for the experiment and to provide easier sampling access.

During the first year of the project, the first contaminant was used to examine breakthrough and ACF regeneration. Breakthrough and regeneration studies continued through the second year. The project report is in review and will be available in January 1997.

Synthetic Studies of a Water Soluble and Recyclable Organotin Reagent

Rick Gaston, Southern Illinois University at Carbondale

The purpose of this project is to produce a water-soluble and recyclable organotin reagent to be used in conjunction with two important reactions: 1) the Stille reaction and 2) tin hydride reductions. Both reactions are commonly used and extremely versatile procedures which lead to the formation of new C-C (carbon-carbon) or C-H (carbon-hydrogen) bonds; important reactions in organic chemistry. Unfortunately, both processes also lead to the production of toxic, non-recyclable organotin waste.

The major benefits of this research to the industries and universities of Illinois are twofold. First, by performing these reactions in aqueous media, the need for organic solvents will be decreased. This will reduce the cost of procuring these chemicals in addition to minimizing the cost of disposing of them. Secondly, by recycling the organotin reagent, the hazards of disposing of these toxic chemicals will be decreased.

The researchers have completed an extended investigation of the water-soluble tin hydride reagent. As a result of this work there has been prepared a reagent with greatly increased stability. This was essential to developing a viable system for future tin hydride reactions. This reagent was examined during the last year for stability and ability to be recycled. A final report is due in November 1996.

Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois

Allen White, Tellus Institute

In conducting this two-year project, Tellus Institute of Boston, MA plans to demonstrate the real economic benefits of successfully imple-

mented pollution prevention programs. They believe current cost accounting systems fail to accurately assess the full economic impact of waste management costs to products and processes. In addition, investigators believe that accounting systems, generally, do not recognize the long-term financial benefits of process improvements. They propose Total Cost Assessment as an alternative method to more accurately monitor these factors. The methodology developed in this project will be specifically beneficial to Illinois' businesses, bankers and accountants. To date, three Illinois facilities have indicated a firm commitment to participating and final discussions are underway with an additional five companies.

In the spring of 1995, Tellus Institute received additional money from WMRC to expand this research project. In addition to assisting targeted businesses with implementing total cost assessment procedures for tracking wastes they generate, Tellus staff will also tackle the important issue of measuring pollution prevention effectiveness within these Illinois companies. Tellus was chosen for this study because they have done a number of previous related studies for USEPA, and are recognized for their expertise in this field.

Product and Process Design Tradeoffs for Pollution Prevention

Deborah L. Thurston, University of Illinois at Urbana-Champaign

Like design for manufacturability, design for the environment poses special problems. No analytical tools exist to integrate these issues into conventional engineering design analysis. Unavoidable tradeoffs must often be made between cost, performance, manufacturability, and customer satisfaction. Decisions must be made under a great deal of uncertainty and with input from multiple sources. The current trend in environmental protection legislation shifts the financial responsibility for environmental mitigation of industrial impact to the industry carrying out the activity. Traditional manufacturing cost analyses do not reflect this total, long-term cost. This project integrates design evaluation and optimiza-

tion and life cycle analyses into a comprehensive design process.

The cost of environmental impacts has been incorporated into the concurrent multi-objective analysis in two ways: 1) statistical manufacturing process control which treats pollution as a product defect; and, 2) the cost of compliance with regulations.

The project was jointly sponsored by WMRC; the Armstrong World Industries facility in Kankakee, IL; and the National Science Foundation. The goal was to seek ways to minimize the formation of pollutants during Armstrong's production process in order to decrease waste treatment costs. The analysis involved designing and conducting a statistical process control experiment to identify process control variables which affect pollution formation.

Measurements of volatile organic compound (VOC) emissions at the stack level were taken from the Armstrong facility and sent to WMRC's laboratory for analysis. Statistical analysis was used to correlate composition of raw materials and emission levels of particular VOCs. A process control experiment which clearly relates manufacturing process parameters (including material choice) to emissions and helps identify the most cost-effective course of action for pollution prevention was suggested. This process modification is being considered by the company. If adopted, a follow-up of the effects of the change will be proposed. A report on the process evaluation and redesign will be available in December 1996.

Galvanizing Bath Life Extension

Tedmund Tibieri, Arid Technologies Incorporated

A Reduction/Recycling Technology (RRT) project was undertaken with Arid Technologies of Chicago, a company specializing in developing membrane technology systems for their clients. The project tested reverse osmosis (RO), a membrane filtration technology, to remove metal contaminants and regenerate and recycle sulfuric acid from a galvanizing metal process line.

The prototype RO unit for this pilot study has been designed by Arid to withstand the high pressure, temperature, and acidity of their client's pickling waste stream. The test took place on-site at the manufacturing facility over a three week period.

The test was successful, and a full-scale RO unit was constructed and put into operation in this facility. Currently, the manufacturing facility generates 5,000 gallons of spent sulfuric acid per week, paying \$.40/gallon for transport and disposal. Raw material costs for the 94% sulfuric acid used by the company are approximately \$.50/gallon.

Arid Technologies estimates the RO system will save the company \$100,000 annually in reduced disposal costs and acid purchases.

Household Pets as Sentinels of Lead Exposure Phase II: A Study of Lead Exposure

William Buck, University of Illinois at Urbana-Champaign

Phase I of this study was conducted to determine the health effects of lead-contaminated soils in dogs, cats and children residing near a secondary lead smelter. The sample sizes were 84 dogs and 26 cats in 80 households with a total of 198 humans. Animals living outside, exposed to soil, were more at risk of having a high blood lead concentration (BLC) than pets living inside. The strongest correlation between children and pets sharing the same household was between younger children (up to 6 years of age) and indoor animals.

The likelihood of finding someone in the household with a high BLC was significantly increased when a pet was found to have a high BLC. However, the range of BLC was fairly small compared to those found in previous studies. Thus, the overall risk from lead contamination in this study appeared limited.

These conclusions follow from the data: 1) dogs and cats in the household are more at risk than their owners of having high BLC when exposed to the same environment; 2) soil lead concentrations should not be the major parameter

used to estimate the risk of increased lead exposure to humans or their pets, since many other factors influence the bioavailability of lead, e.g., soil characteristics (pH and cation exchange capacity), lead particle size and chemical form, and lifestyles of both animals and humans; 3) monitoring dogs and cats would be a cost-effective way to predict risks to humans associated with a lead-contaminated environment.

Phase II of this project examined the effect of native soil cation exchange capacity (CEC) and pH on the availability of lead to rats from both in situ contaminated and lead acetate-dosed soils. The project objectives included determining: 1) the pH, soil types, and CEC of residential soils around the lead contaminated site; 2) the bioavailability of lead in these soils to laboratory rats; 3) whether raising the pH would reduce the bioavailability of lead in the soils; and 4) if extractable lead in soil can be correlated with availability of lead to rats.

To date about 30% of the 1,200 rat liver, kidney, and femur samples have been analyzed for lead content at the State of Illinois Animal Disease Diagnostic Laboratory in Centralia. All the feed samples have been analyzed for chemical content and are undergoing statistical analysis. Blood samples have been analyzed for lead concentration and undergone statistical analysis.

Soils have been characterized for pH, CEC, sand, silt, and clay contents, textural class, and total and extractable lead content. Extractable lead concentrations using PA solution and ammonium acetate were most highly correlated with lime and phosphorus treatments, while lead levels extracted by nitric acid and EDTA were more reflective of total lead levels in the soil. The ratio of total lead in the soil to the lead sorptive capacity of the soil has been shown to be highly correlated with plant uptake. These ratios can be correlated with tissue lead levels in the rats and have potential predictive value as the various extractants.

This study is part of a larger study of lead levels in the residents of communities in and around the East St. Louis area. The larger study received funding from the International Lead Zinc Organization.

Determination of Animal Hazards from Air and Soil Samples from Crab Orchard

Larry Hansen, University of Illinois at Urbana-Champaign

This project uses bioassay methods for hazard identification, hazard characterization and dose-response assessment of various matrices associated with the PCB-laden landfill in Crab Orchard National Wildlife Refuge. The site is on the Superfund National Priorities List. Soil, dust, and air samples have been analyzed for PCB congener composition. Landfill extracts containing contaminants are being used for dosing laboratory rats to determine morphological (acute) toxicity, neurotoxicity, and reproductive and developmental effects.

Results thus far indicate that there are differences in the proportions of analytes in the three sample types (air, dust, and soil). The investigators surmise that some form of slow dechlorination is occurring in the moist, semi-anaerobic subsurface soils because there was a higher proportion of lightly chlorinated PCBs than anticipated. As expected, lightly chlorinated PCBs dominated the air samples, but the dust samples, where moderately chlorinated congeners dominated, contained fewer lightly chlorinated congeners than either air or subsurface soil. PCNs (polychlorinated naphthalenes) and PCDFs (polychlorinated dibenzofurans) were detected in the samples, but no organometallics survived the extraction and cleanup procedures in detectable amounts.

Extracts were acutely toxic to freshwater planaria. Varied dose levels produced loss of consciousness, complete head loss, deformed heads, and depressed dopamine. Studies with young female rats have indicated that the soil extract is estrogenic, induces liver enzymes, depresses serum thyroxine levels, and at higher doses, causes adrenal gland enlargement. These are typical responses to chlorinated aromatic compounds and the relationships among the different effects provide insight into the subtypes of chlorinated aromatics which dominate.

This project will provide an animal hazard ranking, based on multiple biological endpoints,

resulting from exposure to PCB-contaminated samples. The final project report is in review and should be available in December 1996.

The Effects of Chronic Oral Dosing of Bismuth Alloy, Iron, or Lead Shot on the Reproduction of Game-Farm Mallards (*Anas platyrhynchos*)

William Buck and Karen Duncan, University of Illinois at Urbana-Champaign

With the banning of lead shot for hunting waterfowl since the 1991-92 hunting season, the search has been on for a nontoxic shot which is more acceptable than the existing steel alternative. A bismuth alloy shot is currently in use in Australia, Europe, and Canada, and is being evaluated by the US Fish and Wildlife Service (USFWS) for use in the United States. Investigators at the University of Illinois have completed the first two phases of a three-phase study designed to evaluate and compare the effects of bismuth, iron, and lead shot on hand-reared mallards. The USFWS protocol that has been approved is limited to the quantification of blood and tissue concentrations of a wide variety of elements, but ignores the potential effect of bismuth on clinical pathological indices, particularly those that are known to be affected in lead-exposed ducks. In this part of the project, the potential effects of sublethal doses of bismuth and lead on reproductive capacity of the mallards were evaluated by measuring clinical pathological parameters in the ducks, including hematological indices of total white blood cell count and differential, as well as the hematocrit. Changes in red blood cells, white blood cells and platelets were investigated. Serum chemistry profiles include the measurement of glucose, total protein, uric acid, bile acids, aspartate aminotransferase, calcium, and creatinine phosphokinase. The final report for the project is expected in January 1997.

East St. Louis Urban Ecology Project

Kenneth Reardon, University of Illinois at Urbana-Champaign

A once thriving meat-packing, metal-bending, steel-producing and railroading center, East St. Louis is currently one of the poorest urban

communities in the United States. Its residents and community-based organizations have responded to the city's growing economic and fiscal problems by initiating a wide-range of volunteer improvement efforts to address the serious environmental, economic and social problems facing their neighborhoods. Between 1985 and 1995, civic associations and neighborhood organizations were formed in 15 of the city's 20 residential communities. These grassroots organizations are responsible for organizing the cleanup of illegally dumped trash, sealing of abandoned buildings, construction of new playgrounds, and the creation of a 100,000 square foot farmer's market.

Civic leaders have asked faculty from UIUC's Department of Urban and Regional Planning to create a Neighborhood Development Academy that will offer classes that provide the knowledge and skills training needed to assist the community leaders and residents to address the environmental, social, and economic problems they face. WMRC is providing the funding to develop and offer two of these courses during FY96. The courses include an introduction to local, state and federal government structures, processes and policies that impact the urban environment as well as an introduction to the theory, methods and issues related to neighborhood planning. The classes met for two hours on 12 Saturdays at the Southern Illinois University at Edwardsville - East St. Louis Campus. A course manual includes the lesson plan and course materials have been prepared for each course and provided to WMRC as part of the final project report. The manual and report will be available in January 1997.



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