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Illinois
Hazardous
Waste
Research
and Information
Center

Annual Report
Fiscal Year 1995

Hazardous Waste Research and Information Center

Fiscal Year 1995 Annual Report



HWRIC's Mission

The Hazardous Waste Research and Information Center (HWRIC) was formed within the Illinois Department of Energy and Natural Resources (ENR) in 1984. HWRIC 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 also a priority. In September 1989 the signing of the Toxic Pollution Prevention Act (TPPA) formalized the Center's programs to include Research, Information Services, Industrial and Technical Assistance, Data Management and Laboratory Services. This Act (Public Act 86-914), which was amended in 1990 by Senate Bill 2253, expanded the Center's five programs to include a Pollution Prevention Program.

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*Printed by the Authority of the State of Illinois
(X603768 - 600 - 4/96)
Printed by contract. 600 copies at \$3.91 each.*



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http://archive.org/details/annualreportfisc00illi_0

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List of Abbreviations

AAR	Association of American Railroads
ACF	Activated Carbon Fibers
BCR	Bagged-Composting Remediation
BLC	Blood Lead Concentration
BOD	Biological Oxygen Demand
BTEX Center	Benzene, Toluene, Ethylene, and Xylene HWRIC
CEC	Cation Exchange Capacity
CERL	United States Army Corps of Engineers Construction Engineering Research Laboratory
CFC	Chlorofluorocarbons
CICI	Chemical Industry Council of Illinois
CILCO	Central Illinois Light Company
CMC	Chicago Manufacturing Center
CMP	Clean Manufacturing Program
CMS	Central Management Services
CNT	Center for Neighborhood Technology
CONWR	Crab Orchard National Wildlife Refuge
DCCA	Department of Commerce and Community Affairs
DCM	Dichloromethane
DNR	Department of Natural Resources
DPH	Illinois Department of Public Health
ENR	Department of Energy and Natural Resources
EPRI	Electric Power Research Institute
FY	Fiscal Year
GCP ³	Greater Chicago Pollution Prevention Program
GIS	Geographical Information System
GLPPC	Great Lakes Pollution Prevention Clearinghouse
GLRP2R	Great Lakes Regional Pollution Prevention Roundtable
HDFE	High Density Polyethylene
HML	Hazardous Materials Laboratory
HWRIC	Hazardous Waste Research and Information Center
ICP/MS	Inductively Coupled Plasma/Mass Spectrometer
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
IGIS	Illinois Geographic Information System
IP	Illinois Power
IPA	Isophthalic Acid
ISP	Information Services Program
ISPC	In Situ Phosphatizing Coatings
ISPR	In Situ Phosphatizing Reagents
LAN	Local Area Network
LSP	Laboratory Services Program

LUSTs	Leaking Underground Storage Tanks
MEC	Manufacturing Extension Center
MEP	Manufacturing Extension Program
MLI	Motorla Lighting Inc.
MPF	Metal Parts Fabricating
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
NRC	National Research Council
OTA	(Congressional) Office of Technology Assessment
P2	Pollution Prevention
P ² AID	Pollution Prevention Assistance and Information Database
PCB	Polychlorinated Biphenyls
PCDF	Polychlorinated Dibenzofurans
PCN	Polychlorinated Napthalenes
PI	Principal Investigator
PIII	Printing Industry of Illinois and Indiana
PIPP	Partners in Prevention Program
POTWs	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RO	Reverse Osmosis
RRT	Reduction and Recycling Techniques/Technologies
SHWEC	Solid And Hazardous Waste Education Center
TCA	Trichloroethane
THM	Toxic Heavy Metal Ions
TMA	Trimellitic Anhydride
TRI	Toxic Release Inventory
UIUC	University of Illinois at Urbana-Champaign
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOCs	Volatile Organic Compounds
VOM	Volatile Organic Material
VRT	Variable Rate Technology

Chapter 1: Introduction



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

The Center's focus on waste reduction was formalized in September 1989 by the *Illinois Toxic Pollution Prevention Act*. 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 Pollution Prevention Program. The Pollution Prevention Program included the activities of our initial Industrial and Technical Assistance Program. In addition, during FY95 HWRIC reorganized and brought its data management activities under the Information Services Program. Some of the outreach functions previously under Information Services were moved to the Research Program where various publication activities have been located. HWRIC's current organizational structure is illustrated in Figure 1-1. Table 1-1 lists FY95 HWRIC staff.

The state-funded headcount for HWRIC during FY95 was 26 on General Revenue Funds, 4.5 on Solid Waste Management Funds, and 2 on other state funds. Total staff at HWRIC, including contract and part-time personnel, is about 48. The state budget for the Center is \$2.1 million, with approximately \$700,000 of this designated for sponsored research projects.

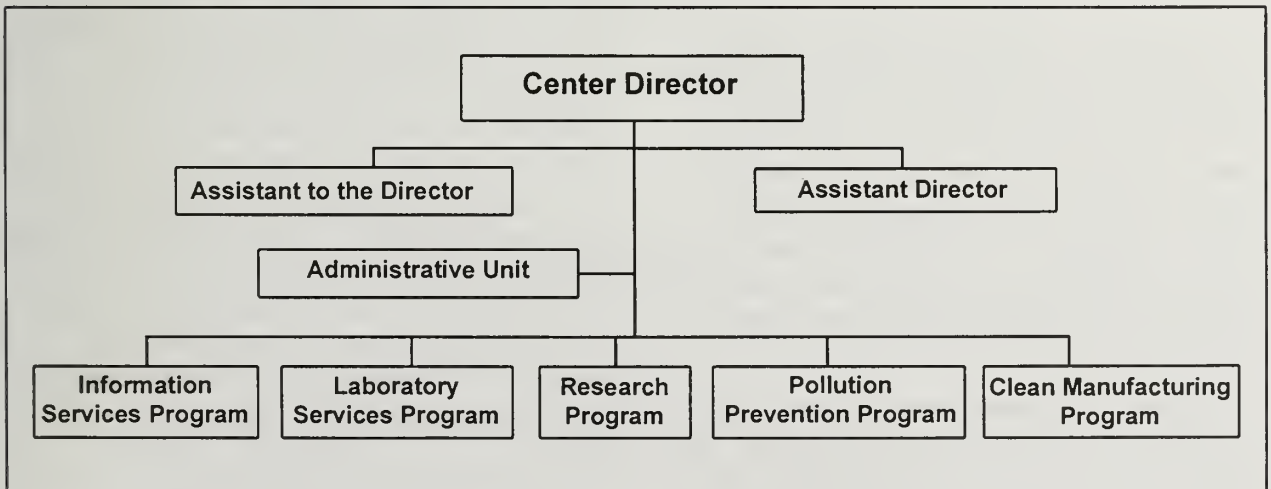


Figure 1-1. HWRIC FY95 Organizational Chart

The Center answers to the Board of Natural Resources and Conservation, which consists of scientific and technical experts in the specialty areas of the Center and the three scientific surveys. It is chaired by the Director of DNR. The Board was formed by legislation (Public Act 80-1218) to approve personnel actions of the scientific surveys and HWRIC, and to provide programmatic oversight. The Center also has a Program Advisory Panel, 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.

This report covers the period July 1994 through June 1995 (the Fiscal Year 1995). The focus is on the integrated nature of all of HWRIC's programs to help meet our mandate of finding solutions to Illinois' hazardous waste problems.

Chapter 2 of the report presents a brief summary of each of the Center's programs and services offered. Descriptions of the activities of each of the Center's programs can be found in previous annual reports available from HWRIC's Clearinghouse (HWRIC, 1993; HWRIC, 1994). Chapter 3 summarizes the Center's technical assistance efforts to various groups within Illinois. The emphasis of this chapter is on HWRIC'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 outlines recent developments of the Center in the area of information resource development, particularly pollution prevention information. A number of new contracts that will expand these activities, and how we network with others nationally are discussed in this section.

Chapter 6 discusses some future activities and priorities for HWRIC designed to bring our state closer to the goal of a sustainable future. We have called our initiative for the future "Sustainable Illinois." Our initiative recognizes that

environmental protection and enhancement, so important for our well-being, needs to be balanced with our state's needs for jobs, a strong economy, and productive industry. We believe that as a society we need to look at "sustainable development," that is, meeting our current societal needs without compromising the ability of future generations to satisfy their own needs. While many others in the state will play a significant role in this regard, the Center's pollution prevention, education, research and outreach activities are all important components to help assure a sustainable future. Last year's annual report (HWRIC, 1994) discussed how the Center's various programs contributed to the goal of a sustainable future. This year we have focused on two primary areas: the clean-up of past sites of contamination and the prevention of future contaminated sites through our pollution prevention efforts.



Over the last ten years HWRIC has grown in size and stature, and has achieved both national and international recognition.



HWRIC celebrates its tenth anniversary this year. Over the last ten years we have grown in size and stature, and have achieved both national and international recognition. Still, it is our goal to grow slowly and purposefully, and to achieve many of our goals 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 report follows last year's annual report in its emphasis on describing the nature and extent of these collaborative efforts.

Table 1-1. HWRIC 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
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
Luann Weidenmann, Inorganic Preparations Chemist
Aaron Weiss, Senior Inorganic/Analytical 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
Angela Simon, Project Officer
Pamela Tazik, Project Officer

Information Services Program

John Marlin, Information Services Program Manager
Laura Barnes, Librarian/Clearinghouse Specialist
Jill Blanchar, Systems Administrator
David Green, Computer Systems Specialist
Steven Murray, Database Management Specialist

Clean Manufacturing Program, Chicago

Malcolm Boyle, Senior Engineer/Office Manager
Jerry Brown, Manufacturing Process Engineer
Clifford Jahp, Environmental Engineer

Chapter 2:

Programs and Services

Introduction _____

The Center's tenth year began with the establishment of an office in Chicago, continued with organizational changes in the Champaign operations, and ended with the state agency reorganization that moved HWRIC into the newly created Department of Natural Resources. The result of these modifications was to increase the ability of the Center's staff to respond more promptly and efficiently to requests for information and assistance. Previous reports (HWRIC, 1993; HWRIC, 1994) contained descriptions of the Center's programs and services. This chapter provides a brief overview of the Center's programs, services and priorities.

Pollution Prevention _____

In 1986, HWRIC's Pollution Prevention 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. The *Illinois Toxic Pollution Prevention Act* (Public Act 86-915), passed in 1989, formalized HWRIC's Pollution Prevention (P2) Program and delineated specific responsibilities. These responsibilities include the following:

- provide information on and publicize the advantages of source reduction;
- establish courses, seminars, workshops, and other training aids;
- publish exemplary accomplishments;
- research pollution prevention methods and technologies and transfer this information;
- provide on-site technical assistance to identify opportunities and develop plans for on-site remediation wherever possible;

- sponsor pilot projects to develop and demonstrate innovative technologies;
- establish and operate a clearinghouse; and,
- use engineering field internships to identify P2 opportunities.

An effective pollution prevention program reduces waste releases to all media—air, water and land. HWRIC's 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 HWRIC'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 as they relate to source reduction legislation and assist with permits, and
- provide assistance with economic justification of implementation strategies.

The most visible aspect of HWRIC'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, recommenda-

tions on appropriate waste handling methods, and referrals to qualified service organizations.

Because HWRIC 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. HWRIC does not report site-specific findings to state regulatory agencies.

Complementing the technical assistance efforts is HWRIC's Reduction and Recycling Techniques/Technologies (RRT) Program which 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. 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.

.....
HWRIC provides up to \$50,000 per year in matching funds to industry for applied research.
.....

Under the RRT program, Center staff may provide technical support to Illinois businesses and industries to conceive and implement workable projects. HWRIC engineers and scientists are available, upon request, to provide "hands on" assistance with project development, initiation, and management. In FY95, HWRIC used its well equipped Clean Technologies Laboratory to solve waste stream separation problems for a number of industries. Technologies such as ultrafiltration, reverse osmosis, vacuum evaporation and centrifugation were evaluated for recovery and recycling of waste stream components. In addition, HWRIC has become a recognized test facility for the demonstration of safe cleaning

techniques, employing aqueous cleaners where hazardous organic solvents were previously used.

Chicago Manufacturing Program _____

December 8, 1994 was the official opening of HWRIC's Clean Manufacturing Program (CMP). Co-located with the Chicago Manufacturing Center (CMC) at Homan Square west of the Chicago Loop, the program is staffed by four full-time engineers and two part-time retired engineers. With this office, the Center is better able to provide environmental, regulatory, and pollution prevention assistance and services to companies and citizens in the northeast area of the state where almost two-thirds of Illinois businesses are located.

The Center's CMP engineers work with CMC staff to add pollution prevention and waste management services to the business development, modernization, and competitiveness programs already provided by CMC. As businesses consider new technologies or upgrade existing technologies, they will be encouraged to factor environmental concerns, including pollution prevention into their decision-making process.

Program staff have also developed a cooperative working relationship with the North Business and Industrial Council (NORBIC) to assist the over 1,200 companies it serves on the north side of Chicago. In addition to providing direct technical assistance to NORBIC members, CMP staff make regular contributions to its newsletter.

The CMP staff provide the same services and information as the Center's P2 staff in Champaign including:

- on-site visits and assessments;
- answers to waste management, pollution prevention, and regulatory questions;
- assistance with technology development and evaluations;
- participation in workshops, focus groups, and technical meetings;
- information on waste management topics; and,
- referrals.

Research

Each year, HWRIC receives an appropriation from the state to support research to:

- 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 FY95, the money appropriated to fund research was \$702,400. These funds are primarily available to investigators working in Illinois, although researchers 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 RRT program. The remainder of the funds support basic and applied research projects. These are selected from preproposals submitted in response to the Center's general request for proposals issued each December. The preproposals that are received are evaluated by Center staff. Full proposals are requested from those researchers whose ideas address important waste management problems and/or offer significant scientific contributions towards our knowledge of waste management issues. Full proposals are evaluated both by Center staff and external peer reviewers. Those projects that respond 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. The project selection schedule for FY95 is provided in Table 2-1.

Projects selected for funding during FY95 are discussed in Chapter 4. While some projects investigate the extent of existing contamination problems, most evaluate methods for treating waste, or techniques and technologies to prevent future waste problems. HWRIC 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 FY96.

Table 2-1

HWRIC Research Project Solicitation Schedule	
Preproposal Solicitation	December
Preproposals Due	January 27
Preproposal Selection	February
Proposals Due	April 28
Project Selection	June
Projects Begin	October

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

Staff must maintain an awareness of other hazardous waste research efforts being supported at a national level to avoid duplication by the Center's Research Program and to 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 HWRIC 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 they contain. Most research projects end in peer-reviewed research reports published by HWRIC and made available through the Center's Clearinghouse.

HWRIC's internal reorganization formalized and expanded the outreach roles of Research Program staff. While always responsible for the technical review of Center-produced documents, research staff now also handle 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 hazardous waste problems. The sophisticated instrumentation and professional staff allow the program to offer analytical and technical support to a broad range of clients. The Hazardous Materials Laboratory was constructed specifically to support such analytical resources and to provide a safe environment for the conduct of research projects dealing with hazardous wastes. A diagram of the laboratories is presented in HWRIC's FY93 annual report.

The LSP supports pollution prevention, remediation and waste treatment research by providing chemical characterization of process and waste streams, both before and after application of engineering technologies to these streams. This information can be used to make decisions on appropriate strategies for treating and reducing wastes and increasing process efficiency.



The program provides support for industrial projects, often in the form of analytical data on the composition of industrial processes and waste streams, and air emissions.



The program provides support for industrial projects, often in the form of analytical data on the composition of industrial process and waste streams, and air emissions. Laboratory instrumentation available to staff permit identification and measurement of most organic and inorganic components likely to be present in such process and waste streams. While much of the work done for industrial clients focused on measuring oil and grease and surfactant levels in cleaning solutions, more sophisticated services were provided as well. Several projects involved the development of analytical methodologies to identify and measure a variety of components in organic chemical industry process and waste streams. The data provided are critical to determining how best to address pollution prevention concerns on such industrial water or solvent streams. The analytical experience gained from working with such complicated matrices is invaluable in preparing the chemists for future work on the wide variety of industrial and other samples they will likely encounter. Specific analytical capabilities of the laboratory are summarized in the FY93 annual report. These capabilities were augmented with the acquisition of a light-scattering detector for the liquid chromatography system that should significantly enhance work done on measuring industrial surfactants.

HWRIC's work with a variety of industrial clients provides access to samples of varied composition. Such real world samples are of considerable interest to vendors of analytical supplies and equipment. HWRIC staff chemists also actively work with vendors to evaluate new products for application to analyses related to pollution prevention concerns in industrial facilities, e.g. oil and grease measurements in waste streams, particularly in the presence of surfactants and other cleaning additives. Similarly, HWRIC staff have been active in evaluating new methodologies and new applications of instrumentation for the analysis of contaminants. Exposure to a wide variety of industrial samples helps vendors evaluate strengths and shortcomings in their products and instrumentation, allowing them to improve the quality and usefulness of those products. HWRIC assists by providing that exposure without compromising the relationship it has with its industrial clients.

The LSP also provides analytical support and guidance to others in the research community. In addition to its industrial clients, most of whom come to HWRIC through P2 Program efforts, the LSP supports a variety of researchers, both public and private, working with hazardous waste problems. Researchers include those receiving HWRIC research funding, and researchers at the scientific surveys, the University of Illinois, CERL or elsewhere who receive funding from other sources. This support generally takes the form of chemical analyses that the researchers are not able to perform themselves. In some cases, the lab staff also gets involved in experimental design or other aspects of the research projects. This year's projects ranged from the determination of low level analysis of gadolinium in human tissue samples to the measurement of chlorinated organic pollutants in tree tissues. Table 2-2 provides a listing of those clients to whom the LSP provided analytical services during the fiscal year.

Table 2-2

FY95 Lab Services Program Clients	
<p>Industrial Clients (via technical assistance efforts)</p> <p>115th Street Corporation Ace Plating Agrifine Arid Technologies Automatic Anodizing Bell Sports BTL Resins Danville Metal Stamping Dover Industrial Chrome Eureka Fulton Harrington Signal Harris Corporation Highland Machine and Screw Maytag Corporation Paul's Machine Shop Radio Flyer RB White R&O Specialties Safety Kleen Twinplex Viobin Vita Foods Witco</p>	<p>Research Program Funded Clients</p> <p>Kelly/State Water Survey Davis/Fehr-Graham Thurston/UI General Engineering Cailas/UI-Chicago Dentistry School Hansen/UI Veterinary School Rayburn/UI Agronomy Department Buck/UI Veterinary School</p> <p>Direct LSP External Clients</p> <p>Adrian/CERL Bricka/US Army Engineers Waterway Experiment Station Sweet/State Water Survey Weiner/UI Beckman Institute Maloney/CERL Webb/Illinois Department of Public Health Guglielmoni/UI Department of Landscape Architecture Harlin/State Water Survey Cropek/CERL</p>

The Center also provides space in the HML to researchers from outside of HWRIC. The Clean Technologies Laboratory represents one component of this laboratory space. This laboratory is used by HWRIC's P2 Program staff to provide evaluations of particular treatment technologies on process or waste streams from a variety of industrial clients. Similar services are provided by P2 staff in the Alternative Cleaners and Process Chemistry Alternatives Laboratories. Additional laboratory space is available to researchers wishing to conduct bench and intermediate scale experimentation. Most of this space is located within the HML's high hazard area which is equipped with special air and waste handling systems facilitating safer handling of toxic materials than might be available in the visiting researchers' own facilities. LSP staff provide coordination of laboratory use and often contribute technical guidance and analytical support to such projects.

Information Services _____

In 1995, the Center combined the clearinghouse, library, database management and computer hardware and software support functions into a unified information services program. The move recognizes that the ever increasing amount of information and data available in electronic form requires close cooperation between specialists in these areas. This reorganization will facilitate the Center's use of the Internet for both obtaining and distributing information.

Fulfilling HWRIC's legislative mandate to compile and disseminate hazardous waste-related information is the principal responsibility of the Clearinghouse and Library. A full-time librarian and half-time assistant librarian along with part-time and student staff are responsible for providing internal (HWRIC) and external clients with information and materials. Table 2-3 provides outreach statistics for FY95.

HWRIC's core information resources are contained in the Library and Clearinghouse. The HWRIC Library contains close to 8,000 items, including books, government reports, journals, maps, video and audio tapes, and articles.

Records for the Library collection are maintained in three separate INMAGIC databases—library (books and audio/visual materials), magazines, and article citations. All staff can access the databases directly from their office computers through HWRIC's Local Area Network (LAN). The Library collection does not circulate outside the Center, but interlibrary loan requests are honored.

Table 2-3

Information Services Program Outreach Statistics for FY95	
Library Reference Queries Answered for General Public	303
Library Items Lent Via Interlibrary Loans	100
Requests Made to Clearinghouse	761
HWRIC Publications Distributed	6,302
Non-HWRIC Publications Distributed	2,184

The Clearinghouse includes two collections of materials. The first is the collection of HWRIC-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 HWRIC, 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. HWRIC generally charges a nominal fee for reports to recover some of the reproduction costs.

HWRIC is increasingly involved in regional and national efforts to network pollution prevention assistance providers and/or clearinghouses.

Several grant applications have been submitted to follow up 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 hazardous waste database for Illinois, responding to requests for information from this database, and managing HWRIC'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.

HWRIC'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 are an integral part of the database and allow hazardous waste data to be analyzed spatially. New information is added to HWRIC'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. Figure 2-1 is representative of the maps produced from the Historical Hazards GIS database that pinpoint sites of past industrial contamination.

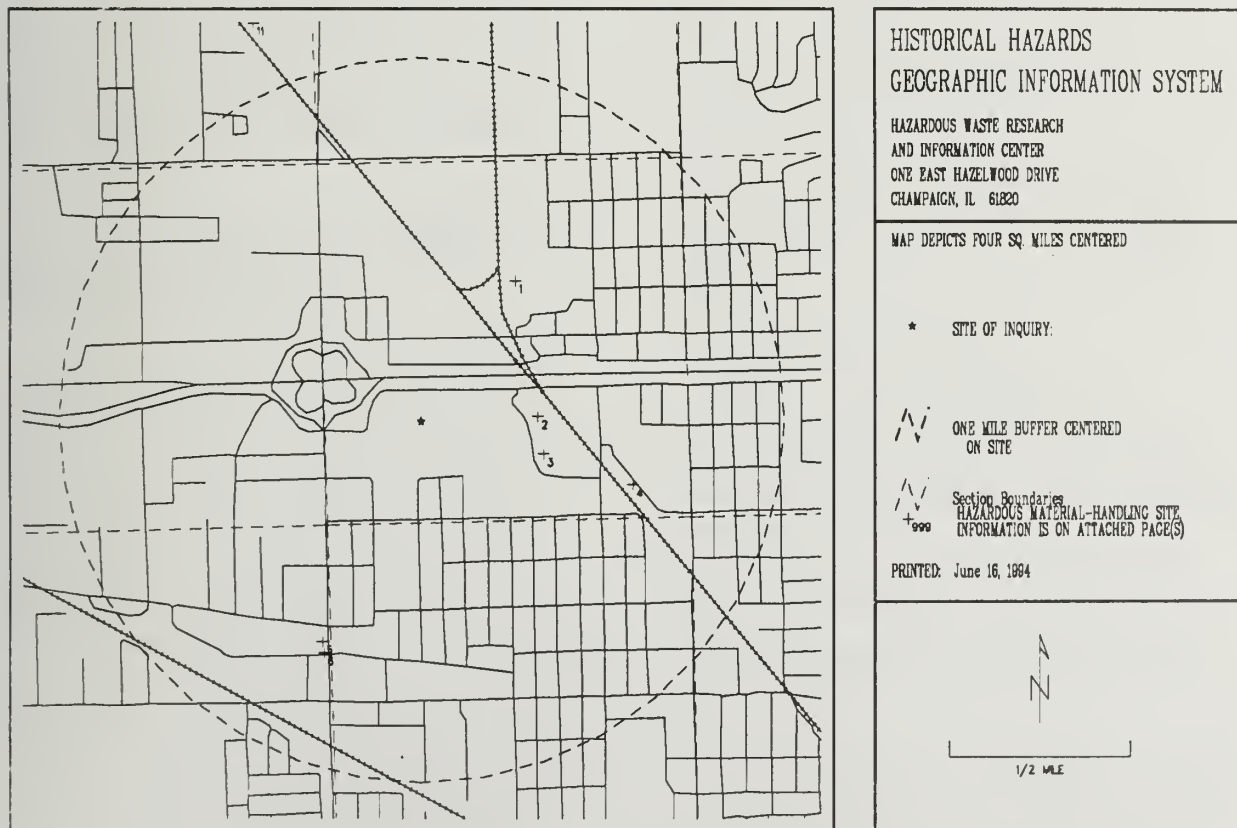


Figure 2-1. Sample Map from Historical Hazards GIS Database

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. HWRIC researchers developed the "Degree-of-Hazard" characterization scheme that can be used to declassify Illinois special wastes not regulated under the federal Resource Conservation and Recovery Act (RCRA).

HWRIC'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.

Chapter 3: Pollution Prevention Assistance



Introduction _____

During its eighth year, HWRIC's Pollution Prevention Program explored ways of further extending its technical assistance outreach philosophy into the state. This included the formation of partnerships with companies within industries' "comfort zone." The "comfort zone" was defined in a HWRIC-sponsored research study as the trusted and respected peers relied upon by small businesses to obtain information for making important decisions (Bierma & Waterstraat, 1995). Peers in the comfort zone of small metal fabricators included suppliers, customers, competitors, and contracted business associates such as attorneys and accountants. In an effort to find access to the comfort zone of small businesses, the pollution prevention team began a partnership program with publicly owned treatment works (POTWs) around the state, as well as electric utility companies and manufacturing extension centers (MECs).

Expansion of HWRIC's Pollution Prevention Network _____

The increase in technical assistance site visits experienced in FY95 can be attributed to the expansion of HWRIC's pollution prevention network. Key additions to the network included using POTWs, electric utilities, and MEC's as referral sources. The various facilities that contacted HWRIC for technical assistance were directed to us from a variety of origins: 25% from POTWs, 25% from manufacturing extension centers, 3% from electric utilities, and 47% from other sources. Other sources include companies that initiated direct contact with HWRIC such that the referral source is unknown. These contacts have helped the pollution prevention technical assistance staff to increase their site assistance

activities to over 200 Illinois industrial facilities in the last fiscal year (see Table 3-1).

Most POTWs are designed and constructed to treat predominantly domestic wastes but often have to treat industrial wastes that they are not equipped to handle. Through their pretreatment programs they often attain considerable knowledge of the wastes that their industrial users are discharging. They are also usually perceived by the industrial users to be waste management experts. The POTW program was established to take advantage of the POTWs knowledge and status in an effort to promote pollution prevention. HWRIC has accomplished this by providing pollution prevention technical assistance to both the POTWs and their industrial users. The assistance efforts offered to the POTWs included:

- compliance with environmental quality standards, including sludge disposal and toxic air emissions;
- reduction of influent contaminant transfers from wastewater to another environmental medium (e.g. land, air, surface or ground water);
- improvements in worker safety and reductions in exposure to toxic gases;
- reduction in sludge management costs;
- reduction of biological oxygen demand, total suspended solids, fats, oils, greases, heavy metals, priority pollutants, hydraulic and slug loads; and,
- maintenance of load levels that allow for projected demands for future sewer services.

The assistance offered to the clients of the POTWs included:

- seminars on pollution prevention for various trade groups,
- detailed assessments to aid industrial facility staff in identifying pollution prevention opportunities,

- developed an action plan for incorporating pollution prevention into the company's way of doing business,
- answered specific waste management and regulatory questions,
- provided case study examples of pollution prevention from our extensive database and library,
- provided technical information (manuals, reports, etc.) regarding pollution prevention,
- evaluated materials and material substitutions used in a specific process and their consequent effects on waste generation, and
- evaluated equipment or techniques for hazards removal using specific process units.

In addition to the POTW program, the pollution prevention group established cooperative programs with the state's manufacturing extension centers (MECs). The goal of these programs is to integrate environmentally focused technical assistance for small and mid-sized manufacturers into existing MEC efforts of business modernization, needs assessments, and training. This will be accomplished in part by training MEC personnel

in the basics of environmental responsibility, pollution prevention awareness, and recognition of pollution prevention opportunities for their client businesses. Additionally, MEC personnel will identify and refer companies in need of specialized technical assistance to HWRIC pollution prevention staff for more comprehensive support.

A partnership with electric utilities has been formed to enhance the customer service efforts of both HWRIC and the utilities. HWRIC provides the customers of the utility with both regulatory and pollution prevention assistance. This is especially useful to the small and medium sized businesses who do not possess environmental staff and cannot afford a consultant to perform a full evaluation of their industrial processes to determine waste reduction potential. The electric utilities benefit from the program because their customers become more competitive through these modernization efforts. For a more detailed description of HWRIC's partnerships with technical assistance providers, please refer to Chapter 6.

Table 3-1: Comparison of Site Visits by P2 Personnel in FY94 to FY95

Business Type	1994 Site Visits	1995 Sites Visits
Fabricated Metals	16	57
Electroplaters	8	39
Auto Repair and Body Shops	5	-
Machine and Welding Shops	3	8
Railroads	2	3
Coil Coaters	2	-
Pharmaceutical Manufacturers	3	3
Research Labs	3	6
Foundries	2	9
Oil Refineries-		
Crude & Vegetable Chemical Manufacturers	2	12
Food Processing	-	21
Printing	-	8
POTWs	-	17
Other ¹	6	21

¹ Includes fiberglass, metal and appliance manufacturers, electronics, plastic and wood manufacturers, and drum reconditioning.

HWRIC's Clean Manufacturing Program _____

HWRIC's technical assistance efforts in the Chicago metropolitan area were greatly expanded by the formation of the Clean Manufacturing Program (CMP). The Chicago office officially opened on December 8, 1994 with a staff of three engineers. The overall goal of the program is to provide more timely technical assistance to businesses in northeastern Illinois and to integrate pollution prevention into the outreach activities of the Chicago Manufacturing Center (see Chapter 2). Over the eight-month time period since its inception, the CMP office has performed over 50 site visits and given numerous outreach presentations. The CMP has also initiated three pollution prevention projects which involve working directly with companies to test process modifications which will generate less waste and pollution.

The CMP has a large growth potential. The accessibility and confidentiality provided by the CMP has contributed greatly to its acceptance in the marketplace. As local awareness of the CMP increases, it is anticipated that the CMP will become a major provider of environmental technical assistance in northeastern Illinois. Consequently, the number of site visits and pollution prevention projects conducted by CMP personnel will probably grow considerably in the upcoming year. The number of presentations should also expand due to the ever increasing environmental awareness of businesses, communities and educational institutions.

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The accessibility and confidentiality provided by the CMP has contributed greatly to its acceptance in the marketplace.

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The CMP has collaborated with the North Business and Industrial Council (NORBIC) to form an outreach effort to businesses in their service area. NORBIC was founded as an economic development organization to assist 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. The partnership will focus on providing these companies with technical assistance on environmental regulations, compliance, and implementation of pollution prevention. The first steps of the partnership were to provide NORBIC the materials necessary to establish a pollution prevention reference library on site, conduct initial meetings with NORBIC clients to discuss the primary environmental issues of concern, and aid in a survey of printers in the NORBIC area to determine their environmental and safety concerns.

Pollution Prevention Projects _____

As industries in Illinois are facing decisions regarding the switch to non-solvent cleaning technologies, they often lack the information and/or resources to accomplish this task. HWRIC's Alternative Cleaning Technology Laboratory was established to assist companies in their efforts to switch to more environmentally benign cleaners. Typically, referrals for this service result from HWRIC site visits, phone inquiries, and references from state and federal agencies. Initial discussions often enable HWRIC and the client to agree upon the extent of the problems, ranging from a simple solvent substitution to re-evaluation of the entire cleaning operation. Ongoing communications determine the exact nature of the cleaning problem and a systematic plan to solve this problem with a less toxic substance is laid out. HWRIC emphasizes to companies the potential financial savings, improved public image, safer work environment, reduced waste generation, and continuous improvement options available with new alternative solvent technologies.

In the past year, 12 companies have been assisted in finding alternatives to solvent-based cleaning. Their concerns have ranged from solvent usage in machine parts washing baths to high temperature oven cleaning, with components of steel, brass, copper, and lead alloys being most prevalent. The majority of requests for assistance

have resulted from the need to convert from vapor degreasers which use 1,1,1-trichloroethane (an ozone depleting solvent) to aqueous-based cleaning in order to avoid Title V permitting under the Clean Air Act of 1990. The alternative cleaner formulations are selected based on customer requirements and potential for recycling. For an overview of the equipment and technologies in the Alternative Cleaning Laboratory, please refer to HWRIC 1994 Annual Report, pages 3-15.

Currently, possible solutions to cleaning problems are dictated by the products available in the marketplace. The available cleaners are being evaluated for their effectiveness under numerous conditions, many of which are dictated by client demand. Cleaners are being classified according to their physical properties, health and safety hazards, surfaces on which they work, and their chemical activity. From this work, the potential replacements for existing cleaning methods are identified. The experience gained from these tests will expand HWRIC's knowledge of current cleaning products and improve our ability to select chemical replacements. Future work in the laboratory will include studies conducted to characterize the resulting waste stream produced by the new cleaning technology, and the creation of a database to incorporate experimental results with existing literature and references to regulatory requirements.



Microfiltration and ultrafiltration have become increasingly popular as companies have made their switch to aqueous-based cleaners.



HWRIC customer demand for technology evaluations in FY95 focused predominantly on projects relating to membrane filtration technologies such as microfiltration, ultrafiltration, nanofiltration and reverse osmosis. HWRIC has acquired eight different membrane evaluation units in our Clean Technology Laboratory that can evaluate membrane performance with respect to a wide range of pore sizes and applications.

Microfiltration and ultrafiltration have become increasingly popular as companies have made the switch to aqueous-based cleaners. This process will separate emulsified oils, greases, and particulates from wastewaters and process solutions. A complete review of the equipment and technologies available in the Clean Technology Laboratory can be found in HWRIC 1992 Annual Report, pages 53-54. Samples of pollution prevention projects conducted over the past year are provided below:

- A chemical specialty manufacturer generated approximately 20,000 gallons of off-specification materials per month. HWRIC's assistance was sought to recover valuable components for reuse from the otherwise low value off-specification material. HWRIC evaluated four different membrane options that might achieve the desired separation for the customer. A nanofiltration membrane was demonstrated to efficiently separate valuable raw materials from the waste stream on a pilot scale. HWRIC is currently working with the manufacturer to identify suitable membrane materials and operating conditions that will ensure successful implementation. Results of the work completed to date show promise and plans are underway to conduct larger scale pilot testing at the company's facility.
- HWRIC engineers evaluated a pilot-scale ultrafiltration system at a machine and welding shop in Villa Grove. The company uses a phosphating/degreasing solution to clean and treat their parts prior to painting. Their facility is located on a greenfield site and, consequently, did not have access to municipal sewer services. The spent phosphating/degreasing solution was causing a significant waste management problem for the company because they had to dispose it as waste. HWRIC conducted tests of an ultrafiltration system both at the Clean Technologies Lab and on-site at the customer's facility. Results of the testing indicated that the company could recycle the phosphating/degreasing solution within the process and reduce their chemical usage by as much as 80% and their waste generation from this process by greater than 95%. The company plans to implement a permanent system in FY96 and anticipates a financial payback within 1 year.

- At the request of a metal cabinet manufacturer, HWRIC engineers helped to evaluate alternatives to their solvent cleaning operations. Many aqueous-based cleaners were investigated in HWRIC's Alternative Cleaning Technology Lab as possible replacements for the methylene chloride degreaser currently being used. The company cleans several metal components and, with HWRIC assistance, has implemented different cleaning chemicals and processes based on the metal being cleaned. The first line to be switched to aqueous cleaners was the aluminum line. A cleaner was selected and preliminary tests showed promise both in the cleaning quality and recyclability of the new cleaner. However, problems with the recycling of the cleaner started after several months in use. This in turn affected the cleaning quality, so a second alternative was sought. The line was switched to the second alternative which is being recycled in-line using ultrafiltration. The system is working very well and the company is now considering aqueous cleaning options for their line which cleans steel parts. As a result of these pollution prevention efforts, this company should reduce their solvent use by at least 80% in FY96.

- HWRIC staff worked with a manufacturer of steel battery casings to replace a mineral spirits degreaser. The battery casings must meet strict cleanliness restrictions, but the manufacturer was unable to get an accurate measurement on the necessary level of cleanliness. It was discovered that the aqueous-based cleaner currently being used was not doing the job as well as the solvent cleaner. Through cleanliness testing at HWRIC, the company was able to formulate a new water-based cleaner which has been implemented in their cleaning process. The new cleaning process is less expensive to use and still meets their quality requirements.

- A small electroplating shop needed a cleaner to remove buffing compound from the small parts that they electroplate. The company also requested assistance in finding an aqueous alternative to trichloroethylene that they were using for another cleaning/degreasing operation. A variety of cleaners for each operation were tested at the Alternative Cleaning Technology Laboratory.

Based on the results of this testing, several alternative cleaners have been suggested to the customer. The company has adopted those suggestions and is now preparing to explore, with HWRIC assistance, recycling options with an ultrafiltration unit at the facility.

Chemical Process Alternatives Laboratory _____

HWRIC is looking at programs to stem pollution at its ultimate source—the design stage. This includes the chemistries and the chemicals that are used to produce and process the materials that offer us the conveniences of everyday life. These initiatives are being coined “benign by design” and “environmentally conscious chemical manufacturing.”

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HWRIC is looking at programs to stem pollution at its ultimate source—the design stage.

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In order to address these issues, the newest addition to the HWRIC Pollution Prevention Program is the Chemical Process Alternatives Laboratory. This lab was established to assist synthetic and process chemists, as they are the architects that design and use the processes that employ and generate toxic materials during manufacturing. Capabilities of HWRIC's laboratory include the equipment necessary to reproduce, at bench scale, the current chemical processes employed by a given industry. This in turn will allow for research into process modifications which will incorporate pollution prevention. Typical reactions will include oxidation, reduction, polarization, catalysts, and others as requested by industries in the state of Illinois.

In the past, chemicals were designed with the philosophy that if more chemicals are produced, more money is made. The full cost accounting of toxic material handling, monitoring and by-product disposal was not considered. The economic impact of incorporating environmentally sound reaction chemistries and recovery tech-

niques to avert expenses associated with compliance, waste disposal, and treatment would be tremendous in industries statewide.

Benign chemistries and environmentally conscious manufacturing processes focus on operating cost reductions through productivity gains, process efficiency improvements, and toxic raw material and product emissions avoidance. These are just a few of the opportunities available for economic gains to businesses who have traditionally spent money on pollution control, compliance, and waste disposal. In addition to the economic gains, the industry will also benefit from an improved image.

Chemists have the option of deciding on the following key pollution prevention issues as a product is scaled-up for manufacturing by looking for ways to reduce:

- the toxic substances that workers handle toxic by-products that are generated and contaminants that are found in the product,
- hazardous wastes that must be dealt with,
- compliance issues that must be met in order to manufacture a product,
- the costs incurred for waste treatment or disposal, and
- liability concerns in the life cycle of the product.

The challenge will be to incorporate a fundamental understanding of toxicology into the chemical design process such that the structure of the chemicals can be altered to prevent them from being metabolized, activated, or toxic to living organisms. The initial efforts of the HWRIC Chemical Process Alternatives Laboratory are focused on real industrial waste stream problems. Often the cost of disposing of these waste streams is minimal in comparison to the potential sales revenues generated once the stream is characterized and marketable by-products are extracted. This laboratory attempts to develop cost effective technologies at 1) the design phase, 2) optimization of existing manufacturing processes, and 3) the recovery of useable products from waste streams. Future goals of the laboratory will include research into aiding businesses in "closing the loop" on pollution by regeneration of waste

streams into the overall plant operations with a goal of zero waste discharge.

Pollution Prevention Case Studies _____

The following case studies are provided to illustrate examples of how pollution prevention practices are being implemented at industrial facilities to reduce pollution and improve efficiency. Both examples demonstrate how environmental stewardship and industrial performance can be improved simultaneously. While each of these facilities has experienced significant accomplishments with respect to their pollution prevention efforts, they continue to search for additional opportunities for refining their processes in order to improve efficiency and reduce waste.

Ace Plating, Inc.

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

HWRIC engineers performed a pollution prevention assessment of the facility and noted that Ace was already practicing some pollution prevention activities, including dead rinse tank usage, countercurrent rinsing, nickel plating tank filtration, and regular monitoring of the plating tanks' bath chemistry. HWRIC staff pointed out other areas where pollution prevention could be implemented. These included: increasing drainage time in order to reduce drag-out, re-using the dead rinse tank contents as make-up water, and replacing a leaky water tank valve.

Ace Plating implemented these suggestions by combining preventative maintenance and operator training. As a result, they reduced the amount of wastewater they discharge to the sewer by about 25%. Initially, metals and cyanide were concentrated in the wastewater primarily due to reduced dilution. Although concentrations rose with the initial waste use reduction of 25%, they decreased

Table 3-2. Contaminant Concentrations in Ace Plating Rinse Water

Analyte	Sample Dates			
	4/94	10/94	1/95 ¹	1/95 ²
Concentration (mG/L)				
Cyanide	0.50	0.60	1.80	0.05
Copper	0.38	0.52	1.78	0.85
Zinc	1.01	0.86	3.20	0.86
Nickel	0.23	0.26	1.12	0.25

¹Concentrations in effluent after reducing water usage by approximately 25%

²Concentrations in effluent after initiating training regarding drag-out control procedures and reducing water usage by approximately 25%

dramatically after the operators were trained on how to extend drainage times and on reuse of dead rinse tank contents as make-up water (see Table 3-2).

In addition to the pollution prevention measures described above, Ace Plating is investigating opportunities to incorporate innovative technologies into their existing processes. With assistance from HWRIC, they have begun testing vacuum evaporation and reverse osmosis equipment on a pilot scale. These tests will determine the technical and economic feasibility associated with concentrating rinse water metals such that they can be reused in the electroplating process. Additionally, the potential for reusing the processed rinse water will be examined.

Vita Food Products, Inc.

Vita Food Products, Inc. is the largest processor of pickled herring and smoked salmon in the United States. The company is a 50-year-old business operating in a heavily depressed west Chicago enterprise zone. The facility employs approximately 100 temporary and full-time workers.

The processing of fish, especially pickling with sugars, generates large quantities of wastewater. From 1992 through 1994, Vita Food Products incurred annual sewer use fees to the MWRDGC averaging \$142,000. High biological oxygen demand (BOD) levels in the effluent accounted for approximately 88% of this cost. Additionally, Vita was spending approximately \$115,000 on labor, chemicals, and sludge disposal associated with the pretreatment system necessary to comply with MWRDGC discharge limits. In total, wastewater disposal cost the company the equivalent of 25% of their gross sales. Consequently, Vita was having difficulty remaining competitive in the industry as a result of the burdensome environmental compliance costs.

Vita approached MWRDGC to seek guidance concerning the hefty user charge fees and were referred to HWRIC for technical assistance. HWRIC staff conducted a site assessment to gather preliminary information on the existing processing techniques in place. Several waste reduction recommendations were made to the company that focused on the loss of product and process solutions. Based on the information gathered during the site visit, it was determined that pickling brines from the herring processing lines were a major source of BOD in the wastewater. HWRIC proposed to investigate the potential for reusing the pickling brine solution. Reuse of the brine would have the advantages of reduced BOD discharge, raw material costs, and wastewater treatment costs.

The project was conducted in two phases. The purpose of Phase I was to focus on the feasibility of reusing the cure brine using a combination of process changes and a suitable membrane technology on a bench scale. Phase I determined that recycling of the cure brine using a membrane filtration system was a viable option for reducing both BOD and raw material usage.

The objectives of the Phase II studies were to demonstrate that satisfactory product could be made with recycled brine in an in-plant trial using a pilot-scale membrane filtration system. Recommendations made as a result of the studies include:

- lowering the amount of cure brine needed per quantity of fish by adjusting the curing and soaking times, and
- recovering the used brine by membrane filtration for up to three more uses.

Implementation of these recommendations is in progress and will result in annual cost savings of \$104,000 in waste treatment costs and \$133,000 in raw material recovery for a total annual savings of \$237,000.

Eighth Annual Governor's Awards Presentation

The annual Pollution Prevention Awards were presented by Senator John Maitland on behalf of Governor Edgar at a luncheon ceremony at the Governor's Executive Mansion in Springfield on September 21, 1994. This year's competitive awards and certificates recognized organizations that have made significant reductions in the amount of waste they generate, while increasing the productivity of their operations.

Seventeen Illinois businesses and organizations received awards and 12 certificates of recognition were given in seven categories (see Figure 3-1). Their winning activities are described in Appendix B. Participants in the ceremony consisted of 120 business and organization representatives, including six company presidents, directors, or CEO's, five vice presidents, and six plant managers.

Following the ceremony, three organizations, Nichols-Homeshield Chatsworth, Argonne National Laboratory, and Central Illinois Light Company, requested re-presentation of their awards or certificates at their facilities. Each ceremony gave company leaders the opportunity to share the honor with all of their employees. It is generally the employees who implement and perpetuate successful pollution prevention activities, and the re-presentations are a way to recognize many of their efforts.



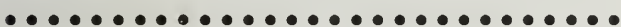
Figure 3-1. Senator Maitland at the Eighth Annual Governor's Pollution Prevention Awards Presenting a Certificate of Recognition to Sundstrand Company Executives

Chapter 4: Research Directions



Introduction

An essential component of HWRIC's mission is to sponsor research into the nature and extent of Illinois' environmental problems particularly those associated with waste and chemical releases. The goals of this research are to find solutions to existing problems and to prevent new ones from developing. Although this task is enormous, Center research efforts of the last 10 years have succeeded in increasing the public's awareness of the effects human activities can have on the environment. HWRIC's research projects have illustrated ways to avoid misuse of our remaining natural resources, reduce further environmental damage, and remediate past sites of contamination. Solutions are now available to many of yesterday's waste management problems, but today's increased technological development has resulted in new and more complex wastes, and the need to explore different waste management strategies.



Center research efforts have succeeded in increasing the public's awareness of the effects human activities can have on the environment.



In 1984, when the Center's research efforts began, state funding was used to support researchers to assess the types and amounts of contamination that existed in Illinois. Searches of historical records, surveys of potential sources of contaminants in different areas of the state, and sampling of the air, soil, and water at clean and contaminated sites across the state, provided the initial data that began to define Illinois' waste problems. For some sites, such as Waukegan Harbor, Calumet, and several areas of the American

Bottomlands, the contamination problem was serious.

In addition to simply describing existing areas of contamination, early Center-sponsored research examined the movement of contaminants through the environment, the effects they had on environmental resources, and the technologies needed to remove and destroy them. An important aspect of all Center-funded projects is the assessment of the risk to humans and the environment, including animal populations, that results from contaminated sites and the various technologies used to restore them to their original condition.

Many of the early HWRIC-sponsored studies gathered information about other hazardous waste activities as well as specific contaminated sites in the state. These data were used to build the Center's hazardous waste databases. Initial state support for research of over \$1 million was used to fund several field evaluations of remediation technologies. Funding of field studies has continued over the last 10 years. Technologies examined include landfarming, low temperature thermal desorption, bioremediation, advanced oxidative processes and other photochemical processes, and hydraulic fracturing. Figure 4-1 shows the locations of HWRIC-sponsored field efforts with a brief description of the project activity. Field studies are costly but are essential to finding and evaluating effective solutions to restore contaminated sites. These field efforts continue to rank high on HWRIC's list of research priorities.

Equally important to HWRIC's research agenda is the exploration of options for preventing waste production and eliminating future contamination. HWRIC has worked to inform all of its contacts about the benefits of waste reduction at the source and to encourage adoption of source reduction techniques and technologies by Illinois companies. The Center has funded research to develop curricula to train students in environmen-

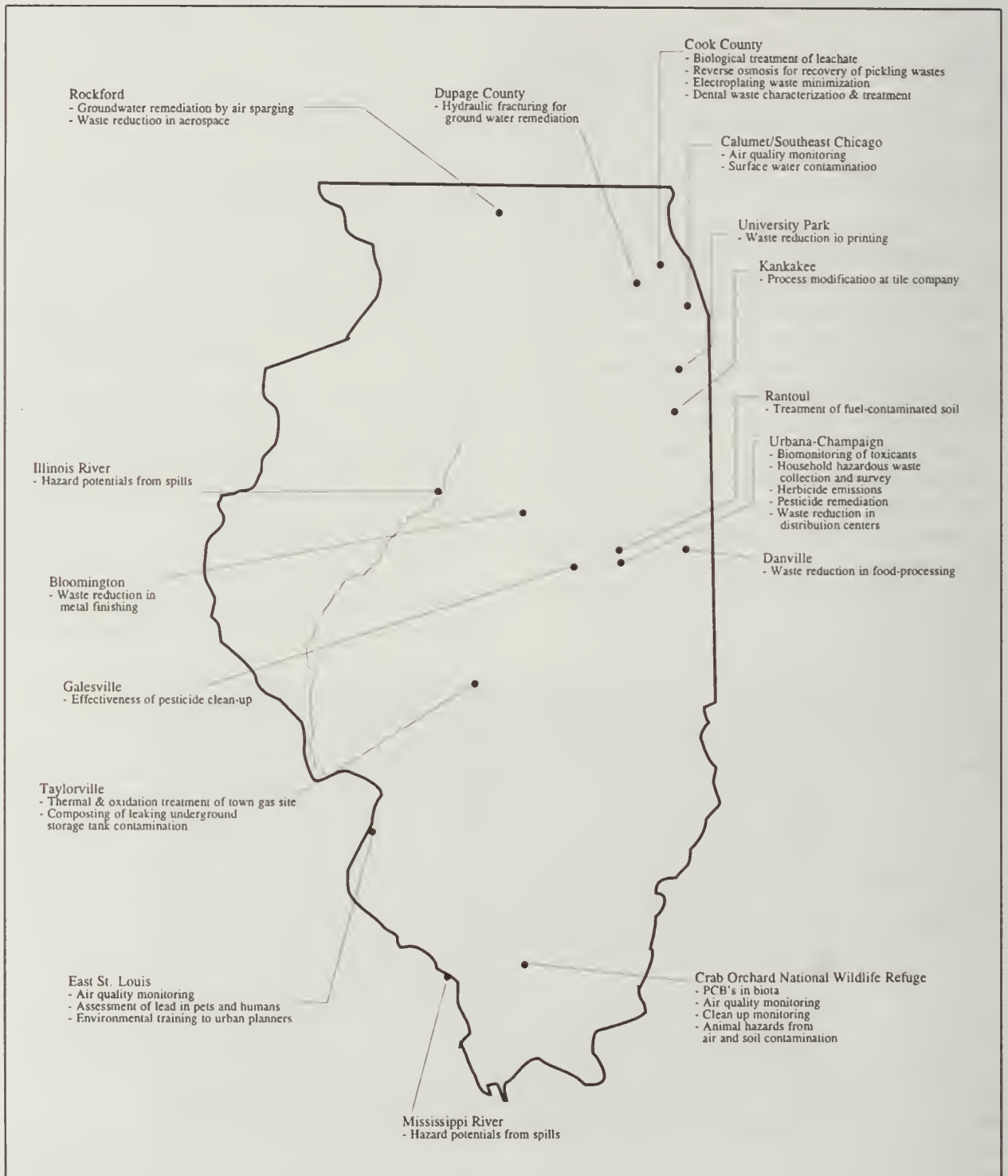


Figure 4-1. Sites of HWRIC-sponsored Field Investigations, 1989-1995

tal and business programs, evaluate pollution prevention technologies and techniques, and find solutions to the waste management problems of individual companies that can also be of benefit to others. Center staff have been increasingly successful in obtaining additional fiscal support from other state agencies, federal programs, industries, and associations to explore practical solutions to efficiently manage and reduce industrial waste streams. As a result of this funding, Center engineers have expanded their understanding of the options available to eliminate, reduce, and treat industry wastes, which has improved their technical assistance capabilities. Each new project increases our knowledge of the environmental and technical problems facing Illinois companies and provides data on the effectiveness of various strategies and technologies used to solve them.

The costs of scientific investigations continue to increase, while state support for the Center's research program has remained relatively constant over the last three years. To supplement our fiscal base for projects, staff have explored co-funding projects of mutual interest with other funding organizations. These funding partnerships have enabled both HWRIC and the co-sponsoring groups to fund more projects and projects involving expensive field components that could not have been sponsored by the agencies individually.

Center-Funded Projects _____

State funding of approximately \$700,000 provided support for 27 projects during FY95, including 12 new projects and 15 continuing projects begun in FY94 or earlier. All Center-funded research projects were selected from preproposals and proposals submitted in response to HWRIC's annual research or RRT solicitations (page 7). Five FY95 projects are completed with final project reports either published, in final review, or being revised prior to publication. Appendix C lists FY95 projects including those that will continue into FY96.

HWRIC-sponsored researchers are encouraged to present the findings of their projects at meetings and in peer reviewed journals. For each project, the Center also requires a final project

report that provides all of the detail needed to reproduce the experiment and/or all of the data used to support the principal investigator's conclusions and recommendations. Final project reports provide background information about the problem that was studied; present a detailed description of the work undertaken, including its successes and failures; draw conclusions from the data; and make recommendations. The final project report must be submitted before the end of the project, but frequently, editorial, technical, and final reviews continue after the project end date. Publication of the project information may not occur for several months after the formal ending of the contract. Table 4-1 lists reports that became available during FY95.

FY95 Center-funded researchers came from state and private universities, the State Water Survey, consulting engineering firms, and industry. The projects that were funded can be grouped into the following four categories: waste management options, remediation technologies, pollution prevention technologies/techniques, and risk assessment. Several Center-funded researchers examined bioremediation. Some looked at how to evaluate and choose the best bioremediation technology and how to enhance the biological activities. Other projects addressed questions such as: what are some site specific limitations to in situ bioremediation, and what are the mechanisms in the biological breakdown of metal compounds. Other remediation technologies being investigated with HWRIC funds included air sparging, composting, and solidification. Health hazards from lead, bismuth, and polychlorinated biphenyls (PCBs) were investigated in other projects. Related to those studies is one that documents the effects of PCBs on starling populations, particularly the effects on reproduction, as models of potential effects in other animal populations and in humans. Two projects evaluated uses for fly ash— as a soil amendment and as a component in small plastic parts. Waste reduction studies included the development of carbon fibers for removal and recovery of volatile organics and the development of a reagent to be used in organic syntheses that can be regenerated and reused. Pollution prevention projects included: facility testing of a single step phosphatizing/coating product, redesigning a

Table 4-1. FY95 Published Reports and Technical Documents

Report Number and Title	Author(s)	Publication Date
RR-063 Air Concentrations of PCBs and Metals at Crab Orchard National Wildlife Refuge	Stephen Vermette, Buffalo State University; MaryAnn Willet, Illinois State Water Survey; Jack Cochran, HWRIC	June 1995
RR-070 Use of Landfarming to Remediate Soil Contaminated by Pesticide Waste	Allan S. Felsot, Washington State University; J. Kent Mitchell, University of Illinois; E. Kudjo Dzantor, Tennessee Valley Authority	July 1994
RR-071 Kinetics of Reductive Dechlorination of Trichloroethane (TCA) by Anaerobic Biofilms	Bruce E. Rittmann, Northwestern University; Brian A. Wrenn, USEPA	January 1995
RR-072 Seasonal/Temporal and Spatial Patterns of PCB Contamination of Fishes in Crab Orchard Lake	Christopher C. Kohler and Roy C. Heidinger, Southern Illinois University at Carbondale	November 1994
RR-073 Stabilization of Arsenic Wastes	Max Taylor and Robert Fuessle, Bradley University	October 1994
RR-074 Measurements of Indoor Toxic VOC Concentrations Attributed to the Residential Storage of Household Products	Clyde W. Sweet and Kevin A. Cappel, Illinois State Water Survey; William B. Rose, Jeff Gordon, and Rose Geier-Wilson, University of Illinois; Stephen J. Vermette, Buffalo State University	January 1995
RR-075 Overcoming Barriers to Pollution Prevention in Small Businesses: Applications in the Metal Parts Fabrication Industry	Thomas J. Bierma and Francis L. Waterstraat, Illinois State University	May 1995
RR-076 LUST Remediation Technologies, Part III: Options for Groundwater Corrective Action	Perino Technical Services, Inc.	June 1995
TR-018 Use of Char for Management of Paint Processing Waste	Carl W. Kruse, Ilham Demir, Stephen L. Carlson, and Massoud Rostam-Abadi, Illinois State Geological Survey; Byung R. Kim, Edward M. Kalis, and Irvin T. Salmeen, Ford Research Laboratory	August 1994
TR-021 Alkaline Noncyanide Zinc Plating with Reuse of Recovered Chemicals	Jacqueline M. Peden, HWRIC	August 1994
TR-023 LUST Remediation Technologies, Part I	Perino Technical Services, Inc.	June 1995
TR-024 Pollution Prevention & Business Management: Curricula for Schools of Business & Public Health, Volumes I & II	Thomas J. Bierma and Francis L. Waterstraat, Illinois State University	April 1995
TR-025 Pollution Prevention & Business Management: Curricula for Schools of Business & Public Health, Volume III	Thomas J. Bierma and Francis L. Waterstraat, Illinois State University	April 1995

manufacturing process to reduce emissions, evaluating membrane technologies for recovery of galvanizing wastes, using supplier contracts to encourage pollution prevention in small businesses, and surveys of schools and water treatment facilities to identify their pollution prevention activities and the waste management problems they believe still need solutions. Finally, planning professionals have developed and are teaching a course to community leaders and residents of East St. Louis that incorporates environmental responsibility into the planning for the redevelopment of the area. Brief summaries of all FY95 Center-funded projects are included with this report as Appendix D.

Special Laboratory Projects _____

HWRIC staff and Center-funded researchers frequently rely on HWRIC's LSP staff for analytical support for their projects. Expanded technical assistance efforts of the Center have required more analyses of waste and process streams. Several analytically complex projects required extensive involvement by LSP staff. These are listed in Table 4-2 and discussed below.

The Illinois Department of Public Health (DPH) has maintained over the years a research

interest in the effects of heavy metals on human health. Funding from USEPA was used to measure the concentrations of metals (specifically arsenic, cadmium and lead) in environmental samples from the East St. Louis area and in the blood of residents from the area. Historical and continuing industrial practices in this area have contributed to elevated environmental levels of these metals. HWRIC helped DPH develop the quality assurance documentation for the project and provided analysis for all soil, household dust, drinking water and air filter samples collected by DPH personnel. Blood samples were analyzed by the Center for Disease Control in Atlanta. DPH is correlating metal concentrations in the environmental samples to blood levels as a first step toward taking action to protect residents, especially children, from continued exposure to these toxic metals.

During FY95, HWRIC continued its association with the US Army Engineers Construction Engineering Research Laboratory (CERL) in Champaign. The LSP worked with several CERL researchers to help them identify potential solutions to problems with disposal of military wastes, primarily energetic and explosive materials. CERL researchers used space in HWRIC's laboratories to conduct their experimentation. LSP staff provided analytical support to these studies,

Table 4-2. Laboratory Services Program FY95 Research Projects

Project Title	Funding Agency	Participating Partner
Analysis of Energetic Compounds and Their Byproducts in Air Emissions	CERL	US Army Corps of Engineers
Analysis of Pinkwater Components from Membrane Separation	CERL	US Army Corps of Engineers
CERL Biodegradation of Energetic Munitions Waste	CERL	US Army Corps of Engineers
Biodegradation of Nitramine Explosives in Manufacturing Wastewaters	CERL	US Army Corps of Engineers
Stable Isotope Evaluation of Soil Metal Speciation by Selective Extraction	Waterways Experiment Station	US Army Corps of Engineers
Analysis of High Volume Air Sample Filters	IL Dept. of Public Health	IL Dept. of Public Health
Analyses of Dust, Soil and Water Samples	IL Dept. of Public Health	IL Dept. of Public Health

including one that focused on composting of rocket propellants. For this effort, Center staff provided analysis for nitroglycerine, nitroguanidine, and the decomposition products of nitrocellulose. A second CERL project used analysis by GC/MS and GC/FTIR instrumentation to confirm data from biodegradation samples analyzed by another CERL-funded research laboratory. In recognition of these and other efforts that assisted CERL in the accomplishment of its mission, HWRIC received a 1995 Commander's Award from the Army Corps of Engineers.

Researchers at the Beckman Institute on the University of Illinois, Urbana-Champaign campus have been looking at incorporation of gadolinium, a rare earth element, into human cells. Gadolinium is used to enhance Magnetic Resonance Imaging, an important medical diagnostic technique. These scientists were concerned about the ultimate fate of the gadolinium in the body, and they were limited by the extremely low levels of this metal they were able to isolate from their cell cultures. LSP staff were asked to analyze these samples. The extremely low metal concentrations required modifications to existing measurement techniques. Once the staff were confident of the quality of the data resulting from the modified method, they analyzed several sets of samples for these researchers. Analyses of these samples will continue in FY96.

Center-Conducted Projects

Most of the research conducted by HWRIC staff are applied studies of a company's or facility's immediate waste management problems. There are, however, a consistent number of analytical questions being answered by research performed by HWRIC's laboratory staff and there is growing participation by Center staff in the development of national information resources (see Chapter 5). Increasingly, these projects represent joint efforts of Center staff, representatives from the funding agencies, industries, and others. A partial list of the FY95 externally funded projects which includes the funding agency

and at least one participating partner is provided in Table 4-3. In some instances, the project was truly a joint effort with all of the participants working on the proposal, sharing the tasks presented in the scope of work, and preparing the final report. For most projects, the partners were the company with the problem or the agencies/organizations that provided information, relevant data, or project review.

Several of the Center's research and development projects have resulted from and supplement our technical assistance efforts. These projects begin with a problem that is often identified after a technical assistance visit or site assessment. The projects explore possible solutions in the laboratory and recommend the best choice to install and evaluate at the facility. Testing may be done for a limited period to determine the optimum operating conditions. The need for this very applied type of project is increasing. Small companies that lack the resources for their own research and development activities need this assistance to comply with the ever increasing numbers of environmental regulations and to improve the efficiency of their operations. Fiscal support for research at larger companies has significantly decreased or been eliminated and they, too, are requesting help in achieving new compliance requirements and reducing their wastes. In the past, companies frequently learned about new products and technologies from vendors and had to make their own decisions about what product to use simply from the claims of the suppliers. Now, these companies can add laboratory and field evaluations of these products and technologies by Center engineers to their decision making process. And finally, for new technologies, these testing and demonstration efforts provide the assurances to the company (and potential investors) that the technology meets the performance claims of the inventor and that there is a market. Without independent verification many new technologies will never make it further than the inventor's laboratory.

Two excellent examples of what can be achieved by this kind of applied project are the Ace Plating and the Vita Foods projects described in Chapter 3. Funding obtained from the state and federal agencies for projects has helped HWRIC

Table 4-3. Other Center FY95 Research Projects

Project Title	Funding Agency	Participating Partner
Pollution Prevention for the Greater Chicago Area	USEPA	Metropolitan Water Reclamation District of Greater Chicago, City of Chicago-Dept. of Environment, IEPA
Promotion of Pollution Prevention Opportunities through Evaluation and Implementation of Solvent and Technology Alternatives for Cleaning	USEPA Region 5	Illinois DCCA, Illinois Industries
Regional Pollution Prevention Information Resources: A Planning Study	Great Lakes Protection Fund	US/Canada Great Lakes Region Advisory Committee
Class V Well Pollution Prevention Assistance in Peoria and Tazewell Counties, Illinois	USEPA Region 5	Peoria and Tazewell County Municipalities, IEPA
Great Lakes Pollution Prevention Networking and Communications Strategy	USEPA Region 5	Great Lakes Regional Pollution Prevention Roundtable Members
Piloting a Model National Pollution Prevention Information Distribution System	USEPA	Northeast Waste Management Officials' Association
Investigation of In-Progress Solvent Recycling through Membrane Technology	Safety Kleen, Inc.	Safety Kleen, Inc.
Evaluation of Membrane Materials for Recycling Aqueous Cleaners at Railroad Facilities	Association of American Railroads	Association of American Railroads
Specialized Assistance with Environmental Issues	Illinois DCCA	State Manufacturing Extension Centers
Integration of Pollution Prevention with Manufacturing Modernization Technical Assistance	Chicago Manufacturing Center	Chicago Manufacturing Center
Casting the Net: Manufacturers, Competitiveness & the Environmental Extension Network	Illinois DCCA	Illinois Cooperative Extension Service

to expand its applied research capabilities. The project partners have further offered their knowledge and experience in resolving problems and implementing solutions. Most importantly, these projects lead to concrete examples of technologies/techniques or product alternatives that can be used by many companies to meet their compliance objectives and at the same time increase the efficiency of their processes and the quality of their products.

Research Plans for FY96 _____

As HWRIC begins its eleventh year, it will continue to support research that evaluates new technologies and new uses for existing technologies, examines waste management practices and how they can be improved, assesses risks to the environment created by industrial activity, and suggests changes to existing policy that will

eliminate or at least reduce future environmental damage. Results of projects will continue to be publicized in the two Center-produced newsletters *LINK* (the newsletter for the Great Lakes Regional Pollution Prevention Roundtable) and HWRIC's *Illinois Update*, project reports, and factsheets. New associations with technical experts will be used to select quality projects. Recent interactions with other funding groups will be explored to avoid redundancy in funding efforts and expand funding capabilities by sharing funding. We will continue to seek the advice of representatives from DNR and other state and federal agencies, universities, industries, public action groups, trade associations, and our colleagues in the research community to set a research agenda that will provide the answers to Illinois' many complex waste management questions.

Chapter 5: Information Networking and Resources Development

Introduction

Businesses today need current, reliable information on pollution prevention technologies, waste management methods and environmental compliance requirements in order to use raw materials more efficiently and reduce the generation of wastes, thereby increasing their competitiveness.

HWRIC's library and clearinghouse are recognized as valuable resources for technical assistance providers and businesses wanting pollution prevention and waste management information. HWRIC works closely with several other pollution prevention programs in the Great Lakes area and Northeast states in particular to collect, compile and distribute the best pollution prevention information available. Past efforts have included creating a case study database, conducting a study on how to create a pollution prevention information network in the Great Lakes region (Tompson, Barnes and Miller, 1994 and Barnes, Tompson and Miller, 1994), and assisting with a national study on how to organize a national pollution prevention information network (Kerr and Lambrecht, 1995). By partnering with these other programs, information resources can be efficiently gathered, maintained and made available to Illinois businesses, policymakers and citizens.

Because of HWRIC's experience with pollution prevention information networks, the Center has been awarded six federal grants to further develop these resources. These projects emphasize collecting and developing materials compiled from the best sources available for industry sectors of importance in Illinois and the Great Lakes region. Information will be distributed through the Internet as well as other means. The ultimate goal is to provide high quality information to busi-

nesses and others effectively through a network of technical assistance organizations.

One recommendation of the recent Kerr and Lambrecht study on effective exchange of pollution prevention information was to develop a network of regional information centers to link state and local pollution prevention programs. For the Great Lakes area the following essential elements of a regional information system were identified:

- facilitate contributions from system users;
- develop a library or clearinghouse as a repository;
- create and deliver synthesized, state-of-the-art reports of pollution prevention information by industry sector for common manufacturing processes;
- establish an e-mail link in the region;
- be a reference to other resources;
- promote resource sharing to avoid duplication;
- use electronic vehicles to link information resources;
- provide quality control of information; and,
- provide system management/administration function.

Technical assistance programs serve a broad range of industries. Therefore, technical assistance providers find it very important to develop efficient networks to share expertise and to draw industry experts into focused dialogues. In addition, hard-copies of the best pollution prevention guidebooks, fact sheets and case studies need to be shared nationally. These are some of HWRIC's goals in working with others to develop information resources and networking.

Summary of Projects

While HWRIC has a leadership role in many of these new federal grants, the contributions of

partner organizations is essential to their success. Funding from these projects will support approximately seven staff members.

Regional P2 Newsletter

Two years ago, with funding from Region 5 USEPA, HWRIC began publication of a quarterly regional pollution prevention newsletter called *LINK*. This newsletter is compiled from contributions made by organizations from throughout the Great Lakes states and 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 and funding has been approved for a third year.

Developing a Pilot Inter-Regional Information System

A second information and networking project funded by the USEPA is titled "Piloting a National Pollution Prevention Information Distribution System." This three-year project was begun in the fall of 1994 in cooperation with the Northeast Waste Management Officials' Association (NEWMOA) and the Solid and Hazardous Waste Education Center (SHWEC) of the University of Wisconsin. The objective of this project is to establish a model program for interstate cooperation on P2 information sharing.

The main tasks of the project are to respond to and implement recommendations generated by the Northeast Roundtable P2 Clearinghouse Committee and the Great Lakes Regional P2 Roundtable.

HWRIC will develop a pilot program to enhance information sharing between government and university pollution prevention programs, National Institute for Standards and Technology (NIST) manufacturing extension centers, and other providers of pollution prevention assistance in these two regions.

The objectives of this project are:

- develop a model for national P2 information distribution;
- support state and local efforts to develop strategies for disseminating P2 information;

- pilot methods for developing synthesized pollution prevention information packets for targeted industries;
- investigate and demonstrate methods for disseminating the packets within the two geographic areas in both hard copy format and electronically;
- train state and local pollution prevention staff to use electronic vehicles for accessing information;
- provide methods of sharing documents, case studies, and vendor databases within the Northeast and Great Lakes states and between the two geographic areas; and,
- evaluate the effectiveness of this pilot project, particularly the inter-regional cooperation, the information packets and the information delivery systems.

HWRIC will develop information packets for the printing industry and iron and steel foundries. These packets will include a report, an annotated bibliography of P2 information, a vendor list, and case studies relating to the industry.

State and local P2 technical assistance programs will be the vehicles for disseminating the targeted P2 information packages to the ultimate customer—industry. The project team works with various committees, programs, and providers of environmental information in their states to determine the best method to get this pollution prevention information to industry.

By developing a regional information system, using existing regional programs to maintain and promote its use and providing training to priority users, we anticipate the system will become an essential communication resource expandable to other regions in the US and Canada. This project will also provide further documentation of workable strategies for a national decentralized clearinghouse for pollution prevention.

The Great Lakes Pollution Prevention Clearinghouse (GLPPC)

The Region 5 office of USEPA is funding HWRIC to implement key recommendations of the Great Lakes Regional Pollution Prevention Roundtable (GLRP2R) study on information

resources. The objectives of this project are to establish a regional clearinghouse that would:

- maintain and distribute a composite bibliographic database, a database of equipment and service vendors and a case study database;
- provide a facilitator (or regional point of contact) for access to hard copy and electronic information;
- maintain and distribute a listing of pollution prevention activities by other regional P2 programs;
- establish an Internet list server on regulatory topics;
- provide state and provincial regulatory compliance information and referrals;
- develop a catalog of videotapes and other training tools; and,
- operate FAX-back and other information distribution services for synthesized P2 information to facilitate access to P2 information for business and industry.

Management of the GLPPC is a collaborative effort between HWRIC, SHWEC, and the member organizations of the GLRP2R. HWRIC will provide physical space for clearinghouse documents, staff, and electronic support; SHWEC will provide expertise in information management and vendor database development; while the GLRP2R will provide long term objectives and evaluation of performance.

Pollution Prevention Information Resources for Printing

HWRIC received a grant from USEPA to develop and establish a Printers' National Environmental Assistance Center. The goal is to centralize existing and future technical and compliance assistance information into a single, highly accessible, user friendly electronic system. Major partners in creating this system include SHWEC; the Graphic Arts Technical Foundation, and the Printing Industries of America. Other partners include the Council of Great Lakes Governors, National Pollution Prevention Roundtable, NIST, Small Business Development Centers (US Department of Commerce), small business assistance programs established under the

Clean Air Act, and two other key industry trade associations. The objectives of this effort are to:

- establish and operate a Printers' National Environmental Assistance Center;
- conduct a needs assessment of printers to guide the development of resources, and information on self-evaluation tools for the Printers' National Environmental Assistance Center; and,
- develop a basic curriculum training package for printers.

HWRIC will direct this effort, and provide expertise on P2 methods for printing, coordinate the needs assessment task, and present the training program to printers in Illinois.

The initial focus will be on building the capacity of existing technical assistance providers to provide current, practical and thorough information to printers, and to enhance information flow among compliance assistance programs. In the first year, a long-term strategy will be developed for the best methods to assist service providers in delivering P2 information directly to printers.

Two Internet listserves will be established and maintained. One will be for technical information on pollution prevention methods and technologies, and the other for regulatory compliance information. An Internet home page will also be created that will provide links to other environmental information sources on printing. These will be accessible by either modem or direct Internet connection. USEPA and state regulatory officials will be involved to identify relevant, up-to-date compliance assistance materials for input.

A second major task will be to undertake an assessment to define the compliance and pollution prevention information needs of printers. This is an important step to design and refine the long-term services of this electronic resource. Organizations in at least five states (candidates include Illinois, Iowa, Michigan, Minnesota, Oregon, Pennsylvania, Texas, Washington and Wisconsin) will conduct 12 focus group meetings with printers for this assessment.

This assessment will also determine the form of information that small to medium sized printers can access (i.e., electronic versus hard-copy distribution systems) and the most effective communication routes (such as through trade associations, government agencies, craftsman guilds and suppliers).

The third major project task is to present a national training teleconference to increase awareness of the availability of training materials for small print shops. Training needs of smaller print shops will be met by pulling together video and printed materials available at low cost for printers, technical assistance, or trade organizations across the US. This task will be led by SHWEC, working closely with the Graphic Arts Technical Foundation and the Printing Industries of America. The teleconference is scheduled to be broadcast in May of 1996. HWRIC will work cooperatively in Illinois with the Small Business Assistance program of DCCA, IEPA and the Printing Industry of Illinois and Indiana to present this teleconference at several locations in Illinois.

Pollution Prevention Assistance and Information Database (P²AID)

This two year project was funded by the NIST of the US Department of Commerce. The overall objective of NIST is to provide Manufacturing Extension Programs (MEPs) with environmental information, analytical tools and other resources to better assist businesses in modernization strategies. The Chicago Manufacturing Center (CMC) was established in 1994 and a state-wide network of business assistance programs is supported under Illinois' COMPETE program. The objectives of the P²AID project are to:

- provide all MEP field engineers with the capability to provide pollution prevention and environmental compliance services to smaller manufacturers,
- customize environmental assessment tools and pollution prevention and regulatory information to meet the level of expertise and specific needs of the field engineers, and
- place this information on the TECnet Internet system (which is specifically designed for the MEPs) in an accessible and interactive format.

Key tasks being undertaken are to:

- develop analytical tools and information for printing, iron and steel foundries and other important industry sectors;
- establish Internet communication tools, vendor information, case studies and bibliographies for use by MEP field agents; and,
- train MEP field agents to use these tools.

Establishing a National Network of Pollution Prevention Information Providers

HWRIC is a primary partner in this project being led by the National Pollution Prevention Roundtable. Funding will come from the Office of Research and Development of USEPA. The overall goal of this project is to accelerate reduction and elimination of industrial hazardous waste and toxic emissions through providing reliable, focused information about pollution prevention technologies and techniques. Network users will be federal, state, local, tribal, non-profit and university P2 technical assistance providers, and businesses that can directly use pollution prevention information.

HWRIC will serve as a national point of contact or referral for access to pollution prevention information. Through an 800 number a staff person will help other regional organization and technical assistance providers find pollution prevention information within the national network.

Information Functions being Undertaken _____

There are several common types of tasks that are being undertaken by HWRIC on these six projects that will build on each other. These tasks are:

- information generation and collection,
- information synthesis,
- information distribution, and
- management and coordination.

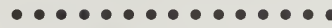
Objectives and Future Plans _____

HWRIC's goal in undertaking these projects is to develop comprehensive regional pollution prevention information resources of current, reliable information that is easily accessible by technical assistance providers and businesses. This resource will benefit Illinois and other states throughout the US. Priority will be given to developing and distributing information for businesses common to the Great Lakes region. Printing and foundries will be emphasized during 1995 and 1996. Other business sectors that will likely be emphasized are electronics, food processing, chemical manufacturing, heavy machinery assembly and metal finishing.

During the coming year HWRIC will work closely with government agencies in Illinois, including IEPA, DCCA, Argonne National Laboratory, the City of Chicago, and the Metropolitan Water Reclamation District of Greater Chicago; trade associations including the Printing Industry of Illinois and Indiana, NORBIC, CMC, and the Chicago Association of Neighborhood Development Organizations; and community groups such as the Center for Neighborhood Technologies in Chicago to find effective means to distribute pollution prevention information. This will include linking with the Illinois DCCAs' Access Illinois resources on the Internet, conducting industry workshops, developing a network of pollution prevention assistance providers in the Chicago area, and providing training for businesses on various current pollution prevention topics.

Chapter 6:

Sustainability Through Partnering



Sustainable development is often defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” For wealthy nations, sustainable development involves “maintaining economic growth while producing the absolute minimum of new pollution, repairing the environmental damages of the past, using far fewer nonrenewable resources, producing much less waste, and extending the opportunity to live in a pleasant and healthy environment to the whole population” (Presidents Council on Sustainable Development, 1993).

Last year’s annual report (HWRIC, 1994) included a discussion of a Sustainable Illinois Initiative which identified the elements of the Center’s programs that contribute to a sustainable future for the state. In particular, we discussed our efforts to enhance remediation of contaminated sites; promote pollution prevention and cleaner technologies; develop increased environmental awareness through education, training and information dissemination; and minimize the potential environmental impacts of waste through the development of more effective treatment technologies. In this report we focus our discussion on partnering with others to remediate and restore contaminated sites, and to prevent future waste problems by assisting industry with pollution prevention techniques and technologies.

Partnering is essential for a sustainable development program because the cooperation of many different elements of our society is required to achieve sustainability. Ultimately, each citizen has to understand that she/he has a role to play in extending the life of valuable natural resources and in protecting the environment which we all share and enjoy. Education is a key element to achieving this level of participation.

More specifically, HWRIC’s roles are 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. This discussion begins with remediation and restoration efforts in both urban and rural areas in the state. These efforts are designed to characterize the nature and extent of past contamination problems, to help promote the testing and development of remediation technologies, and to help find ways to bring such lands back into use. Cleaning up past sites of contamination in urban settings can lead to redevelopment in areas with existing infrastructure and population. This beneficial reuse of previously contaminated urban areas can slow the urbanization of prime rural agricultural or forested sites. The discussion continues with the Center’s long-term efforts to protect the environment. These efforts focus on preventing future sites of contamination by working with industry, and other organizations that work with industry, to prevent the generation of pollution while maintaining or enhancing economic competitiveness.

Partnering for Site Remediation and Restoration

Urban Problems

Some of the most pressing environmental problems reside within traditionally heavy industrial sectors of older cities. City, state and federal programs are beginning to reevaluate the potential value of abandoned urban sites as locations for reestablishing industrial activities. Such programs have the potential to also address some traditional inequities associated with neighborhoods adjacent to these abandoned sites.

Brownfields Partnership—An increasingly vexing economic and environmental problem facing cities across the US is abandonment of industrial properties due, in part, to environmental

contamination. These sites are commonly termed brownfields. Site abandonment also occurred at older facilities that were no longer competitive because of the owner's failure to modernize, or because of the retirement of ownership, and a failure to provide for succession. Additional reasons for site abandonment included relocation of suppliers, customers and management, and the lure of new development in suburbs (termed greenfields). These deserted urban properties represent loss of jobs, reduction in the tax base and potential threats to community safety. Brownfield sites generally deteriorate with time and are prime targets for illegal dumping and scavengers. They are not being redeveloped nearly as fast as new sites are being created. The number of brownfield sites is increasing rapidly in cities like Chicago and other older Illinois industrial cities, while greenfield sites are being developed at the expense of prime farmland and natural areas. Demand for industrial space in urban areas is high. In Chicago demand exceeds supply by three to one (City of Chicago, 1995). There is growing interest from companies to locate in Chicago, but environmental issues and other institutional constraints have deterred such redevelopment. Clearly, there is a need to rethink priorities.

In Chicago alone, there are thousands of abandoned properties, mostly industrial, that are difficult to redevelop because of the real or perceived costs of environmental cleanup. These sites not only present environmental and health concerns, but also real estate, business, banking, and community problems. In the fall of 1995, the city convened an interdisciplinary task force known as the Brownfields Forum which included over 100 individuals representing: government agencies, including HWRIC; businesses; financial institutions; environmental interests; and community and civic organizations. The purpose of the Forum is to identify barriers to redevelopment, propose ways to overcome these barriers, and develop proactive approaches to cleaning up and redeveloping brownfields sites.

The Forum stressed the need for a coordinated, comprehensive effort involving all of the key stakeholders. No single group can solve these

problems. Organizations that have an important role to play are city, state and federal agencies; the banking industry; businesses; legal, insurance and real estate professionals; community, industrial and economic development groups; trade associations; environmental and public interest groups; labor and community health organizations; and others.

The primary issues HWRIC is addressing are identifying and characterizing contamination at sites, preventing future contamination and abandonment of industrial properties through pollution prevention and environmental technical assistance to existing businesses, and assisting prospective businesses in using pollution prevention operating practices as they redevelop brownfield sites.

A project team consisting of NORBIC, CMC and HWRIC was chosen to lead the effort to develop a pollution prevention initiative for the Chicago area. Also involved are the Chicago Association of Neighborhood Development Organizations, Argonne National Laboratory, the Southeast Chicago Environmental Task Force, USEPA, IEPA, the Center for Neighborhood Technology (CNT), and Navistar, Inc. HWRIC will work with these organizations to establish an effective network of pollution prevention resources in the Chicago area. The task force set the following objectives:

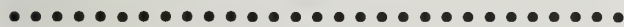
- foster a pollution prevention-friendly system of regulation and enforcement;
- link pollution prevention to eligibility for public funding;
- encourage organized labor and community participation in pollution prevention;
- identify ways of transferring effective pollution prevention approaches from big businesses to small businesses by stressing the cost saving potential and efficiencies of pollution prevention efforts;
- identify best delivery systems of pollution prevention information including establishing a "one-stop" service center for businesses and community groups with technical and financial assistance to cleanup and redevelop sites; and,
- formulate a plan to educate the public about the benefits of pollution prevention.

In a related project, HWRIC is joining with the City of Chicago's Department of the Environment and several other government, private and community organizations to inventory publicly available data on brownfield sites. Besides this inventory, the Forum recommended creation of a publicly accessible brownfield information database on an Internet site or some other delivery vehicle that will provide instant access to county, state and federal information.

Environmental Justice—One issue that must be considered in discussions of siting waste management facilities and in redeveloping urban industrial sites is the impact on the communities bordering these sites. Traditionally, lower income and minority citizens have carried the burden for urban environmental problems. When industries relocated or closed, residential property values in adjacent neighborhoods dropped, which made it difficult for many residents to move out of these areas. These citizens were left without jobs and had to live with the contamination of years of industrial operation. As efforts are made to redevelop abandoned industrial sites, attention must be focused on the impact of these efforts on the neighboring communities. Certainly education and job training will emerge as important issues in this process.



HWRIC's role in the environmental justice issue has been to better define the nature, extent and impact of urban site contamination.



HWRIC's role in the environmental justice issue has been to better define the nature, extent and impact of urban site contamination. Center staff have been actively working with researchers to define unusual health risks to people living in urban areas that have historically been exposed to heavy industrial pollution. We have helped assess risks associated with development of community garden plots in East St. Louis, and have looked at air, water and soil pollution in both the southeast Chicago/Lake Calumet area and the East St. Louis area.

HWRIC is currently sponsoring University of Illinois Urban and Regional Planning Department staff to incorporate environmental issues into a community-based course offered on Saturday mornings in East St. Louis. The course participants include city planners, community action group representatives, civic leaders and residents. Although the focus is on community planning for economic development, environmental concerns are incorporated into the discussions. A description of the project is included in Appendix D.

HWRIC has the potential to directly influence such issues. The technical expertise and laboratory capabilities of the Center can be used on further problem definition, particularly as brownfields begin to be used. Research monies available to the Center could be directed toward addressing potential neighborhood impacts of site recovery activities or of new industries occupying the sites. In particular, HWRIC can work with new companies moving into these areas to introduce pollution prevention concepts which can help avoid future contamination.

Restoring Sites of Contamination

HWRIC efforts to facilitate the restoration of contaminated sites have been primarily focused through the Research Program. Funded research has included complete assessment of contamination at various sites, the movement of contaminants in the environment, and the testing of remediation technologies.

Site characterization has occurred at a number of locations in Illinois, including Crab Orchard National Wildlife Refuge in southern Illinois, the Calumet area of southeast Chicago, the American Bottomlands, the Illinois River, Waukegan Harbor, and the Rockford area. Samples collected and analyzed at these locations have included air, soil and water. At Crab Orchard, numerous biological samples were taken to determine uptake of chemicals at various levels in both the terrestrial and aquatic food chains. Information collected at these sites will serve as a baseline for determining the effectiveness of proposed remediation technologies.

Various remediation technologies have been tested with funding from HWRIC for both

laboratory and field scales. Some of these projects are described in Appendix D of this report. Field research has often been hindered by the lack of access to sites of contamination. HWRIC has attempted to find ways to increase access to field sites for such testing. The Center has worked with Argonne National Laboratory and others interested in using a portion of the Joliet Arsenal as a test bed site for remediation technologies. Now that legislation has been enacted designating the Joliet Arsenal as a national prairie and a national veterans' cemetery, it is unclear whether testing of technologies on waste sites at the Arsenal will be allowed.

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The ultimate goal is to fully restore contaminated habitats.
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Another possibility for testing innovative remediation technologies in the field may be at contaminated sites owned, at least in part, by the State of Illinois. Some of our state parks and fish and wildlife management areas have been contaminated by past industrial or associated activities. These sites may be useful for studying the movement of contaminants in the environment and their potential ecological effects. They may also prove useful for testing remediation technologies. Such studies can help the state determine the true risks associated with many different contaminants and the best approaches to reduce those risks. The ultimate goal is to fully restore contaminated habitats. Partnering with the owners of various lands, and giving full consideration to their goals for future use, should assure that site restoration progresses to meet future land use needs while providing valuable "laboratories" to evaluate emerging technologies.

A second major obstacle to field evaluation of innovative remediation technologies is the considerable expense of such studies. Studies that have been supported by HWRIC in the past have been funded largely by the company offering the technology and/or the site owner. HWRIC's role in such efforts lies in helping to identify testing sites, in supplying information on technologies,

and in helping to assemble the funding team, perhaps supplying seed money where appropriate.

Partnering with Industry to Prevent Pollution _____

Although HWRIC possesses the necessary facilities, equipment, and staff to help most Illinois businesses solve their waste problems, access to individual industrial facilities can sometimes be a problem. Governmental agencies such as HWRIC are often perceived by businesses as being a threat to them even though the agency serves no regulatory function. In an endeavor to overcome this obstacle, HWRIC initiated partnering with entities that are trusted and/or are "opinion leaders" that businesses turn to for advice regarding innovations. By forming partnerships with opinion leaders such as electric utilities, publically owned treatment works (POTWs), industrial trade groups, and manufacturing extension programs, we have been able to use their well-established, long-term relationships with businesses to facilitate access to industrial facilities. This improved method of access has made it easier for HWRIC engineers and scientists to educate companies about pollution prevention concepts and innovations and demonstrate techniques and technologies that may be appropriate for reducing waste within their facilities.

According to Bierma and Waterstraat (1995), four groups are in the "comfort zone" for small metal parts fabricators in Illinois: suppliers, customers, competitors, and contracted business associates (accountants, attorneys, etc.). These are the groups that they turn to for information. Governmental agencies tend to be in the perceived "danger zone" and are often avoided. The problem with getting pollution prevention information to these small businesses is that the groups they trust are not familiar with pollution prevention concepts and those that have the knowledge about pollution prevention are not trusted or sought out for such information.

POTWs

Most treatment operations used by POTWs were established to deal primarily with domestic

wastes. Consequently, many wastes generated by industrial facilities can cause problems with POTW wastewater treatment operations, particularly if the wastes are released in large quantities over short durations. Traditionally, POTWs have attempted to mitigate treatment problems from industrial discharges by monitoring and regulating these wastes. These practices have been somewhat successful in reducing industrial impacts to POTWs. However, the waste reductions achieved have been at the expense of industries who have, in many cases, implemented costly waste pretreatment systems in order to comply with POTW requirements.

POTWs are in a unique position to help industries find solutions to their waste management problems. Through their monitoring and regulatory programs, they possess in-depth knowledge of the facilities having problems controlling their waste discharges. Additionally, they are recognized by industry as being experts at treating and managing wastes. Therefore, POTWs can use their familiarity with industrial dischargers combined with their status as waste management experts to help companies find solutions to their waste problems. By implementing pollution prevention practices, industries can comply with POTW standards by improving the efficiency of their processes, often avoiding costly pollution control measures.

Although POTWs are well positioned to assist companies with their pollution prevention efforts, they usually lack the staff and technical expertise to solve waste problems at the process level. In an effort to combine the status and knowledge of POTW personnel with the pollution prevention expertise of HWRIC staff, the Center's POTW "load reduction" program was developed. The purpose of this program is to form partnerships between HWRIC and POTWs to:

- identify companies who would benefit most from pollution prevention technical assistance,
- convince companies of the potential for pollution prevention practices to solve their waste problems, and
- provide appropriate technical assistance to the companies that request it.

These partnerships maximize the strengths of both HWRIC and the POTWs and enable HWRIC to provide technical assistance and pollution prevention information to facilities that were previously inaccessible.

To date, partnerships have been established with 56 Illinois POTWs who have referred dozens of their industrial users to HWRIC for technical assistance. Future plans include surveying the POTWs to learn which industry types and wastes cause the most problems and in which technical areas we can provide the most useful assistance. HWRIC will continue to build partnerships with POTWs under this program.

Electric Utilities

The Center has formed a partnership with Illinois Power (IP) that provides environmental assistance to their industrial and commercial customers. IP's Environmental Solutions Program began with the realization that the same environmental technologies that improve business performance and competitiveness also require electrical power. Several of these "electrotechnologies" are now being marketed by IP. They have asked the Center to enhance their customer service efforts by providing:

- environmental expertise,
- regulatory and technical assistance,
- environmental site assessments that complement their energy audits,
- pilot laboratory demonstrations to evaluate plant processes and wastes and explore applications of new technologies,
- assistance with capital investment cost justifications, and
- pollution prevention training programs.

HWRIC staff serve as third party scientific and engineering advisors in this partnership.

IP's account executives were introduced to the program during a two-day training session conducted at HWRIC in early April. They were instructed on how to identify pollution prevention opportunities and provided with specific examples of how the proper deployment of new technologies has saved businesses money. The training ended with a tour of the Center's facilities, which

focused on clean technologies, alternative cleaners, and analytical laboratories.

The IP partnership complements the POTW Load Reduction Program because a number of IP's best customers are municipal wastewater treatment facilities. Both partnerships heighten awareness of the Center's pollution prevention activities in the industrial community. Companies are now often being referred to the Center by more than one trusted supplier or service provider. HWRIC will continue to build partnerships with other utilities in the state, and to maximize the benefits of such arrangements to our business customers.



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Manufacturing Extension Programs

Seven manufacturing extension centers (MECs) have been established across the state over the past two years to help small and medium sized companies modernize and become more competitive. These efforts include many business aspects ranging from production technologies and accounting methods to environmental health and safety programs. In a recent survey funded by the Illinois Coalition (DRI/McGraw-Hill, 1993), Illinois businesses identified "assistance for businesses with pollution prevention and environmental regulations" as vital to improving manufacturing processes. The survey also concluded that this assistance should be provided by government.

HWRIC engineers began working with the staff of the Chicago Manufacturing Center to provide pollution prevention and regulatory technical assistance to industrial clients in August of 1994. In June of 1995, HWRIC was awarded a grant from DCCA to offer the same type of technical assistance to the industrial clients of the other six MECs. This partnership allows the

MECs to refer clients who need technical assistance related to waste reduction and waste management issues to HWRIC. Additionally, it provides a conduit for us to refer to the MECs companies needing other types of manufacturing assistance. Future plans for this partnership include providing training to MEC staff to enable them to identify pollution prevention opportunities and conducting a series of seminars to promote pollution prevention.

Trade Associations

Many industry groups have formed associations for various purposes. Some trade associations are primarily lobbying organizations while others focus on providing technical assistance to their members. By working with industry groups with strong technical trade associations HWRIC has gained credibility and reached more of their members. During FY95, HWRIC undertook several projects that involved significant partnerships with different industry groups. In addition, the feasibility of partnering with several other industry associations on issues of mutual interest was explored.

The North Business and Industrial Council (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 on the north side of Chicago 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. During FY95, HWRIC provided funding to NORBIC to establish a satellite office that offers technical assistance services and a reference library and clearinghouse in their facility. HWRIC staff also conducted surveys of the waste management needs of NORBIC's members, published articles in their newsletter about HWRIC's services, and conducted workshops to assess manufacturers' environmental assistance needs.

The NORBIC collaboration has provided HWRIC's Chicago Office with opportunities to assist businesses in pollution prevention, regulatory compliance, and safety concerns. HWRIC

staff presentations to NORBIC members at luncheon and dinner meetings have been enthusiastically received. The reference library and clearinghouse have been actively utilized by NORBIC's members to obtain information on pollution prevention and alternative materials.

For the past three years, HWRIC has been working on the Great Printers Project with several governmental, environmental and industrial organizations including the Printing Industries of America and their local affiliate, the Printing Industry of Illinois and Indiana (PIII). The two primary purposes of this project are to: (1) encourage lithographic printers in the Great Lakes states to adopt pollution prevention options that will reduce the potential harm their activities may cause to the environment and human health; and, (2) recast society's approach to environmental policy by bringing together representatives from government, industry, labor, and environmental groups to focus on the common goals of protecting the environment and strengthening the economy.

In this project, the printer's role is to voluntarily seek out information on their shop's environmental performance and communicate its environmental impacts to buyers; to perform compliance and pollution prevention assessments and correct compliance problems; and, to measure their own progress in preventing pollution. Buyers of printed products should be educated on the environmental impacts of various options available for producing a quality product. Printers' suppliers and distributors should seek environmentally superior materials, chemicals and equipment to produce high-quality results. Regulatory agencies should create a pollution prevention friendly regulatory framework including streamlined reporting and permitting requirements, and more efficient enforcement. Governmental and private assistance programs should provide reliable, up-to-date information specifically for the printing industry, deliver services to small printers that are better coordinated and packaged, and market these upgraded services in cooperation with printing industry associations. Besides Illinois, the states of Michigan, Minnesota and Wisconsin have agreed

to undertake adoption of the Great Printers' principles.

In the spring of 1995, HWRIC joined with PIII, IEPA, CNT and several Illinois printers in a pilot project to begin implementing these recommendations. An advisory committee was formed and a work plan developed with tasks for each participating organization. Initial tasks will focus on streamlining the regulatory system for printers in Illinois and on promoting the adoption of environmentally sound printing practices throughout the industry. Criteria are being developed for what constitutes a Great Printer. Companies that qualify will receive official recognition as a means of encouraging these practices by others throughout the industry.

Nontraditional Groups

Bierma and Waterstraat (1995) recommended that government agencies such as HWRIC use non-traditional mechanisms to promote pollution prevention. One of these groups is accountants. As the authors state in their report, one of the most significant barriers to P2 implementation is manager ignorance of waste volumes and associated costs. The accountant/small manufacturer relationship offers an opportunity to implement more effective methods for monitoring the costs of wasting raw materials and products.

HWRIC has discussed with the Illinois EPA ways that accountants can be trained in the basics of pollution prevention and used to provide P2 information to small businesses. One large Chicago accounting firm has been contacted and has shown a willingness to partner in this way. One possible activity that could occur in the coming year is to sponsor a day-long seminar to businesses, a portion of which would look at accounting practices and pollution prevention.

Partnering with groups such as accountants should expand our customer base by allowing us to work through a source of information trusted by small businesses. HWRIC is currently funding a study on improving a computerized system that provides assessments of the true costs of industrial processes and the resultant wastes (discussed in Appendix D). Such tools will be instrumental in involving accountants and other financial advisors

in the pollution prevention process. In particular, future programs to reach small businesses will have to involve organizations not traditionally considered in environmental protection. A successful sustainable development program will depend on these associations (with accountants, lawyers, bankers, suppliers, etc.) through which these groups receive environmental training and introduce an active environmental component into their business dealings.

Exploring New Opportunities

HWRIC continues to seek out new mechanisms and associations by which its limited resources can deliver technical assistance to the widest possible client base while strengthening the economic base of the state. Several such opportunities have evolved during the year and will become focal points in the future.

In the past, HWRIC has conducted pollution prevention technology demonstration projects primarily with individual companies and facilities. These projects have often resulted in significant economic and environmental performance benefits to the facility. However, it has been difficult to distribute the information from these projects to other facilities that might benefit from it. In most cases, networks do not exist to facilitate the distribution of the information and attempts at mass mailings have mostly been ineffective. Further, many smaller companies have their own way of doing things. The management of these firms are more inclined to invest resources in a process or treatment change that has been demonstrated to work in their facility, than one described in a technical publication.

From a practical point of view, it would take decades to individually influence all of Illinois industries to adopt pollution prevention practices. In an effort to conduct projects that will have more widespread impact on Illinois businesses, HWRIC has initiated research projects in cooperation with trade associations that have identified specific environmental problems that might benefit from innovative technologies. One such project

involves working with the Association of American Railroads (AAR) to help them develop a membrane filtration system that can be used in many railroad facilities to recycle their aqueous cleaning chemicals. AAR is providing the funding for this project and will play an active role in distributing the results to their members. Similar opportunities may develop from HWRIC's work with electric power utilities which would enable us to work with the Electric Power Research Institute (EPRI), who has well established information distribution networks. These types of partnerships should significantly broaden the impact of our applications research. They will help HWRIC evaluate technologies and distribute information more efficiently than the single facility focus allowed.

HWRIC has worked with various trade groups to reach businesses with information and to solicit referrals to companies that need technical assistance. We hope to develop closer relationships with these organizations to enable us to train their technical staffs in pollution prevention and related concepts, and to work with them to jointly provide on-site assistance to their members. The Chemical Industrial Council of Illinois (CICI) has a contract through the state to provide assistance to businesses. HWRIC will join CICI to make the Center's pollution prevention and other technical services available to their affiliated companies.

Partnering with various groups has opened new routes by which the Center can distribute technical literature to industries needing such information. But more effective information dissemination remains a central focus. HWRIC plans to increase its use of electronic media such as the Internet and World Wide Web. By participating in regional and national information exchange partnerships, we will be able to more efficiently provide Illinois industries with current, specialized information generated by HWRIC and other programs. Our Information Services Program staff is making such items as publication lists, fact sheets and technical documents available to industries and service providers with Internet access. As a practical matter, companies with a question will be able to find assistance by directly accessing the Internet or contacting a trade

association or manufacturing extension center suggested as a source for more information. HWRIC is committed to expanding its capabilities to provide information electronically and helping others make use of the increasing numbers of electronic resources available for addressing waste issues.

The state has an opportunity to both increase and broaden its economic base by embracing environmental technology development. A recent issue of Chemical & Engineering News (April 24, 1995, p 9) cited two studies released by the National Commission for Employment Policy. One study, "Promoting Growth and Job Creation through Emerging Environmental Technologies," predicts the environmental sector will generate an additional 184,000 jobs between 1994 and 1998, representing a rate of job creation twice that of the overall US economy in recent decades. The second study, "Environment and Jobs: The Employment Impact of Federal Environmental Investments," says federal expenditures on environmental technologies in fiscal 1994 created between 68,000 and 80,000 private-sector jobs and contributed between \$3.5 billion and \$3.7 billion to the gross domestic product. The news article stated that this is partly because companies become more productive and competitive as they use energy and resources more wisely.

Helping companies wisely use energy and material resources is precisely the role that HWRIC plays in working with industry to upgrade, modernize, or use new technologies to reduce waste and increase operational efficiencies. The investment is low and the payback is rapid in this area of technology development. In addition, HWRIC is continuing to help companies test various treatment and remediation technologies. This market continues to grow. According to OTA (1993) much of the current environmental technologies market is for well-known, widely used approaches and technologies for end-of-pipe pollution control, waste disposal, and remedial clean-up of pollution. They cite estimates of a global market that probably amounted to \$200 billion in 1990, and that could grow to \$300 billion annually by the year 2000. However, according to a recent report by the Illinois Coali-

tion (1995), Illinois ranks only 45th in per capita spending for state cooperative technology programs.

The Center will continue to promote the need for research and development that will assist in bringing new technologies to market. We will continue to utilize our research funds, and to seek other sources of funds, to help companies test and demonstrate various environmental technologies related to waste treatment, waste reduction and site remediation. Finding sites to field test some of these technologies will be an important component of future remedial technology support functions of the Center.

.....
*Working with many of the managers
and users of Illinois' natural
resources provides the Center with
potential new partners to broaden
our sustainability efforts.*
.....

The Center is now a part of the state's new Department of Natural Resources. This association provides us with additional opportunities to partner with others interested in the environmental resources of the state. Working with many of the managers and users of Illinois' natural resources provides the Center with potential new partners to broaden our sustainability efforts. Similarly, we see opportunities to cooperate with other state agencies, both to increase our impact on the industries of the state, and to assist the state in improving the environmental responsiveness of its own operations. HWRIC has been working for years with IEPA and with DCCA's Small Business Assistance Program to promote pollution prevention concepts and technologies to businesses in Illinois. We continue to explore new opportunities to work more closely with these agencies to raise awareness and address needs in the industrial community. We will also look for opportunities to work with CMS, IDOT and other state agencies that might benefit from our assistance in defining ways for them to operate their facilities with greater attention to environmental responsibilities. Finally, we will begin to explore, cooperatively

with IEPA, changes to the state's procurement processes to encourage waste reduction, recycling and promotion of products of environmentally progressive companies.

Summary _____

A sustainable development program for the future of Illinois will involve a wide variety of governmental, industrial, and other private sector groups working together. It will also involve an educated citizenry that understands the value of its natural resources and the need for planned and wise use of these resources.

We continue to explore ways to expand our role as a facilitator and a source of technical resources for those wishing to improve their environmental performance. Our focus has been in restoring and enhancing past sites of contamination and in preventing future sites through pollution prevention strategies. The more groups with which we can partner who share these goals, the closer we will be as a state to a sustainable future.

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Barnes, L. "Pollution Prevention Information Sharing Projects: An Update for the Great Lakes Region." Presented at the USEPA Region 5 Great Lakes States Information Management Conference (Chicago, IL, November 16, 1994).

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Appendix B: Governor's Pollution Prevention Awards

Large Facility _____

Chrysler Corporation—Award Winner *Belvidere, Illinois*

Chrysler Corporation's Belvidere Assembly plant produces the Plymouth Neon and Dodge automobiles. Operations at the facility include assembly, painting, stamping, and fascia molding. The plant has undertaken numerous programs to reduce their total emissions to the air, land, and water. These programs included using waterborne paints for vehicle topcoats which reduced solvent use by 20% and using waterborne underbody deadener which eliminated solvent hazardous waste amounting to 0.12 pounds per car. They also replaced Freon 12 with HFC-134(a) in vehicle air conditioners and modified wastewater treatment precipitation by substituting alum for Dearborn 412 which resulted in a 90 cubic yard per month reduction in sludge generation. Sealer reformations have reduced phalate usage by over 98% and coal to gas boiler conversions increased utility efficiency to 85%. Through implementation of these and other programs Chrysler has reduced its emissions to the air by 735 tons per year and reduced their waste disposal by over 17 tons per year. The economic benefits of these programs are well over \$350,000 per year. Chrysler's total pollution prevention program is composed of management and employee teams and provides pollution prevention training to all Chrysler employees.

Olin Corporation—Award Winner *East Alton, Illinois*

The Olin-East Alton facility is a manufacturing facility that produces and distributes brass and brass alloys as well as Winchester ammunition for both private and public sector clients. Since 1990 Olin has had a "Total Chemical Management" program in which various operating areas evaluate

their processes, identify chemicals used and the waste they generate, and identify and implement techniques to reduce usage of these chemicals. Multi-disciplinary teams from the various production areas are in charge of the evaluation process. Some of the teams' accomplishments included: the use of alternative products, equipment modification, product elimination, and a 79% reduction in the use of the solvent trichloroethane (TCA) in various production areas by reformulating an existing product. Mineral spirits used throughout the facility for parts cleaning were reduced by 88% through substitution with a water-based alternative or use of an industrial cleaning machine that does not require an aqueous-based cleaner. In the Winchester production area, bullets were cleaned using a combination of corn cobs (cob meal) and TCA as the tumbling media (lead from the bullets was also contained in the waste). The tumbling media was replaced with Triple Super Phosphate which encapsulates the lead so that the metals cannot be leached. This project saved Olin a total of \$132,665 in raw materials and disposal costs.

Amoco Chemical Company—Certificate Winner *Joliet, Illinois*

Amoco Chemical Company is an organic chemical manufacturing facility. The company has implemented numerous environmental programs at their Joliet plant including the creation of a trimellitic anhydride (TMA) unit dehydration tower to condense tower vent emissions and recover the pseudocumene (a raw material) which is then recycled back to the reactor feed. Amoco's purified isophthalic acid (IPA) unit has implemented reactor catalyst changes through substituting materials, lowering reactor temperature, optimizing mother liquor recycle that feeds from their crystallizer filter, and condensing the dehydration tower vent to reduce volatile organic

chemical (VOC) releases. In the polystyrene unit process, VOC emissions were reduced by lowering the inert gas purge on feed dissolvers and vacuum system reservoirs (new procedures were written to keep the inert gas purge lower). These projects have reduced Amoco's VOC emissions by 465 tons per year and their SARA air emissions by 42%. Amoco further reduced its fugitive emissions by 90% through implementation of a Leak Detection and Repair Program. Additionally, by reclaiming methane gas produced in their anaerobic wastewater treatment plant and by using it as a fuel source in their industrial boilers, Amoco has reduced their natural gas usage by 10%.

Argonne National Laboratory—Certificate Winner

Argonne, Illinois

Argonne National Laboratory (ANL) is a Department of Energy laboratory operated by the University of Chicago. ANL used "life-cycle" engineering in the design phase of the construction of an Advanced Photon Source system. ANL engineers reviewed procedures for cleaning accelerator parts and refabricated components to reduce the need for large quantities of surface contaminants, i.e. insoluble cutting oils, in the manufacturing process. Cleaning procedures for accelerator parts were developed with ultra-sonic power cleaning baths which used degradable detergents. This new cleaning procedure for aluminum and stainless steel parts produces a cleaner surface than previous state-of-the-art procedures. The completed procedure will eliminate degreaser solutions, strong caustics, acids, and solvents. The initial savings on this front-end design will be \$300,000 in waste disposal costs the first year.

Mobil Oil Joliet Refinery—Certificate Winner

Joliet, Illinois

Mobil Oil processes a mixture of U.S. and Canadian crude oils into gasoline and distillate products for distribution to markets throughout the Midwest. Mobil initiated the Clean Fuels Project for production of Low Sulfur Diesel fuel. Process modifications which were implemented include the

installation of a third amine train and three stage Claus Sulfur Recovery Unit that recovers 99.8% of the sulfur, reducing their emissions by 1,465 tons per year. Mobil reduced their volatile hydrocarbon emissions (specifically benzene) by installing new fully enclosed sampling stations to replace the purge flow sample stations which now allows fresh samples to be taken without the need to purge the sample line to the oily water separator. Spent lime from the water softening process is being used as a substitute fertilizer for the local fertilizer market, saving \$115,000 in dewatering/filter press and landfill disposal costs. In addition to having a waste minimization team and waste minimization program in place, Mobil recycles/reuses its used catalyst offsite to save \$280,000 per year.

Motorola ILO2 Facility—Certificate Winner

Schaumburg, Illinois

Motorola ILO2 designs, manufactures, and distributes analog and digital two-way radio products, quartz and ceramic products, and systems for conventional, shared and private applications worldwide. Through formation of a Total Customer Satisfaction Team, Motorola has reduced its Volatile Organic Material (VOM) emissions from 98 tons per year (tpy) to 24.7 tpy; a reduction of 75%. Motorola achieved their self-imposed reduction goal by considering VOMs a defect and used quality improvement techniques to address the challenge. By reducing their VOM emissions, Motorola saved \$5 million dollars by remaining an "area source" rather than a "major source" of VOM emissions. Additional process changes to their Nitrogen Wave Soldering equipment saved Motorola \$151,000 per year.

Motorola Lighting Inc.—Certificate Winner

Buffalo Grove, Illinois

Motorola Lighting Inc. (MLI), a manufacturer of electronic ballasts, successfully transferred a technology that eliminated the use of terpene-based cleaners on circuit boards in their ballasts. Implementation of the no-clean technology reduced MLI's volatile organic chemical emissions by 85% and saved \$588,000 per five million ballasts manufactured. Through substitution of a

lower lead content alloy, MLI also reduced the lead content in the alloy used to solder magnetic components to the ballast by 55%. These process changes reduced waste volume and toxicity throughout MLI's manufacturing plant.

Sundstrand Aerospace—Certificate Winner
Rockford, Illinois

Sundstrand Aerospace is a manufacturer of aerospace components. This company has reduced its solvent usage by 59%, saving \$355,000 in raw material and disposal costs. This reduction was the result of numerous programs to reduce waste volume including elimination of vapor degreasers and installation of an aqueous ultrasonic cleaning system and a high-volume low-pressure paint system.

An important element in Sundstrand's Waste Minimization/Pollution Prevention Program is energy conservation. Sundstrand has made an impressive reduction in energy use through modification and installation of energy efficient lighting systems throughout the plant and adjacent areas. They have also reduced the electrical consumption of their air conditioning systems by modernizing their controls and installing new motors and an energy management system. These modifications have saved Sundstrand \$200,000 a year in energy costs.

Medium Facility _____

Nichols-Homeshield Chatsworth—Award Winner
Chatsworth, Illinois

Nichols-Homeshield Chatsworth rollforms mill finished and painted aluminum and steel into pre-engineered shapes. They have a total pollution prevention program that utilizes work center teams to provide, evaluate and implement pollution prevention projects as well as rewarding employee involvement. Employees initiated a program to utilize solvent distillation still-bottoms as a paint reducing agent for their coil coating department. This initiative resulted in a \$3,000 per year savings in waste disposal and raw material purchases. They implemented a counter flow

coil washing and rinsing process which reduced water usage by 67%, saving \$5,000 annually in operating costs. Their maintenance department substituted naphtha solvent used for parts cleaning with an aqueous-based cleaner. This change out eliminated the toxicity of the waste stream. An inventory tracking system was implemented and used to reduce paint waste associated with end-of-shelf life by 110 gallons annually. Nichols-Homeshield eliminated the use of four SARA 313 chemicals by switching to a less volatile clean-up solvent.

Small Facility _____

Medi-Physics, Inc.—Award Winner
Arlington Heights, Illinois

Medi-Physics, Inc. manufactures and distributes radiopharmaceuticals used in diagnostic and therapeutic nuclear medicine, and therapeutic radioactive sources used in the treatment of cancer. Medi-Physics designed and implemented a new process to replace acid dissolution of enriched targets used to produce short-lived isotopes. The new process utilizes chemical engineering technology to mechanically enhance the removal of the isotopes from the targets. The new process eliminated the isotope by-product and enhanced the yield of the needed isotope during target bombardment. The process modification resulted in a 52% reduction in lost raw materials for a savings of \$76,000 per year. The amount of long-lived isotope in the corrosive waste stream was reduced by a factor of 2,000, reducing Medi-Physics' waste disposal costs by \$10,000 per year. Medi-Physics utilizes employee teams to conceive, develop, and implement pollution prevention activities.

Central Illinois Light Company—Certificate Winner
Peoria, Illinois

Central Illinois Light Company's (CILCO) Duck Creek Power Plant is a coal-burning power plant. CILCO's business plan states they will "reduce, reuse and recycle waste and by-products to support CILCO's pollution prevention policy" In support of this policy, CILCO has modified

their process to allow “coal fines” to be used as a fuel source for electric energy production. These “coal fines,” a waste by-product from a nearby coal mine, allow for less use of virgin coal (less mining to the land). The employee-inspired modification allows for the entire slurry pond material (3 million tons) to be used without water resources. This reclamation project will save utility customers over \$900,000 annually. Employees are encouraged to suggest pollution prevention ideas through the “Share-The-Savings” program at CILCO.

Trade Organization _____

Chemical Industry Council of Illinois— Certificate Winner

Rosemont, Illinois

The Chemical Industry Council of Illinois (CICI) is an association of 137 member companies that promotes pollution prevention activities within its membership. CICI has formed an advisory panel for the Partners in Pollution Prevention Program (PIPP) comprised of members of Illinois business associations, IEPA, and environmental groups. This panel was formed to increase statewide PIPP membership. As a partner in the Chemical Manufacturers Association’s Responsible Care Program initiative, CICI has conducted training classes and promoted this initiative which has been adopted by the chemical industries in Europe, Japan, Mexico, and Australia. CICI also promotes safety to school children regarding chemical spills and natural disasters, and assists Northwestern Illinois communities who are combatting graffiti.

Vendor _____

Eichrom Industries, Inc.—Award Winner

Darien, Illinois

Eichrom Industries, Inc. delivers innovative and cost-effective metals separations technologies for analytical, process, recycling, and decontamination applications worldwide. Eichrom Industries, Inc. has developed Eichrom’s Spec resins as an alternative method to the three common

analytical methods (precipitation, solvent extraction, and ion exchange) used to determine the levels of radioactivity in the environment. The separation process is called extraction chromatography and generates considerably less laboratory waste. Based on employee suggestions the company has revamped its manufacturing process and through process reutilization, distillation, and on-site recycling has reduced its use of methanol by 75% and its use of acetone by more than 60%. Eichrom’s technical services group assists client laboratories in streamlining analytical methods and reducing the wastes generated in environmental analyses. Eichrom recognizes the best efforts of its employees to make the company more efficient and environmentally aware through its “Hero of the Month” award.

Illini FS Inc.—Certificate Winner

Urbana, Illinois

Illini FS is a farm supply and service cooperative. They have implemented the use of Variable Rate Technology (VRT), an environmentally positive technology that varies the applied rates of fertilizer, lime, and herbicides at different locations in a field. VRT is a computer-applied application which is based on present nutrient levels of the soil. Soil input is gathered utilizing a computerized soil analysis system and a Global Positioning System to enhance accuracy and location. VRT usage has reduced the prescribed rates of applied chemicals by 10-15%. Additionally, Illini FS has constructed a pump and piping arrangement to recover its spills and rinsate and segregates them for direct loading and use, reuse as make-up solution or spreading as diluted solution when possible.

Poly Enviro Laboratory, Inc.—Certificate Winner

Alsip, Illinois

Poly Enviro Laboratory, Inc. manufactures specialty chemicals for the metal working industry, such as synthetic lubricants for cutting, grinding and forming. Poly Enviro Laboratory has developed a unique heated applicator and a 100% solids lubricant to replace solvent based lubricants. This lubricant is applicable to the soft-

drink, beer, and food can manufacturing industries in their can neck-in process. The new lubricant reduces lubricant consumption by 90% and solvent emissions by >95%.

physically challenged persons to collect recyclable materials.

Educational Institution _____

University of Illinois—Certificate Winner *Urbana, Illinois*

The University of Illinois at Urbana-Champaign is a state educational facility housing over 36,000 students. In their residency dormitories the University has replaced the 75 watt incandescent light bulbs used in student desk lamps with 22 watt fluorescent bulbs. This substitution has saved the University 32% in electrical energy costs, a savings of \$50,000 annually. They have also replaced all showerheads with low flow showerheads which reduced the amount of water used in the dormitories by 17%. In addition to these activities the U of I also has an extensive recycling program.

Community _____

Northwest Community Hospital—Certificate Winner *Arlington Heights, Illinois*

Northwest Community Hospital encompasses a 465 bed hospital, a day surgery center, a 200 bed nursing home, 3 treatment centers, 6 physician office buildings and a business Center. Northwest has installed a Microwave Disinfection Unit which shreds, injects with steam, and disinfects potentially infectious medical waste. This technology reduces the volume of solid waste by 80% with zero air or water emissions. The project will save the hospital over \$114,000 per year in disposal costs. The hospital also has a comprehensive waste management plan; staff training; and has had a five fold expansion in their recyclable materials program. This program saves the hospital over \$16,000 per year in cost avoidance. Northwest Community Hospital was able to expand the later program through a community involvement activity that employs mentally and

Appendix C: Continuing and Completed Research Projects

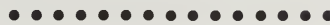


Table C-1. Projects Continuing in FY96

Title	PI/Affiliation
Waste Management Options	
Effect of Chemical Immersion on Interface Strengths of Hazardous Waste Landfill Liner Systems	Timothy Stark, University of Illinois
Accelerated Aging of Stabilized Hazardous Wastes	Max Taylor and Robert Fuessle, Bradley University
Remediation Technologies	
Toxic Heavy Metals in Biodegradation and Bioremediation Technologies	Eric Niederhoffer and John Koropchak, Southern Illinois University at Carbondale
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
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	
Waste Management Survey of Illinois Higher Education Institutions	Diane O'Rourke, University of Illinois at Chicago
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
Synthetic Studies of a Water Soluble and Recyclable Organotin Reagent	Rick Gaston, Southern Illinois University at Carbondale
Total Cost Assessment: Catalyzing Corporate Commitment to Pollution Prevention in Illinois	Allen White, Tellus Institute
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
Innovative Technology for the Beneficial Reuse of Ash Residue	Edmund Sylvester, Nextech Industries, Inc.
Pollution Prevention Through Innovative Supplier Contracts: Strategies for Small Business	Thomas J. Bierma and Francis L. Waterstraat, Illinois State University
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.
Risk Assessment	
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
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 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

Table C-2. Projects Completed in FY95

Title	PI/Affiliation
Impact of Fly Ash Disposal on Plant Development	A. Lane Rayburn, University of Illinois at Urbana-Champaign
Identifying the Site Specific Limitations to Successful In Situ Bioremediation of Agrichemical Retail Sites	Michael Cole, University of Illinois at Urbana-Champaign
Technology Transfer to Aid Pollution Prevention and Waste Management	Vicki Gwasda, Survey Research Laboratory
Field Testings of In Situ Phosphatizing Coatings	Chhiu-Tsu Lin, Northern Illinois University
Overcoming Barriers to Pollution Prevention	Thomas Bierma and Francis Waterstraat, Illinois State University

Appendix D: Research Project Summaries



Research Projects Continuing in FY96

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.

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 will be performed to understand the reliability of the acceleration method. Apparent age will be characterized by degree of silicate polymerization, infrared spectroscopy, x-ray diffraction, calorimetry, and expansion coeffi-

cients. These measurements will be 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 HWRIC and the Portland Cement Association.

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 results of this study will contribute to the development of more efficient strategies for biodegradation and bioremediation of mixed THM/organic contaminated sites such as CONWR.

Air Sparging Investigation at Mattison Machine Works

Quentin Davis, Fehr-Graham & Associates

Air sparging (aerating water to clean it) is a recent technology which currently 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 further 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 will be measured. At a minimum, the optimum design for a sparging system should be 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 have been installed and samples taken from the site are being analyzed by HWRIC's laboratory to measure the contaminant removal rate.

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.

To date, the researchers have found that all four compounds studied have degraded under their experimental conditions. Toluene degraded especially rapidly, and about 10 mg/L was removed within one week. Ethylbenzene and *o*-xylene degraded to below detection levels over several weeks, and benzene took slightly longer. Benzene has often been found to be the most recalcitrant of the monoaromatic compounds under anoxic conditions. In most of the experiments, the degradation was accompanied by increases in Fe(II) concentrations, which provide strong circumstantial evidence for bacterial iron reduction. There has been no evidence for denitrification or sulfate reduction.

Studies planned for the remainder of the project include examining reaction processes, intermediaries, and rates more closely for some of the compounds using ¹⁴C-labeled techniques. These studies will help elucidate the reaction pathways, rate-controlling steps, and cell yield, which are important for understanding and modeling the system.

Biodegradation of Dichloromethane

David Freedman, University of Illinois at Urbana-Champaign

This two-year research project is examining biodegradation of dichloromethane (DCM), a chlorinated solvent. This hazardous solvent is used in paint stripping, plastics manufacturing, and pharmaceuticals. Methods for controlling discharges of DCM are urgently needed while the search for nonchlorinated solvents continues. The overall objective of the project is to develop a high rate biological method for treating DCM-contaminated waste streams using denitrifying bacteria. The results of this project will be usable by industries in Illinois that treat DCM-contaminated wastes. Currently, the researchers are fine-tuning the design of fluidized bed reactors used in this study and conducting initial qualitative and quantitative tests of the systems. Detection limits

of the gas chromatograph used to measure DCM concentrations have also been completed.

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 proposed 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 to be 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 will be demonstrated using laboratory-scale mesocosms containing contaminated soils or aquifer materials and simulating representative in situ and ex situ bioremediation systems.

During this initial phase of the study the researchers concentrated on preparing a synthetic waste for the experiment and designing the mesocosms to be used. The next phase will be to run preliminary evaluations of the mesocosm degradation of the contaminants. This will be followed by full scale testing of the system.

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 has been selected as the site for testing BCR using five bags with both gasoline and diesel-contaminated soil.

Waste Management Survey of Illinois Higher Education Institutions

Diane O'Rourke, University of Illinois at Chicago

At the end of 1991, this group conducted a survey of waste management policies and practices of Illinois institutions of higher education. They are currently surveying the participants of the original study to learn what has happened to their waste management programs over the last four years. Participants have been asked to respond via mail to questions regarding the solid, hazardous, and other waste management practices on their campus. In addition, the survey will gather detailed information about the institutions' waste management programs and generation sources, personnel, and their need for waste management assistance.

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) are being 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 will be regenerated using a nitrogen carrier gas and electrical resistance heating. The nitrogen gas stream containing the concentrated toxic gas will then be treated cryogenically with liquid nitrogen. Cryogenic treatment of the gas stream will condense the toxic materials from its carrier gas, making the toxic material available for reuse in the original process.

This research is being performed in collaboration with Liquid Carbonic, Inc., an Illinois-based company that developed and manufactures the cryogenic air quality control device. Collaboration with Liquid Carbonic allows for 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. The first contaminant was used to examine breakthrough and ACF regeneration. Breakthrough and regeneration studies will continue over the next several months.

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.

This project seeks to rectify this problem by synthesizing a reagent which can be used for both of these reactions. 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 cut down on 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.

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 implemented 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 im-

provements. 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 HWRIC 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.

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 will be identified. Mercury and silver determination, particle size distribution and pH profile analyses, zeta potential measurements, and electron microscopy are the main experimental techniques which will be applied in the study. This project will also examine treatment alternatives for this waste stream and will establish 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.

Innovative Technology for the Beneficial Reuse of Ash Residue

Edmund Sylvester, Nextech Industries, Inc.

This study involves investigating an innovative technology for encapsulating coal-derived ash residue in a thermoplastic matrix. It will determine the feasibility of the beneficial reuse of ash residue as a reinforcing agent in radically different polymers and define the property enhancements thereof. The expected result of this study is the discovery of the beneficial reinforcing effects of ash residue in diverse polymer resins. The net benefits of this technology are threefold. One, the amount of landfilled ash will be reduced. Two, the new reinforced polymer alloys will be available to the commercial sector at a lower cost given the anticipated low cost of ash as a raw material. Three, if the performance of ash residue as a filler compares to fillers currently produced from scarce natural resources, the net economic and environmental costs of producing these fillers will be lowered.

Nextech will work with a manufacturer of small plastic parts to produce prototype products using the ash residue for testing.

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. The researchers will examine these incentive contracts and adapt them to small businesses in the metal products fabricating industry with participation by both facility managers and their suppliers.

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 optimization and life cycle analyses into a comprehensive design process.

The cost of environmental impacts will be 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 is jointly sponsored by HWRIC; the Armstrong World Industries facility in Kankakee, IL; and the National Science Foundation. The goal is to seek ways to minimize the formation of pollutants during Armstrong's production process in order to decrease waste treatment costs. The analysis involves 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 have been taken from the Armstrong facility and sent to HWRIC's laboratory for analysis. Statistical analysis should allow a correlation between composition of raw materials and emission levels of particular VOCs. The final step will be 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.

Galvanizing Bath Life Extension

Tedmund Tibieri, Arid Technologies Incorporated

A new Reduction/Recycling Technology (RRT) project is underway with Arid Technologies of Chicago, a company specializing in developing membrane technology systems for their clients. The project will test 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 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 \$.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 examines 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 include 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 will reduce the bioavailability of lead in the soils; and 4) if

extractable lead in soil is 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. The analyses are expected to be completed in September 1995. All the feed samples have been analyzed for chemical content and are ready for statistical analysis. Blood samples have been analyzed for lead concentration and are ready for statistical analysis, although the white cell counts have not yet been completed.

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, neuro-

toxicity, 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. Specific congener analyses have been completed, but not thoroughly evaluated. 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. Initial 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. Preparation of the final project report will take place during the last quarter of the project.

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 during the final quarter of the project. Based on the findings, HWRIC is considering funding this project for an additional year.

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 will be 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. Any changes in red blood cells, white blood cells and platelets will also be investigated. Serum chemistry profiles will include the measurement of glucose, total protein, uric acid, bile acids, aspartate aminotransferase, calcium, and creatinine phosphokinase.

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. HWRIC is providing the funding to develop and offer two of these courses during FY96. The courses will be an introduction to local, state and federal government structures, processes and policies that impact the urban environment and an

introduction to the theory, methods and issues related to neighborhood planning. The classes will meet for two hours on 12 Saturdays at the Southern Illinois University at Edwardsville - East St. Louis Campus. A course manual which will include the lesson plan and course materials will be prepared for each course and provided to HWRIC as part of the final project report.

Research Projects Completed in FY95

Impact of Fly Ash Disposal on Plant Development

A. Lane Rayburn, University of Illinois at Urbana-Champaign

Over the past decade, a resurgence in the use of coal for the generation of electricity has occurred, and with that comes an increase in the residues from burning coal that need safe and ecologically sound disposal methods. Fly ash has been suggested as a soil amendment for agricultural land. Studies at the whole plant level have demonstrated that such uses would be beneficial to crop productions. The purpose of this study was to determine if fly ash caused subtle genetic changes in plants that would accumulate over time with harmful results.

Nuclei isolated from maize tissue grown in fly ash amended soil were analyzed by flow cytometry to determine the type and extent of genetic changes. Native fly ash was found to cause significant alterations in the nucleus and in the cell cycle. However, no large chromosomal or nuclear alterations were observed. When native fly ash was weathered (leached with water), it did not affect the genetic organization of the nucleus. The genotoxic property causing the nuclear alterations was present in the leachate, and appeared to be epigenetic in nature. The nuclear alterations that occurred during the development of growing plants were not passed on to successive generations, suggesting that perhaps the genotoxic component was leached out of the associated plant or that a genetic mechanism reset the nuclear structure.

In conclusion, using weathered fly ash as a soil amendment does not cause a genotoxic response in maize as measured by flow cytometry. Indications are that the use of weathered fly ash on agricultural land would not result in plant nuclear alterations. However, concern over the genotoxic properties of the leachate from weathered fly ash is raised. Further studies are needed to determine if the genotoxic responses are transient or if they have long-term effects. The final report will be available through HWRIC.

Identifying Site Specific Limitations to Successful In Situ Bioremediation of Agrichemical Retail Sites

Michael Cole, University of Illinois at Urbana-Champaign

Pesticide-contaminated material was obtained from five locations at four agrichemical retail facilities in Illinois. The physical, chemical, and microbial attributes that may limit bioremediation of the materials were identified. Limitations included inappropriate pH values for good plant growth or microbial activity, high soluble salts content, high bulk density, low organic matter content, low plant nutrient availability, low microbial activity, and the presence of phytotoxic organics in addition to identified herbicides. To improve the physical properties, increase microbial activity, and increase plant growth in the contaminated matrix, the material was mixed with uncontaminated soil or with mature yard waste compost. The impact on plant establishment and growth, rhizosphere populations, development of soil microbial populations and activity, and herbicide degradation were measured.

Plants were established and grew well in pesticide-containing soil when consideration was given to compatibility between plant herbicide tolerance and the specific herbicide(s) present. Rhizosphere fungal and bacterial populations developed to levels typical in uncontaminated soil. Soil bacterial populations were significantly higher in compost-containing mixes than in contaminated soil alone or in soil mixes. Fungal populations were significantly higher in planted mixes and in unplanted mixes with compost than in contaminated soil alone. Microbial activity, as measured

by dehydrogenase activity, was significantly higher in compost-containing mixes than in soil mixes. Planting contaminated material with a herbicide-tolerant plant species or a combination of planting and compost addition resulted in significant increases in herbicide degradation in the contaminated materials. The results strongly suggest that remediation of herbicide contamination at agricultural retail facilities can be achieved quite rapidly and at moderate cost by natural bioremediation organisms stimulated by vegetation and/or increasing the organic content of the contaminated soil. The final report (RR-77) is available through HWRIC.

Technology Transfer to Aid Pollution Prevention and Waste Management

Vicki Gwiasda, UIC Survey Research Laboratory

A survey of Publicly Owned Treatment Works (POTWs) in Illinois is being conducted to determine the industries that would benefit most from pollution prevention. The survey will sample POTW operators to determine the industrial pollutant types and volumes that cause their facilities the most problems. It will also assess the status of pollution prevention technical assistance currently provided to POTWs and their industrial customers, and identify the technical areas where HWRIC's expertise could be beneficial.

Analysis of the results will take place in the fall. A report will be prepared in January that will be used to develop pollution prevention approaches for industrial facilities.

Field Testings of In Situ Phosphatizing Coatings

Chhiu-Tsu Lin, Northern Illinois University

The objective of this research project was to develop and test environmentally and economically sound in situ phosphatizing coatings (ISPCs) that give superior protection to metal surfaces, eliminate several process steps, and more importantly, reduce pollution problems during manufacturing. The chemical principle of ISPCs (i.e., the polymer chemistry and phosphate chemistry can proceed independently and simultaneously) has been verified. An optimum amount of the pre-

dispersed in situ phosphatizing reagents (ISPRs) in the paint formulation was shown to react in situ with the metal surface to form a metal phosphate layer that suppresses corrosion and enhances the coating adhesion. The type and amount of phosphatizing reagents used in ISPCs are sensitive to the crosslinking density and coating thickness required for a specific industrial application. The ISPCs have been formulated for solvent-borne, water-borne, thermal curing, and air-dry paint systems. The researchers evaluated three ISPCs: 1) ISPCs for zinc or zinc phosphate pre-treated substrates to increase coating adhesion without a post treatment, 2) coil coating ISPCs for untreated cold rolled steel, and 3) water-borne ISPCs to reduce the levels of volatile organic compounds (VOCs). The project proved that the researchers' in situ phosphatizing technique combines the phosphate, primer, and topcoat application into a single-step process that saves time, energy, material, and labor.

Overcoming Barriers to Pollution Prevention

Thomas Bierma and Francis Waterstraat, Illinois State University

Even with the strong push by federal, state and local agencies to provide pollution prevention help, it is not being widely accepted. If pollution prevention benefits companies in various ways from decreasing the amount of waste generated to bettering the bottom line, why haven't more companies adopted it?

Illinois State University researchers, Dr. Thomas Bierma and Francis Waterstraat, sought answers to this question through a HWRIC research grant. In addition, they also wanted to know what strategies could be used by pollution prevention (P2) information providers to significantly accelerate the adoption of P2 by these same companies.

Focusing on the metal parts fabricating (MPF) industry in Illinois, some of the conclusions drawn by the researchers include:

- conditions for P2 diffusion appear to be good, yet diffusion is very limited,

- though MPF managers are demanding other manufacturing innovations, they are not demanding P2 innovations,
- familiar technology transfer mechanisms are not promoting P2, and
- government-driven P2 technology transfer mechanisms have limited effectiveness.

Recommendations to providers of P2 to improve the adoption of P2 technologies and techniques by companies in Illinois are:

- approach P2 promotion as a marketing problem,
- enhance the traditional P2 promotion program through marketing insights,
- use non-traditional mechanisms for P2 information dissemination such as the supplier/MPF relationship,
- use relationships among competitors and other local businesses,
- expand the availability of capital for P2 investments, and
- use the language of business rather than the language of government to promote P2.



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