

ENVIRONMENTAL
RESEARCH & TECHNOLOGY

**Report on
Environmental Research,
Technology Development
and Awareness Activities
1991/92**

Environmental Research Program
Environmental Technologies Program
Environmental Education and Awareness Program

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Technology Development
and Awareness Activities
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This Report contains summaries of all active research, technology development and awareness projects in programs coordinated through the Research and Technology Branch, Environment Ontario, in the period April 1991 to March 1992. It also includes listings of all projects previously conducted under these and other similar ministry programs administered by the branch.

Summaries of research and technology development projects contained in this report should not be cited without the permission of the Research and Technology Branch, Environment Ontario.

IMPORTANCE OF ENVIRONMENTAL RESEARCH, TECHNOLOGY DEVELOPMENT AND AWARENESS

New developments in all areas of science and industry are occurring at a tremendous rate. Innovative products, materials and industrial processes are constantly appearing. Developments in these areas can affect the environment by introducing new contaminants, creating new waste management issues, or by overloading the capacity of existing systems.

To deal with such issues requires a strong commitment to ongoing research and technology development programs. Such programs support the activities of university and private researchers, environmental protection companies and industry in providing the knowledge and systems necessary to address these issues.

In conjunction with these scientific and technological endeavours, there remains the ongoing necessity for increasing public awareness of environmental issues. Whether achieved through publications, theatrical performances or forums, public environmental literacy is fundamental to the resolution or avoidance of such concerns.

These technical and educational ventures work in parallel towards a common objective, enhanced environmental quality. It is through such initiatives that the environmental problems of the past can be remediated, those of the present diminished, and those of the future prevented.

THE RESEARCH AND TECHNOLOGY BRANCH

Environment Ontario's goal is "to protect and enhance the quality of the environment for the present and future well-being of the people of Ontario and of the ecosystem in which they live." In recognition of the increasing importance of environmental research and technology development in fulfilling this mandate, the Research and Technology Branch (RTB) was created in 1988.

The RTB ensures that the ministry remains at the forefront of knowledge and skills in environmental management and technology. Its primary role is to coordinate and promote internal and external research projects of the ministry and foster the development of innovative environmental protection technologies. More recently, support for public awareness activities has assumed increased importance.

The RTB has responsibility for three programs:

- ▶ Environmental Research Program
- ▶ Environmental Technologies Program
- ▶ Environmental Education and Awareness Program

An increasingly important responsibility of the RTB is to communicate developments and the results of research, and to encourage their implementation in the community. To date, this has been done mainly through the annual Technology Transfer Conference. During the year, this technology transfer initiative was expanded to strengthen liaison with research organizations, technology based groups and other agencies to ensure the transfer of new technologies and information from the government to the private sector. A feature of this process in 1991 was the inaugural publication of *The Proving Ground*, a bulletin on current environmental research and technology development activities.

In performing its role, the RTB promotes and supports the environmental protection industry in Ontario, and ensures that a wide range of expertise and information is available to the ministry for developing policy and regulations.

ENVIRONMENTAL RESEARCH PROGRAM

Environment Ontario encourages excellence in environmental research through the Environmental Research Program (ERP). Since 1977, this program has supported nearly 650 research projects at universities, private consulting firms and laboratories, and public agencies.

Overall responsibility for the ERP exists with the ministry's Research Advisory Committee, which establishes priorities and ensures that research activities are consistent with ministry policies and objectives.

In previous years as the initial step in an annual process, the ministry published a document entitled "Research Needs" which broadly defined its environmental research priorities in six categories:

- ▶ Air Quality
- ▶ Water Quality
- ▶ Liquid and Solid Waste
- ▶ Analytical Methods and Instrument Development
- ▶ Environmental Socio-Economics
- ▶ Multimedia Contaminants and Biotechnology

Researchers were then invited to submit proposals addressing some aspect(s) of these broad criteria.

In 1991, the ministry, through the Research and Technology Branch and the Research Advisory Committee, embarked on an initiative aimed at establishing its strategic directions for research. The purpose of the process was to identify:

- ▶ the priority programs of the ministry; and
- ▶ the specific research/technology questions in each program

The resulting document, entitled "Strategic Directions for Environmental Research and Technology Development - 1992", was intended to provide greater precision to the definition of research needs, and thus better guidance to applicants in the formulation of proposals. Key topics and issues were identified in ten areas:

- ▶ Acid Rain
- ▶ Air Quality
- ▶ Analytical Instrumentation
- ▶ Biotechnology
- ▶ Environmental Socio-Economics
- ▶ Multi-Media Contaminants
- ▶ Pest Control
- ▶ 3Rs
- ▶ Waste Management
- ▶ Water Management (including sewage treatment)

(Pest control research was integrated into the, program in 1992; it was previously a separate program under the Ontario Pesticides Advisory Committee).

Issues in these research and technology development areas were also linked to current ministry programs in order to more closely align research priorities with current ministry policies and direction, and therefore provide an improved basis on which to review submissions. These programs included:

- ▶ Accelerated 3Rs
- ▶ Air Toxics / Global Warming
- ▶ Beaches Restoration
- ▶ Biotechnology
- ▶ Countdown Acid Rain
- ▶ Drinking Water Protection
- ▶ Groundwater Protection
- ▶ Long Range Transport
- ▶ Materials Management Policy
- ▶ MISA
- ▶ Multi-Media
- ▶ Ozone Depletion
- ▶ Pesticide Reduction
- ▶ Remedial Action Plans
- ▶ Risk Assessment
- ▶ Vehicle Emissions Strategy
- ▶ Multi-Program Support

In 1992, in response to increasing financial constraints and the necessity of ensuring funding for environmental research is directed to those areas most closely matching current ministry priorities and policy directions, this focussed approach has continued. The objective of the process has been the generation of a limited number of very specific research needs for 1993 which incorporate the principles of pollution prevention, multi-media considerations and zero discharge.

Researchers will be asked to submit proposals to address these needs which will truly reflect the research priorities of the ministry, and have a multi-disciplinary approach. This will ensure that those research projects that are funded will produce a useable product for the advancement of ministry programs. A small pool of money, however, will still be made available for the support of proposals addressing more general concerns. Other aspects of the coordination and administration of the ERP will remain similar to that of previous years.

The deadline for receipt of proposals for the ERP is January 15 each year. Technical review of applications is overseen by ministry Research Coordinators and is conducted within six weeks. This review, and recommendations of the RAC, are based on such criteria as:

- ▶ compatibility with ministry needs and priorities
- ▶ scientific merit
- ▶ evidence of a multi-disciplinary approach
- ▶ degree of collaborative arrangements between institutions and/or other groups
- ▶ competence of the researcher(s) and quality of facilities
- ▶ likelihood of achieving objectives on time
- ▶ potential for sharing costs with other organizations
- ▶ potential for implementation of results

Based on these evaluations, as well as research priorities and available funds, applications are recommended by the RAC to senior management for approval or rejection. Final approval may depend on changes to the budget or the research protocol.

Projects are then assigned a ministry Liaison Officer (LO) whose responsibility it is to monitor technical progress. A close working relationship between the LO and researcher benefits the ministry by facilitating the inclusion of research findings into its programs and activities.

Researchers must provide interim reports on the project, and a final report upon completion. During the course of the project, funds are released only upon the provision of acceptable progress reports. Investigators are also required to deliver at least one presentation at the annual Technology Transfer Conference.

The ERP makes a significant contribution to the support of environmental research not only through its funding activities, but in its encouragement of links between the ministry and the scientific community. It facilitates access to a broad range of expertise and resources, and provides opportunities for synergistic links between ministry scientists, and universities and consultants, in solving environmental problems.

ENVIRONMENTAL RESEARCH PROGRAM

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General enquiries requesting program guidelines, application forms and other publications should be addressed to the Grants Assistant

Ms. Ana Rosati
(416) 323-4649

ENVIRONMENTAL RESEARCH PROGRAM PROJECT DIRECTORY

The following directory summarizes active projects in the Environmental Research Program in the 1991/92 fiscal year, including those approved for initiation in the 1992/93 year. This edition of the Report also contains details of all other projects previously conducted in the program. An explanation of each entry follows:

- 999 Report catalogue number
 NOTE: THIS NUMBER HAS NO RELEVANCE BEYOND THIS DOCUMENT.
 Project title
 Principal investigator(s)
 Affiliation/Contact details
 Project summary (current projects only)
- 5/1990 (2) Month and year of initiation (duration in years)
- \$75 000 Total amount approved
- (ER 443) Environmental Research Program project number
- [] Environmental Research Program research area
- [AQ] Air Quality
 - [WQ] Water Quality
 - [LSW] Liquid and Solid Waste
 - [AMID] Analytical Methodology and Instrument Development
 - [ESE] Environmental Socio-Economics
 - [MMCB] Multimedia Contaminants and Biotechnology
 - [PR] Pesticides Research
- Final Report (if any)
- () Availability of report
- (RAC) Published under ministry white cover
 - (PUB) Presently in publication
 - (REV) Under review by ministry
 - (LQO) Limited quantities of original report
 - (BLO) Research and Technology Branch library only

Where this information is omitted, it is unavailable from current or archival sources.

For reference purposes, Environmental Research Program project numbers are cross-referenced to the Report catalogue number in an index beginning on Page 96.

SOLID WASTE DIVERSION

1991/92 Projects

001 Development of the Backfill and Construction Application Guidelines

Mr. Brian Whiffen

(519) 579-3500

CH2M Hill Engineering Ltd.
Suite 600, 180 King St. S.
Waterloo, Ont. N2J 1P8

This project established the usefulness of such industrial waste material as fly ash and blast furnace slag for specific construction or backfill applications. The study primarily involved detailed bulk quality characterization and leachate testing of material from selected sites as well as on-site hydrogeologic investigations. The guidelines developed will assist in the development of environmentally safe and beneficial uses for solid industrial waste.

7/1987 (2) \$195 000 (ER 336) [LSW]

Final Report Received (REV)

002 Experimental and Theoretical Study of Guelph Pilot Scale Solid Waste Composter

Dr. Lambert Otten

(519) 824-4120

School of Engineering
University of Guelph
Guelph, Ont. N1G 2W1

Detailed monitoring of the City of Guelph's pilot scale hybrid aerated pile/in vessel composting system has been undertaken in this project. This determination of inbound waste composition, temperature and moisture content profiles in the reactor, and compost quality will allow an accurate assessment of reactor performance. To date, recording of temperature-time conditions throughout the aerated pile and measurement of pathogen content in the final compost product indicates that sanitizing conditions are routinely achieved during the process. With the exception of mercury, chemical analysis of mature compost shows that metal concentrations and other quality parameters are all within ministry draft guidelines.

4/1990 (2) \$90 540 (ER 501) [LSW]

003 Bioconversion of the Mechanically Separable Paper Fraction of Municipal Solid Waste to Fuel Alcohol

Dr. Morris Wayman

(416) 978-4905

Dept. of Chem. Engineering and Applied Chemistry
University of Toronto
Toronto, Ont. M5S 1A4

This project centred on the development and optimization of an enzymatic process for the bioconversion of the mechanically separable paper fraction of municipal solid waste to ethanol, a potential fuel additive. Studies demonstrated that enzymatic liquefaction of waste paper and fermentation of the resulting sugars can produce ethanol yields of 350-400 litres per tonne of paper, equivalent to 200 litres per tonne of refuse. This represents 75 - 80% of the theoretical yield. The study also included a determination of more efficient methods for the production of the saccharifying cellulase enzymes.

5/1990 (2) \$96 000 (ER 502) [LSW]

Bioconversion of MSW Paper to Fuel Ethanol: A Waste Reduction Project. Wayman, M., University of Toronto. 1992. 90 Pp. (PUB)

004 Municipal Recycling Programs and Household Conservation Behaviour

Dr. Reid Kreutzwiser

(519) 824-4120

Department of Geography
University of Guelph
Guelph, Ont. N1G 2W1

Respondents in 161 randomly selected households in Guelph, Ont. involved in either Blue Box or Wet Dry recycling programs were interviewed to record recycling behaviour, energy and water conservation behaviour in the home, consumer behaviour, and attitudes about solid waste problems and solutions. Although the level of recycling activity and environmentally responsible consumer behaviour was greater among Wet Dry respondents, the latter difference was not statistically significant once the influence of education was eliminated. No differences in energy and water conservation behaviour or in waste management attitudes between the two groups were found. Consequently, this study found only limited support for the hypothesis that participation in municipal recycling programs fosters other forms of household conservation behaviour.

5/1990 (1) . \$6165 (ER 508) [ESE]

Municipal Recycling and Household Conservation Behaviour - A Study of Guelph, Ontario. Kreutzwiser, R., University of Guelph. 1991. 40 Pp. (RAC)

Previous Projects

005 Development of Guidelines to Control the Disposal of Wastes as Backfill Material In Ontario. Mr. R. Rush, Canviro Consultants Ltd. 1985 (1) \$26 900 (ER 217) [LSW]

Guidelines for the Utilization of Industrial Wastes in Backfill and Construction Applications. Canviro Consultants Ltd. 1986. 63 Pp. (BLO)

006 Determinants of Participation In Solid Waste Source Separation Programs In Apartment Buildings. Dr. V. MacLaren, University of Toronto. 1987 (2) \$19200 (ER 366) [ESE]

SOLID WASTE DISPOSAL

1991/92 Projects

007 Field Demonstration of Membrane Technology for Treatment of Landfill Leachate

Mr. Philip Canning

(416) 639-6320

Zenon Environmental Inc.
845 Harrington Ct.
Burlington, Ont. L7N 3P3

The technical and economic assessment under field conditions of a membrane based reverse osmosis process for the treatment of landfill leachate was the basis of this undertaking. The study was conducted at the Township of Muskoka Lakes landfill where the leachate contained excessive iron and other metals and low levels of organics. The leachate was treated by a two-stage process: lime pretreatment and microfiltration followed by reverse osmosis, which reduced the BOD in the leachate by 94 percent of the dissolved solids. This process offers another alternative for treating landfill leachate and may provide a viable method for reducing leachate volume for off-site disposal.

4/1989 (1) \$130 000 (ER 439) [LSW]

Field Demonstration of Membrane Technology for Treatment of Landfill Leachate. Zenon Environmental Inc. 1991. 90 Pp. (PUB)

008 Retention of Toxic Landfill Leachate Metals by Soil

Dr. Les Evans

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Department of Land Resource Science
University of Guelph
Guelph, Ont. N1G 2W1

The objective of this study is to determine the influence of pH and the presence of chloride ions on heavy metal retention by soils. Results demonstrate that lead, cadmium and, particularly, mercury cations are readily removed from soil in the presence of chloride due to their ability to form electrically neutral or negatively charged complexes with this anion. This change in speciation effectively overcomes the attraction of the metals to the negatively charged surfaces of soil and sediment particles resulting in increased mobility of the metal in the landfill soil system. This has implications for the retention of these metals in landfill systems under conditions of high salt loadings.

5/1990 (2) \$78 050 (ER 484) [LSW]

009 Physical Modelling of Contaminant Plumes from Landfills

Dr. Robert Mitchell

(613) 545-2133

Department of Civil Engineering
Queen's University
Kingston, Ont. K7L 3N6

The application of a geotechnical centrifuge technique to *the* modelling of soluble contaminant transport in partly saturated soils is the focus of this project. This system holds promise as a means of producing realistic and accurate data on contaminant migration from landfills and such other situations as tank leakages or spills, data which will contribute to *the* extension of numerical techniques currently applicable only to saturated soils. Centrifuge modelling has the added advantage of accelerating flow and transport phenomenon so that several years of real life contaminant migration can be observed in a period of days.

5/1990 (3) \$50 500 (ER 505) [LSW]

010 Solid Waste Stabilization In a Landfill Environment

Dr. Donald Kirk

(416) 978-7406

Dept. of Chem. Engineering and Applied Chemistry
University of Toronto
Toronto, Ont. M5S 1A4

Through extensive chemical, physical and morphological analysis of material, and analysis of leachate using simulated landfill test columns, the purpose of this study is to determine the stabilization mechanisms and fate of solid wastes and heavy metal species within a landfill environment. Various test cells, some containing hazardous waste, have also been maintained to the stage of landfill stabilization presenting a unique opportunity to compare transformations of municipal refuse and hazardous waste both in the presence and absence of the other waste type.

12/1990 (2) \$78 071 (ER 517) [LSW]

011 Evaluation of the Capacity of Peat to Attenuate Landfill Leachate

Mr. Jake Dick

(613) 728-3571

J.L Richards and Associates Ltd.
864 Lady Ellen Pl.
Ottawa, Ont. K1Z 5M2

The efficacy of a peat trench system for the removal of such contaminants as heavy metals and trace organic

compounds from leachate impacted groundwater is being assessed in this project. Using laboratory column experiments, parameters for the construction and monitoring of a full-scale treatment trench at the Township of Lanark landfill site are being developed. Successful development and demonstration of this method would provide an inexpensive method for leachate treatment for small and large municipalities having access to a suitable peat source.

7/1991 (2) \$92 410 (ER 536) [LSW]

012 Centrifugal Physical Modelling of Clay Liner Compatibility

Dr. Robert Mitchell

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Kingston, Ont. K7L 3N6

This study is a comprehensive evaluation of the combined effects of liner placement methods and liner-leachate compatibility on the long term performance of clay liners for waste containment. Experimental work is centred on the use of a 0.5m radius geotechnical modelling centrifuge, a technique shown previously to be an effective means of rapidly evaluating clay liner permeability under prototype stress conditions. The study will provide guidance in the selection of clay types and specification of placement methods for waste containment facilities, and further establish the centrifuge modelling methodology as an effective tool for experimental and practical applications.

6/1991 (2) \$29 135 (ER 537) [LSW]

013 An Engineered Landfill Liner Utilizing Coal Ash

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Dept. of Chem. Engineering and Applied Chemistry
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Toronto, Ont. M5S 1A4

The objective here is to develop a cost effective municipal landfill liner utilizing coal fly ash, a waste lime product and other additives. This application would make effective use of two materials now being stored or treated as nonhazardous wastes. The liner would be an effective hydraulic barrier and potentially have attractive chemical barrier properties. Due to its alkaline nature, the compounded material would also provide an additional protection against heavy metals and microbial activity at the landfill-environment interface.

6/1991 (2) \$61 240 (ER 539) [LSW]

014 Microbiological indicators for Assessing Hydraulic Connection In Buried High Permeability Zones at Waste Disposal Sites

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The development of methodology to track bacteria through groundwater at landfill sites and in high permeability zones using numerical taxonomy and specific gene indicators is the goal of this project. The use of the indigenous population of such bacteria as lead and cadmium tolerant strains as indicators of hydraulic pathways could result in improved detection and tracing of contaminant plumes in sub-surface soils near landfill sites.

6/1991 (3) \$149 213 (ER 543) [LSW]

015 Attenuation by Soils of Metals Dissolved in Landfill Leachates at Muskoka Lakes

Dr. Graeme Spiers

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This study will provide invaluable information from a unique natural laboratory on the attenuation and mobility of leachate applied metals, The Muskoka Lakes MSW spray irrigation site for leachate disposal will be sampled for detailed mineralogical, microchemical and micro-morphological examination. The samples will be analyzed for levels of cadmium, chromium, copper, iron, manganese, lead, vanadium and zinc to enable estimates of attenuation rates following approximately 12 years of spray irrigation. Detailed *in situ* microchemical examination will provide information on the distribution of the applied elements at the submicroscopic level. Geochemical modelling will also be used to provide information on the speciation of the applied metals in the soil solutions.

5/1992 (1) \$36 004 (ER 620) [LSW]

Previous Projects

016 Sanitary Landfill Site Investigation at Canadian Forces Base, Camp Borden. Dr. J. Cherry, University of Waterloo. 1978 (3) \$36 250 (ER 16)

Hydrogeological Studies of a Sandy Aquifer at an Abandoned Landfill. MacFarlane, D.S., Cherry, J.A., Gillham, R.W. and Sudicky, E.A., University - of Waterloo. 1980. 500 Pp. (BLO)

Leachate Patterns: Leachate Transport and Mathematical Modelling of Flow and Contaminant Transport. Soyupak, S., Farquhar, G., and Sykes, J., University of Waterloo. 1980. 500 Pp. (BLO)

017 The Study of Gas Production and Migration at Closed Landfill Sites. Dr. J. Nunan, Hydrology Consultants Ltd. 1978 \$287 500 (ER 23) [LSW]

018 Attenuation In Groundwater of inorganic Contaminants from Sanitary Landfills: Attenuation of Leachate. Dr. J. Cherry, University of Waterloo. 1980 \$116 000 (ER 44) [LSW]

Attenuation in Groundwater of Inorganic Contaminants from Sanitary Landfills on Sandy Unconfined Aquifers, Vol. 1. Buszka, P.M., University of Waterloo. 1981. 83 Pp. (BLO)

Attenuation in Groundwater of Inorganic Contaminants from Sanitary Landfills on Sandy Unconfined Aquifers, Vol. 2. Cherry, J.A., Barker, J.F. and Reardon, E.J., University of Waterloo. 1982. 96 Pp. (BLO)

019 Field Measurements: Infiltration Through Landfill Covers. Dr. P. Lee, Gartner Lee Associates Ltd. 1982 \$9 000 (ER 58) [LSW]

Field Measurement of Infiltration Through Landfill Covers. Lee, P.K., Gartner Lee Associates Ltd. 1985. 49 Pp. (BLO)

020 Design of Groundwater Monitoring Programs for Waste Landfill Sites. Dr. P. Byer, University of Toronto. 1982 \$30 000 (ER 63) [LSW]

Design of Groundwater Monitoring Programs for Waste Landfill Sites. Byer, P.H. and Schwarz, R.R., University of Toronto. 1984. 32 Pp. (BLO)

SOLID WASTE DISPOSAL

021 An Extraction and Concentration Method for the Testing of Landfill Leachates, Soil Fractions, and Liquid industrial Wastes for Genotoxic Organic Compounds. Dr. G. Thomas, ORTECH International. 1984 (3) \$300 000 (ER 103) [LSW]

022 Occurrence and Mobility of Hazardous Organic Chemicals in Groundwater at Ontario Landfills. Dr. J. Cherry, University of Waterloo. 1984 \$331 000 (ER 118) [LSW]

The Occurrence and Mobility of Hazardous Organic Chemicals In Groundwater at Several Ontario Landfills. Barker, J.F., Cherry, J.A. and Reinhard, M., University of Waterloo. 1989. 107 Pp. (LQO)

023 Leaching Studies of Polychlorinated Dibenzo-p-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF) from Municipal Incinerator Fly Ash. Dr. F. Karasek, University of Waterloo. 1984 \$15 000 (ER 126) [AQ]

Leaching Studies of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans From Municipal incinerator Flyash. Karasek, F.W., Tong, H.Y. and Reuel, G.J., University of Waterloo. 49 Pp. (LQO)

024 Development of Design Criteria for Optimal Recovery of Leachate Under Sanitary Landfills. Dr. R. Farvolden, University of Waterloo. 1984 \$25 000 (ER 131) [LSW]

Numerical Modelling Study of Drain Efficiency in Leachate Collection. Abdul, A.S., St. Amaud, L. and Farvolden, R.N., University of Waterloo. 1985. 32 Pp. (BLO)

025 Geochemical Investigation of the Origin and Properties of Near Surface Fractures In Clay Till (for Potential Application In Siting of Landfills in Clay). Dr. M. Dusseault, University of Waterloo. 1984 \$29 400 (ER 147) [LSW]

The Fractured Clay Till of Southwestern Ontario: Geotechnical Investigations. Dusseault, M.B., University of Waterloo. 1988. 103 Pp. (BLO)

026 An investigation into the Redox Conditions of a Landfill Leachate Plume Containing Volatile Organics, Gloucester, Ontario. Dr. W. Gorman, Queen's University. 1984 (2) \$30 450 (ER 151) [AMID]

027 Laboratory and Numerical Model Studies to Design Criteria for Optimal Recovery of Leachate Under Sanitary Landfills. Dr. R. Farvolden, University of Waterloo. 1984 (3) \$107 050 (ER 153) [LSW]

028 To Determine the Integrity of Solidified Wastes by Large Scale Leach Columns Under Environmental and Controlled Conditions. Dr. D. Kirk, University of Toronto. 1984 \$90 600 (ER 156) [LS W]

Determining the Integrity of Solidified Wastes by Large Scale Leach Columns. Kirk, D.W., University of Toronto. 141 Pp. (BLO)

029 Assessment of a Prototype System for Pyrolysis of Refuse Derived Fuel. Mr. Lawrie, Energy From Waste Systems. 1985 (1) \$30 000 (ER 191) [LSW]

Evaluation of a Prototype RDF Pyrolyser for the Ministry of Energy and the Ministry of the Environment. Thomdyke, S.J. Ontario Research Foundation / ORTECH International. 1987. 86 Pp. (BLO)

030 Effects of increasing Amounts of Non-Polar Organic Liquids In Domestic Waste Leachate on the Hydraulic Conductivity of Clay Liners in Southern Ontario. Dr. R. Quigley, University of Western Ontario. 1985 (2) \$48 000 (ER 213) [LSW]

Effects of increasing Amounts of Non-Polar Organic Liquids in Domestic Waste Leachate on the Hydraulic Conductivity of Clay Liners in Southern Ontario. Quigley, R.M. and Fernandez, F., University of Western Ontario. 1989. 178 Pp. [Joint report with ER 364] (RAC)

031 Municipal Solid Waste - Feasibility of Gasification with Plasma Arc. Mr. G. Carter, Resorption Canada Ltd. 1986 (2) \$75 000 (ER 234) [LSW]

032 Treatment of Landfill Leachate by Spray Irrigation. Dr. A. Gordon, University of Guelph. 1986 (1) \$82 500 (ER 244) [LSW]

Treatment of Landfill Leachate by Spray Irrigation (Muskoka Lakes). McBride, R.A., Gordon, A.M. and Groenevelt, P.H., University of Guelph. 1988. 161 Pp. (LQO)

033 Brock West Landfill Site - Odour Control Gas Burner Environmental Testing. Mierzynski, Metropolitan Toronto. 1986 (1) \$22 500 (ER 253) [LSW]

SOLID WASTE DISPOSAL

034 Dispersion of the Stouffville Contaminant Plume. Dr. R. Farvolden, University of Waterloo. 1986 (2) \$42 900 (ER 261) [LSW]

Analysis of the Contaminant Plume in the Oak Ridges Aquifer. Proulx, L and Farvolden, R.N., University of Waterloo. 1989. 131 Pp. (RAC)

035 Clay Leachate Compatibility Study Hydraulic Conductivity of Ottawa-Carleton "Leda Clay" Barrier Soils Permeated with Domestic Waste Leachate. Dr. M. Quigley, University of Western Ontario. 1987 (1) \$25 000 (ER 299) [LSW]

Clay/Leachate Compatibility Study Hydraulic Conductivity of Ottawa/Carleton "Leda" Clay Barrier Soils Permeated with Domestic Waste Leachate. Quigley, M., Fernandez, F. and Ohikere, C., University of Western Ontario. 1989. 118 Pp. (RAC)

036 Technical and Economic Assessment of Reverse Osmosis for Treatment of Landfill Leachate. Dr. J. Coburn, Zenon Environmental Inc. 1987 (1) \$49 600 (ER 303) [LSW]

Technical and Economic Assessment of Reverse Osmosis for Treatment of Landfill Leachate. Coburn, JA., Zenon Environmental Inc. 1989. 88 Pp. (LQO)

037 Establishing Vegetation on Erosion-Prone Landfill Slopes In Ontario. Dr. T. Hilditch, Gartner Lee Associates Ltd. 1987 (3) \$193 000 (ER 307)

Manual for Establishing Vegetation on Landfills in Ontario. Leech, R.E.J. and Hilditch, T.W., Gartner Lee Associates. 1990. 71 Pp. [RAC]

038 Enhanced Sanitary Landfill: A Demonstration Trial. Dr. R. Laughlin, ORTECH International. 1987 (1) \$195 000 (ER 308) [LSW]

The Enhanced Sanitary Landfill - Phase I. The Anaerobic Treatability of Landfill Leachate. Vicevic, G. and Laughlin, R.G.W., ORTECH International. 1989. 71 Pp. [BLO]

039 Slow Rate Infiltration Land Treatment and Recirculation of Landfill Leachate in Ontario. Dr. R. McBride, University of Guelph. 1987 (3) \$472 400 (ER 333) [LSW]

040 Technology Review of Biological Treatment of Trace Level Toxicants In Landfill Leachate. Dr. J. Fein, Diversified Research Laboratories Ltd. 1987 (1) \$31 800 (ER 339) [LSW]

Technology Review: Biological Treatment of Hazardous Landfill Leachates. Fein, J. and Yu, P., Diversified Research Laboratories, Ltd. 1988. 220 Pp. (LQO)

041 Erosion of Landfill Covers. Dr. K. McKague, Ecologistics Ltd. 1987 (1) \$75 000 (ER 340) [LSW]

Erosion of Municipal Solid Waste Landfill Covers. McKague, K.J., Ecologistics Ltd. 1989. 83 Pp. [BLO]

042 Determining the integrity of Solidified Wastes by Large Scale Leach Columns Under Environmental and Controlled Conditions. Dr. D. Kirk, University of Toronto. 1987 (1) \$146 509 (ER 362) [LSW]

043 Effects of Increasing Amounts of Non-Polar Organic Liquids In Domestic Waste Leachate on the Hydraulic Conductivity of Clay Liners In Southern Ontario. Dr. R. Quigley, University of Western Ontario. 1988 (1) \$24 000 (ER 364) [LSW]

Effects of Increasing Amounts of Non-Polar Organic Liquids in Domestic Waste Leachate on the Hydraulic Conductivity of Clay Liners in Southern Ontario. Quigley, R.M. and Fernandez, F., University of Western Ontario. 1989. 178 Pp. [Joint report with ER 213] [RAC]

044 Treatment / Leachability Study of MSW Incinerator Ash. Mr. S. Sawell, Wastewater Technology Centre. 1987 (1) \$60 000 (ER 370) [LSW]

Evaluation of Contaminant Leachability from Residues Collected at a Refuse Derived Fuel Municipal Waste Combustion Facility. Sawell, S.E., Constable T.W. and Klicius, R.K., Environment Canada. 1989. 26 Pp. [BLO]

Evaluation of Solidified Fabric Filter Ash from a Modular Municipal Waste Incinerator with Lime-Based Air Pollution Control. Sawell, S.E., Caldwell, R.J., Constable, T.W., Scroggins, R.P. and Klicius R.K., Environment Canada. 1989. 27 Pp. [BLO]

045 Studies of Methodology for Rapid Evaluation of Leaching from Municipal Wastes. Dr. F. Karasek, University of Waterloo. 1988 (1) \$46 000 (ER 406) [AMID]

SOLID WASTE DISPOSAL

046 Landfill Monitoring Protocol Development for Ontario.

Mr. H. Mooij, H. Mooij & Associates. 1988 (1) \$21 635 (ER 410) [LSW]

Groundwater Monitoring Practices at Landfills: Procedures and Protocols. Mooij, H.; H. Mooij & Associates Ltd. 1989. 57 Pp. (BLO)

047 Classification and Leachability of Hazardous Waste Residues. Dr. K.B. Harvey, Atomic Energy of Canada Ltd. 1988 (2) \$61 829 (ER 411) [LSW]

Classification and Leachability of Hazardous Wastes and Hazardous Waste Residues. Harvey, K.B., Atomic Energy of Canada Ltd. 1991. 32 Pp. (BLO)

048 Monitoring and Evaluation of Landfill Cover Lysimeters. Dr. K McKague, Ecologistics Ltd. 1988 (1) \$15 000 (ER 425) [LSW]

Evaluation of Prototype Landfill Cover Lysimeters. McKague, K.J., Ecologistics Limited. 1990. 75 Pp. (RAC)

049 Geoflow Meter, Application to Measuring Gas Flow in Soil. Mr. M. Pullen, Marshall Macklin Monaghan Ltd. 1989 (1) \$56 638 (ER 438) [LSW]

050 Quantifying infiltration Through Municipal Solid Waste Landfill Covers. Dr. K McKague, Ecologistics Ltd. 1989 (2) \$121 990 (ER 440) [LSW]

Quantification of Infiltration Through Landfill Covers. McKague, K.J., Ecologistics Ltd. 1991. 40 Pp. (RAC)

051 Preparation of a Handbook of Practical Guidelines for the Monitoring of Waste Disposal Sites. Dr. E. Rosinger, Canadian Council of Ministers of the Environment. 1989 (1) \$15 000 (ER 448) [LSW]

052 Ontario Hydrobiotite-Vermiculite as a Potential Landfill Liner and Adsorbent. Dr. L. Curtis, Curtis & Associates Inc. 1990 (1) \$47 735 (ER 485) [LS W]

Ontario Hydrobiotite-Vermiculite as a Potential Landfill Liner Material and Adsorbent of Organic and Inorganic Pollutants. Farka, H. and Curtis, L.W., Curtis & Associates Inc., and Yong, R. and Mohamed, A., McGill University. 1991. 74 pp. (RAC)

053 Accurate Control Testing for Clay Liner Permeability.

Dr. R. Mitchell, Queen's University. 1990 (1) \$12 600 (ER 506) [LSW]

Accurate Control Testing of Clay Liner Permeability. Mitchell, R.J., Queen's University. 1990. 57 Pp. (RAC)

GROUNDWATER CONTAMINATION

1991/92 Projects

054 Development of a Hydrologic Model to Predict the Environmental Fate of De-icing Salts

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The development of a hydrologic salt and water balance model that will predict, on a catchment scale, the longterm environmental fate of road de-icing chemicals was the objective of this project. Performance of a mass balance approach to the Highland Creek basin in Toronto has revealed that only 45% of the salt applied annually to the catchment is being removed by surface runoff. Calculations suggest that the average chloride concentrations in groundwaters underlying the basin may therefore eventually reach 426 mg/L. A similar chloride concentration can be expected in stream baseflow, representing a 3-fold increase over present baseflow concentrations. The value of 426 mg/L is nearly twice the drinking water quality objective of 250 mg/L (aesthetic objective).

5/1988 (3) \$98 650 (ER 356) [WQ]

055 The Origin and Distribution of Methane In the Alliston Aquifer

Dr. James Barker

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The objective of this project was the identification of both the origin of methane in the Alliston sand aquifer and the geochemical and hydrogeological factors controlling its distribution. Results suggest that microbial processes (methanogenesis) within certain parts of the aquifer, encouraged by the availability of a rich carbon source, are responsible for methane formation in this aquifer. Distribution of the methane appears to be controlled by migratory transport in groundwater from these production zones to different parts of the aquifer. This contrasts with other parts of Ontario where leakage or migration of methane from permeable limestone bedrock is the source.

10/1987 (3) \$63 175 (ER 383) [WQ]

Final Report Received (REV)

056 Measuring Groundwater Velocity and Hydrodynamic Dispersion In a Single Fracture in Fractured Shale

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Detailed characterization of a fracture zone in shale at a site near Clarkson, Ont.; is being undertaken with a view to developing new hydraulic and tracer testing techniques for more accurately determining the parameters necessary for predicting groundwater velocity. Recent evidence suggests considerable uncertainty in the accuracy of predictions of groundwater velocity along such fracture planes. As these fractures may be a dominant pathway for the subsurface migration of contaminants in low permeability rocks, accurate measurements are essential in determining the potential for contaminant transport from nearby waste and industrial sites.

6/1988 (3) \$120 000 (ER 393) [LSW]

057 *In situ* Biodegradation of Chlorinated Solvents as a Remedial Technology for Contaminated Groundwater

Dr. David Major

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The factors and processes governing the *in situ* transformation and degradation of tetrachloroethylene in the groundwater at a chemical transfer facility were investigated in this project. Laboratory and field data indicate that tetrachloroethylene is undergoing anaerobic microbial dechlorination to dechlorinated products and vinyl chloride. The vinyl chloride appears to be further dechlorinated to ethene gas at a rate sufficient to contain the vinyl chloride plume in an aquifer of low permeability. Anaerobic transformation of tetrachloroethylene may therefore be an attenuating mechanism and could be exploited in remediation of the site. Further work is aimed at understanding the underlying physical, geochemical and microbial processes that promote these reactions.

5/1989 (2) \$80 000 (ER 441) [WQ]

Final Report Received (REV)

058 Groundwater Impact from Large Septic Systems for Sewage Disposal in Ontario

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This project has involved the study of contaminant attenuation processes in large septic systems and the development of a method to predict the extent of aquifer contamination near new large septic systems. Monitoring of a shallow sand aquifer impacted by a large-flux septic system indicated that effluent ammonium is largely oxidized to nitrate in the unsaturated zone. High nitrate levels disappeared in the down-gradient anaerobic plume core zone apparently as a result of denitrification. The persistence of nitrate along the aerobic upper fringe of the plume, however, demonstrates the ability of such septic systems to cause significant water-quality degradation of sand aquifers when conditions are not favourable for denitrification.

5/1989 (3) \$195 000 (ER 444) [WQ]

059 Bias Due to Sampling Groundwater and Surface Water for Trace Organic Contaminants

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An examination of two critical sources of bias when sampling waters for fixed gases and organic compounds was the focus of this study. Volatilization losses of such gases as methane, benzene and toluene were evaluated by comparing six different sampling systems. Sorption of hydrophobic organics onto well casing and/or sampling material was tested with four materials, polyethylene (control), polytetrafluorethylene, rigid polyvinylchloride and stainless steel, the latter three materials being commonly used in sampling surface and ground water for organic contaminants. Various chlorobenzene and chlorobiphenyl compounds were considered. Information from this study will contribute to the development of improved protocols for sampling ground and surface waters for organic contaminants.

5/1989 (1) \$46 750 (ER 449) [WQ]

Bias Due to Sampling Groundwater and Surface Waters for Organic Contaminants. Hoff, J., Arthur, C., Baerg, D.,

Barker, J.F. and Gillham, R.M., University of Waterloo.
1992. 20 Pp. (RAC)

060 Determination of Hydrogeological and Contamination Transport Properties of Fractured, Weathered Leda Clay in Eastern Ontario

Mr. Norm Castonguay

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In this study, the hydrogeologic properties of the weathered fractured zone of the otherwise impervious Leda clay deposit in Eastern Ontario are being defined through monitoring and field testing of physical properties, contaminant migration and groundwater flow. With the possibility of burial of waste in this area, characterization of such hydrogeologic properties is essential as the presence of an active fracture network could provide a lateral and vertical pathway for contaminant migration. The project will also allow the determination of the thickness of clay beneath a disposal site that is necessary to ensure sufficient protection of underlying aquifers.

10/1989 (2) \$79 159 (ER 466) [LSW]

061 Impact of Livestock Manure and Fertilizer Application on Nitrate Contamination of Groundwater

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This projects focus is on evaluating the amount of nitrate and dissolved organic carbon (DOC) leaving the root zone as influenced by nitrogen source (ammonium nitrate, solid beef cattle manure and liquid dairy cattle manure) and rate of application. Manures may provide more dissolved DOC to promote the denitrification process below the root zone thereby lessening the contribution of nitrate to groundwater contamination. The effect of time of manure application on crop response and nitrate movement to the groundwater is also being considered. This information will be important in determining maximum environmentally safe application rates of manures and fertilizers to land on livestock farms in Ontario.

11/1991 (3) \$212 690 (ER 488) [WQ]

062 The Use of Environmental Isotope Surveys In Assessing Contamination Potential for "Confined" Aquifers

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This project demonstrates the usefulness of regional environmental isotope surveys in assessing contamination potential for confined aquifers. Parts of the confined overburden aquifer in Essex County are covered by thick clayey overburden and are remote from obvious recharge areas, yet regional tritium data indicate very recent recharge. A linear morphological feature, reported to be a buried esker, is the suspected locale of the recent recharge (and therefore a potential contaminant pathway) for this aquifer. Preliminary drilling and isotopic results confirm the presence of the feature, corroborate the regional isotopic data, and indicate unusually rapid vertical recharge over the feature.

5/1990 (2) \$50 972 (ER 500) [WQ]

063 Determination of Geochemical Modification of Groundwater Entering Surface Waters from an industrial and a Municipal Disposal Site

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The changes in chemistry and flux of heavy metal ions and such compounds as phenols in the biogeochemical transition zone existing at or near the sediment/water interface of discharge zones are being determined in this project. Without consideration of the potential reactions occurring in this geochemical interface, it is not possible to predict solute fluxes from zones of onshore groundwater contamination to contiguous surface waters. Field studies near a steel plant and municipal landfill, and controlled laboratory tests using large seepage tanks are all included.

5/1990 (2) \$36 215 (ER 510) [WQ]

064 Reduction of Nitrogen Losses from Animal Manures by Stabilization with Ammonium Adsorbing Minerals

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This project is investigating the use of various adsorbent minerals to reduce the loss of ammonia from animal waste systems, particularly, confined livestock buildings. The use of such naturally occurring clay materials as bentonite, zeolite and vermiculite, with their high adsorption and exchange capacities, offers potential to increase the nutrient value of animal manures and reduce contamination of ground and surface waters by retaining ammonia in a non-mobile form. This simple system using readily available materials could be implemented immediately in many Ontario livestock operations.

6/1991 (2) \$71 790 (ER 540) [LSW]

065 Enhanced *In situ* Bioremediation of Groundwater Contaminated with Chlorinated Solvents Using a Permeable Nutrient Delivery Wall

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A bioremediation method for treating such dissolved chlorinated solvents as carbon tetrachloride and tetrachloroethene is being developed. The technique involves the degradation of target contaminants in the soil by the stimulation of indigenous organisms. For chlorinated solvents which biotransform under anaerobic conditions, for example, selected nutrients and/or substrates could be injected into the contaminant plume to impose favourable localised reducing conditions for microbial degradation. A suitable biological decontamination method would be extremely valuable as chlorinated solvents can pose a particular remediation problem with their deep penetration of aquifers.

6/1991 (3) \$72 500 (ER 546) [LSW]

066 Susceptibility of Groundwater to Contamination: A Case Study with Policy implications

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This project is a case study on the susceptibility of the middle Grand River valley to groundwater contamination. Current knowledge of the geological characteristics that control the occurrence of groundwater in the region is being assimilated with newly acquired data. Past and present land use in the region is being documented to illustrate the relationship between land use and groundwater contamination and to estimate the level of infiltration and migration of contaminants from various land uses. Recommendations concerning legislation and policies regarding the management of groundwater in Ontario will also be offered.

5/1991 (1.5) \$185 000 (ER 564) [WQ]

067 Hydrogeology of the Oak Ridges Moraine

Dr. Ken Howard

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This project is a comprehensive, regional scale study of the geology and hydrogeology of the Oak Ridges Moraine aimed at generating a detailed hydrostratigraphy; understanding hydrogeologic behaviour; and developing a ground flow model for the Moraine. The model will permit identification of the potential contaminant pathways, and assessment of potential impacts of land use and climate change on groundwater contribution to river headwater areas and wetlands.

6/1991 (3) \$218 500 (ER 578) [WO]

068 Nitrate Persistence in Slightly Permeable Sediments in Ontario

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This field investigation is of the mobility and persistence of nitrate within slightly permeable overburden materials in Southern Ontario. Confined aquifers overlain by these aquitards, which are the major source of drinking water for such communities as Guelph and Kitchener, are vulnerable to nitrate contamination from septic system discharges and agricultural practices. Slightly permeable deposits may promote attenuation of nitrate by such biodegradation reactions as denitrification whereby nitrate is converted to nitrogen gas. This study will increase the understanding of the fate of nitrogen loaded in the subsurface and provide a more advanced scientific basis on which to manage the problem of groundwater contamination in Ontario.

6/1991 (3) \$169 500 (ER 581) [WQ]

069 Groundwater Recharge and Contamination: Sensitivity Analysis for Carbonate Aquifers In Eastern Ontario Using the Jock River Basin

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The Jock River basin is a heavily exploited carbonate aquifer, typical of eastern Ontario. This study involves the monitoring of a series of groundwater wells and river gauging sites to determine whether short or long term (seasonal) variations occur, and to calculate groundwater mean residence times (age of groundwaters). Strong variations in isotopes and young groundwater ages would suggest that little attenuation or mixing of recharge events occurs, that flow paths are short, and groundwaters are vulnerable to contamination from development activities in the recharge environment. A better understanding of the sustainability of groundwater-resources in this basin is essential to any development plan for the region.

5/1992 (2) \$10 730 (ER 627) [WQ]

Previous Projects

070 An investigation of the Environmental Health Hazards Associated with Road Oiling. Mr. Guillaume, L.S. Love & Associates Canada Ltd. 1977 \$136 100 (ER 05) [LSW]

Report on The Environmental Effects of Waste Oil as a Road Dust Suppressant. Jones, G.A., L.S. Love & Associates Canada Ltd. 1978. 52 Pp. (BLO)

071 investigations of Nitrate Distribution and Nitrogen Transformations in a Shallow, Sandy Aquifer near Allston, Ontario. Dr. R. Gillham, University of Waterloo. 1982 \$141 100 (ER 62) [WQ]

Studies of Nitrate Distributions and Nitrogen Transformations in Shallow Sandy Aquifers. Starr, R.C. et al., University of Waterloo. 1987.49 Pp. (BLO)

072 Assessing the Impact of Hazardous Liquids Spilled onto Soil. Dr. G. Farquhar, University of Waterloo. 1984 \$141 800 (ER 104) [LSW]

Assessing the Impact of Hazardous Immiscible Liquids in Soil. Farquhar, G.J., McBean, E.A. and Pearson, R.G., University of Waterloo. 1990. 85 Pp. (BLO)

073 Road Dust Suppressant Study. Dr. R. Gillham, University of Waterloo. 1984 \$22 500 (ER 130) [LSW]

Application of Industrial Liquid Waste to Secondary Roads in Ontario for Dust Control: Implications with Respect to Groundwater Quality. Gillham, R.W. et al., University of Waterloo. 1985. 77 Pp.

074 Investigation of the Distribution, Origins and Behaviour of Local Shallow Groundwaters Containing Elevated Concentrations of Chloride. Dr. K. Howard, University of Toronto. 1984 \$80 600 (ER 145) [WQ]

Distribution, Origins and Behaviour of Local Groundwaters Containing Elevated Concentrations of Chlorides. Howard, K.W.F., University of Toronto. 1988. 58 Pp. (RAC)

075 Development and Validation of Protocols for Sampling Surface and Groundwaters for Volatile Organic Contaminants. Dr. J. Barker, University of Waterloo. 1984 (2) \$21 600 (ER 148) [WQ]

Sampling Groundwaters and Surface Waters for Volatile Organic Contaminants. Barker, J.F., McAlary, T.A. and Travis, G.M., University of Waterloo. 1987. 85 Pp. (LQO)

076 Groundwater/Phosphorous Leaching Studies. Dr. Thomas, University of Guelph. 1984 \$5 420 (ER 186) [WQ]

077 Evaluation of Contaminant Velocity Groundwater in Low-Permeability Fractured Shale. Dr. J. Cherry, University of Waterloo. 1985 (3) \$90 000 (ER 214) [LSW]

Evaluation of Contaminant Velocity in Low-Permeability Fractured Shale. Cherry, J. et al., University of Waterloo. 55 Pp.

078 Township of Ignace Groundwater Quality identification. Mr. D. Tumball, International Water Supply Ltd. 1986 (1) \$45 600 (ER 252) [LSW]

079 Method for the Removal of Organic Compounds from Ground Water. Dr. D. Smith, Water and Earth Science Associates Ltd. 1987 (1) \$15 000 (ER 291) [WQ]

Low Cost Treatment Technology for Gasoline Contaminated Groundwater-Delta, Ontario. Woeller, R.M., Devlin, J.F. and Keil, T.R., Water and Earth Science Associates Ltd. 1989. 18 Pp. (RAC)

080 The Mobility and Persistence of Selected Organic Solutes In Anaerobic Groundwater and Possible In situ Remediation. Dr. J. Barker, University of Waterloo. 1987 (3) \$378 900 (ER 330) [LSW]

The Mobility and Persistence of Selected Organic Solutes in Anaerobic Groundwaters and Possible Remediation Measures. Barker, J.F., University of Waterloo. 1991. 27 Pp. (BLO)

081 The Carbon and Sulfur Cycle in Shallow, Unconfined Aquifer Systems. Dr. R. Gillham, University of Waterloo. 1987 (2) \$68 335 (ER 382) [WQ]

Final Report Received (REV)

082 A Study of Geochemical Modification of Groundwater Discharging Into Surface Waters from an Industrial Disposal Site. Dr. D. Lee, University of Waterloo. 1988 (2) \$29 050 (ER 392) [LSW]

CONTAMINATED SITE REMEDIATION

1991/92 Projects

083 Development and Demonstration of Permanent On-Site Solutions for Hazardous Waste Site Rehabilitation and Restoration at an Organic Chemical Plant

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Through a review of state of the state-of-the-art and 'emerging' technologies for organic contaminant behaviour modelling and treatment, selected technologies are being developed and demonstrated on a field scale at the Uniroyal Chemical manufacturing plant at Elmira, Ont, a location that typifies organic contamination problems at waste disposal and industrial sites. Emphasis in the project is on selecting treatment technologies and developing a rehabilitation management model that will also have wide application to the many other similar sites in Canada.

10/1987 (3) \$401 590 (ER 368) [LSW]

084 Retractable Absorbents for Environmental Clean-Up: Commercialization Program and Field Trials

Dr. Hillar Auski

Eco Corporation (disbanded)

The effectiveness of using crosslinked ethyl absorbent beads for the retrieval of chemical spills from underwater sites was demonstrated in this project. Absorbent mats placed on the bottom of the St Clair River proved successful in absorbing pools of perchloroethylene remaining from the major spill at this location in 1985. The mats were easily placed and retrieved from the river bottom and were able to maintain their integrity under the conditions existing on the bed of this fast flowing river. The technique was also effective in absorbing other chemicals that were either associated with the spill or were present in the river sediment from previous discharges.

6/1989 (1) \$97 340 (ER 456) [WQ]

Final Report Received (REV)

085 Nonaqueous Phase Liquid Removal from Soil and Rock

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The objective of this research is to identify and quantify technologies which may be suitable for application to the removal of non-aqueous phase liquids (NAPLs) from soil and fractured rock. Various methods including dissolution and flushing, heating and chemical oxidation have been considered. One method showing particular promise at both the laboratory and field scale involves the *in situ* oxidation of perchloroethylene and trichloroethylene by flushing potassium permanganate through the contaminated zone. Given the number and severity of NAPL in rock problems in North America, the development of reliable clean up-methods would be of much interest to concerned corporations and regulatory agencies.

5/1990 (2) \$160 000 (ER 477) [LSW]

086 Characterization and Biotechnical Uses of the Extracellular Emulsifying Agent Produced by *Pseudomonas aeruginosa*

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This project involves the characterization of extracellular biosurfactants produced by *Pseudomonas aeruginosa* UG2, and the evaluation of their potential for use in the remediation of contaminated soil. Partitioning studies have shown that significant amounts of hydrocarbons such as tetra- and hexachlorobiphenyl and naphthalene can be removed from soil using partially purified UG2 surfactant, as well or better than the chemical detergent SDS. Further studies focussing on the removal of hydrocarbons from soil columns using this bio-emulsifier and an investigation of the use of the compound to enhance microbial degradation of hydrocarbons in a soil environment are planned.

5/1990 (3) \$141 900 (ER 496) [MMCB]

087 An Experimental Research Study on Methods of Revegetating the Kam-Kotla Tailings Site

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The Kam-Kotia mine/mill site is an area of 275 hectares covered to varying degrees with sulphide-rich acid-generating tailings. An evaluation of revegetation as a low-cost alternative to expensive mechanical and technical solutions for the closing out of this site is the focus of this project. Preliminary results suggest that the use of such cover materials as loam or gravel covering topped with loam and incorporating such neutralizing agents as ground dolomitic limestone is successful as a means of counteracting the upward movement of acidic water. Successful transplanting of metal-tolerant ecotypes of such native species as dwarf beech and tufted hairgrass also appears possible.

8/1990 (1) \$12 000 (ER 515) [LSW]

088 Remediation of Volatile Organic Compounds In Porous Media

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Such volatile organic compounds as gasoline can be present in both the gas and water phase of the unsaturated zone, as well as in solution in the saturated zone. They can also exist as a separate immiscible phase. Utilizing laboratory studies and numerical model simulations, this investigation is of the movement of volatile organic compounds in and between the saturated and unsaturated zones of porous media. This understanding of transport mechanisms is essential to the design and improvement of groundwater remediation systems for such compounds.

6/1991 (3) \$145 410 (ER 541) [LSW]

089 Chemical Oxidation of Coal Tar Residuals Below the Water Table

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This project is a critical evaluation at the laboratory scale of *in situ* remediation of such representative coal tar organic compounds as polynuclear aromatic hydrocarbons and phenolics using such strong oxidizing chemicals as peroxide and permanganate. Identification of those compounds able to be oxidized and those resistant along with the approximate rates and products of oxidation would then be the basis for an evaluation of the methodology using actual coal tars. The application of this methodology under actual field conditions could then be assessed.

6/1991 (2) \$68 500 (ER 542) [LSW]

090 Heavy Metals in Soils - A Multimedia Risk Assessment Model for Regulatory Use.

Dr. Marsha Sheppard

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This study involved an assessment of the performance of the Soil Chemical Exchange and Migration of Radionuclides (SCEMR) model with the objective of demonstrating its usefulness in assessing soil remediation techniques and its role in multi-media risk assessment. The basis of the assessment was data from real or likely scenarios dealing with heavy metal contamination in Ontario soils. Use of the SCEMR model for this purpose would fill the need for a means of reliably predicting the fate of heavy metal migration in the surface environment. The model would have application in such areas as indicating the expectations of remedial measures and the selection of appropriate remedial measures for existing-contaminated sites.

7/1991 (1) \$31 115 (ER 556) [MMCB]

Heavy Metals in Soils - A Multimedia Risk Assessment Model for Regulatory Use. Sheppard, M.I. and Hawkins, J.L. AECL Research. 1992. 62 Pp. (PUB)

091 Remote Detection of Hydrocarbon Fuel Contaminants in the Subsurface

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This study provides a sound physical basis for evaluating the effectiveness of electrical property based geophysical methods and improving the survey data obtained with their methods as related to the detection of hydrocarbon contamination of soil, including those from a spill site. By determining typical electrical properties signatures of normal and hydrocarbon fuel contaminated soils, it is possible to assess the applicability of ground penetrating radar and conductivity mapping techniques to the detection of hydrocarbon fuel contaminants in soil. The interpretation of survey data collected with these field techniques can also be improved.

5/1991 (1.5) \$52 145 (ER 561) [WQ]

092 Characterization of Contaminant Migration Processes In Fractured Geologic Media and Numerical Analysis of Pump-and-Treat Remediation

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This project will make use of sophisticated numerical models recently developed by the researchers in order to: 1) shed new light on processes controlling contaminant transport in complex-structured geologic media; 2) examine optimal strategies for contaminant plume detection and monitoring; 3) demonstrate the effectiveness of pump-and-treat strategies to remediate contaminated groundwater in fractured media; and 4) examine prediction uncertainty and data worth issues. This will lead to an improved understanding of the contaminant fate and pathways in fractured geologic systems and permit management decisions to be made regarding the effective application of pump-and-treat remediation processes in areas of Ontario with fractured geologic media.

5/1992 (2) \$119 433 (ER 596) [WQ]

093 PCP Catabolic Activity of *Pseudomonas resinovorans*

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This study is an investigation of the biochemical and physiological basis of PCP biodegradation in a PCP-degrading strain of *Pseudomonas resinovorans*. As bioremediation is becoming an increasingly attractive alternative for remediating contaminated sites, such information is important in order to understand the kinetics of the process as well the potential for production of toxic by-products of transformation. Better understanding of the metabolic pathways involved in microbial degradation will also assist in the design of rational bioremediation approaches.

5/1992 (1) \$25 000 (ER 603) [MMCB]

094 Soil Remediation Using Supercritical Fluid Extraction

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University of Guelph
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The use of Supercritical Fluid Extraction (SFE) is proposed as an alternative remediation technology for the removal of immiscible organic petroleum compounds from contaminated soil. In SFE, contaminated soil is exposed to supercritical carbon dioxide which acts as a solvent and extracts the organic contaminant from the soil, leaving no residue. The specific objective of this study is to experimentally determine the distribution coefficient and mass transfer coefficients for petroleum products in a supercritical carbon dioxide - soil system as a function of the supercritical conditions and soil type. These coefficients are essential for the design of a SFE system and to estimate the cost and timing involved in a given cleanup situation.

5/1992 (1) \$16 000 (ER 617) [LSW]

Previous Projects

095 Replacement of Lead Contaminated Soil Around Three Secondary Lead Smelters. Canada Metals Company. 1977 \$82 980 (ER 01) [LSW]

Contamination of Vegetation and Soil by Lead and Other Elements in the Vicinity of the Canada Metal Company, Eastern Avenue, Toronto - 1983, 1984, 1985. Rinne, R.J., Air Resources Branch, Ontario Ministry of the Environment. 1986. 5 Pp. (BLO)

096 Environmental Clean-Up of Inactive and Abandoned Mining Properties. Mr. Rhodes, Ontario Ministry of the Environment. 1977 \$125 000 (ER 02) [LSW]

The Chemical Characteristics of Mineral Tailings in the Province of Ontario. Hawley, J.R., Waste Management Branch, Ontario Ministry of the Environment. 1979. 234 Pp. (BLO)

097 PCB Clean-Up and Assessment near Dowling, Ontario. Mr. L. Fitz, Ontario Ministry of the Environment. 1977 \$64 200 (ER 09) [LSW]

Hydrodynamic Containment for the PCB Spill near Dowling, Ontario. Meneley, W.A., W.A. Meneley Consultants Ltd. 1979. 29 Pp. (BLO)

098 Retractable Composite Adsorbents for Environmental Clean Up. Dr. A. Redpath, Ecoplastics Ltd. 1986 (1) \$29 600 (ER 257) [AMID]

099 Behaviour, Detection and Control of Hazardous immiscible Liquid Movement in Soil. Dr. G. Farquhar, University of Waterloo. 1987 (3) \$169 200 (ER 334) [LSW]

100 Retractable Composite Adsorbents for Environmental Clean-Up. Dr. A. Redpath, Ecoplastics Ltd. 1987 (1) \$152 582 (ER 375) [AMID]

Retractable Composite Adsorbents for Environmental Clean-Up. Gillies B., Ecoplastics Ltd. 1989. 120 Pp. (BLO)

MUNICIPAL WASTES AND EFFLUENTS

1991/92 Projects

101 The Effectiveness of a Stormwater Management Pond in the Removal of Urban Contaminants from Stormwater

Dr. Edgar Watt

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Department of Civil Engineering
Queen's University
Kingston, Ont. K7L 3N6

This study involves the Monitoring of an existing on-line stormwater management control pond in Kingston township with the objective of ascertaining the pond's ability to remove such waterborne contaminants as bacteria, nutrients, metals and suspended solids. The work program includes the gathering of three seasons of water quantity and quality data, the modelling of the water and contaminant balance for storm runoff events to study pond behaviour and the contaminant removal effectiveness of the pond, and the making of recommendations for improving future stormwater management ponds for contaminant removal.

4/1990 (3) \$89 600 (ER 491) [WQ]

102 Fate of Contaminants In Municipal Pollution Control Plants

Dr. Donald Mackay

(416) 978-4019

Institute for Environmental Studies
University of Toronto
Toronto, Ont. M5S 1A4

Collection, analysis and mathematical modelling of data on the fate and removability of hazardous compounds in municipal water pollution control plants with a view to developing a validated generic model of chemical fate is the goal of this project. The new model, an extension of an existing steady state version, will include the latest Quantitative Structure Activity Relationships for prediction of degradability as well as consider unsteady state (transient) conditions. It could be used to provide guidance to the ministry, municipalities and industry about the likely fate of new and existing hazardous chemicals in treatment facilities, and assist in the design of sewage treatment plant Monitoring schemes.

5/1991 (1.5) \$39 000 (ER 559) [WQ]

103 Fate of Volatile Organic Compounds In Wastewater Collection Systems

Dr. Richard Corsi
(416) 824-4120
School of Engineering
University of Guelph
Guelph, Ont. N1G 2W1

The study of gas-liquid transfer, biodegradation and adsorption of volatile organic compounds (VOCs) in operating sewers through field experiments and computational analysis is featured in this undertaking. Data from field sampling will be used in the development and evaluation of a VOC fate model for wastewater collection systems. The model could be used to identify combinations of sewer characteristics, wastewater flow and fluid properties, gas ventilation patterns and VOC properties that lead to significant VOC emissions from such sources, and have application in the development and implementation of VOC discharge and control strategies.

6/1991 (3) \$161 524 (ER 577) [WQ]

104 Documentation of the Biological Community of Polishing Ponds (Sutton Concept Sewage Treatment System)

Mr. Jeff Graham
(519) 376-7612
Henderson, Paddon Environmental Inc.
Suite 212, 945 Third Ave. E.
Owen Sound, Ont. N4K 2K8

This project involves the seasonal description of the biological community in the polishing pond in the "Sutton Concept" sewage treatment system. The biological community in the polishing pond, which receives waste activated sludge from the primary water pollution control plant, may play a key role in production of high quality effluent. The study will provide initial information on the possible impact of this community of treatment plant upset, sewage by-pass or overloaded conditions. This enhanced knowledge of the key plant and animal species that develop in such ponds will be valuable as this type of treatment system becomes an increasingly popular option for small municipalities.

6/1991 (1) \$66 240 (ER 583) [WQ]

105 Performance Review of Perforated Pipe-Grass Swale Stormwater Drainage System

Mr. Jean-Francois Sabourin
(613) 523-6100

Paul Wisner & Associates Inc.
Suite 309, 1800 Bark St.
Ottawa, Ont. K1V 0W3

A systematic analysis and review of the performance of grass swales used in combination with perforated pipes for the reduction of stormwater run-off through consultation, literature review, and laboratory and field testing is central to this project. The study will determine if such a system, when installed in a semi-rural subdivision, results in reduced runoff quantity and hence pollutant loadings to receiving waters by infiltrating the first few centimetres of rainfall. Such a system could be a cost effective alternative to such techniques as wet ponds for stormwater management if found to be suitable for Canadian conditions.

7/91 (1) \$73 034 (ER 585) [WQ]

106 Hybrid Constructed Wetland Marsh for Sewage 'Polishing'

Dr. Edgar Lemon
(416) 468-7138

The Friends of Fort George
P.Q. Box 1323
Niagara-on-the-Lake, Ont. L0S 1J0

This small short-term pilot project is intended to test new design ideas to increase wintertime oxygen supply in marsh rootbeds, thus improving sewage effluent 'polishing' characteristics. The pilot cells to be used incorporate underdraining to promote horizontal and vertical fluid flow. This feature, plus periodic flooding and draining, increases root bed aeration from both top and bottom. This research should contribute to understanding methods of using constructed wetlands as a year round sewage treatment option in Ontario, with low capital and maintenance costs and favourable environmental impact.

5/1992 (1) \$12 600 (ER 597) [LSW]

Previous Projects

107 Disposal of Sewage Sludge on Agricultural Land. Dr. T. Bates, University of Guelph. 1978 \$358 100 (ER 12) [LSW]

108 Effects of Applying Digested Sewage Sludges to Agricultural Land: Lysimeter Studies. Mr. R. Rush, Rush Engineering. 1978 \$105 000 (ER 13) [LSW]

109 Development of an Experimental Marsh Treatment Facility at Listowel, Ontario. Mr. Fisher, Town of Listowel. 1978 \$200 000 (ER 18) [LSW]

Listowel Artificial Marsh Project Report. Herskowitz, J., Town of Listowel. 1986. 253 Pp. (LQO)

110 Effect of Hydraulic Characteristics and Effluent Chlorination on the incidence of Microorganisms of Public Health Significance in Waters Receiving Sewage Treatment Plant Effluents. Mr. S. Hodd, Beak Consultants Ltd. 1979 \$202 700 (ER 28) [WQ]

The Effects of Hydraulic Characteristics and Effluent Chlorination on the incidence of Microorganisms of Public Health Significance in Receiving Waters. Hodd, S., IEC Beak Consultants Ltd. 1982. 93 Pp. (BLO)

111 Kennedy-Burnett Urban Stormwater Runoff Treatment Study (in Conjunction with ER 37). Regional Municipality of Ottawa. 1979 \$100 000 (ER 30) [WO]

Rideau River Stormwater Management Study. Gietz, R.J., Regional Municipality of Ottawa-Carleton. 1983. 256 Pp. (BLQ)

112 Rideau River Stormwater Management Study, Ottawa, Ontario (in Conjunction with ER 30). Regional Municipality of Ottawa. 1980 \$750 000 (ER 37) [WQ]

Report on Rideau River Stormwater Management Study-Phase I. Anderson, J. and Perks, A.R., Gore & Storrie and Proctor & Redfern respectively. 1981. 197 Pp. (BLO)

Report on Rideau River Stormwater Management Study - Phase II. Anderson, J. and Rowney, A.C., Gore & Storrie and Proctor & Redfern respectively. 1983..124 Pp. (BLO)

113 Compilation of Summation Report on Nine Years of Research Studies on the Disposal of Sewage Sludge on Agricultural Land. Dr. T. Bates, University of Guelph. 1981 \$11 500 (ER 46) [LSW]

Land Disposal of Sewage Sludge. Soon, Y.K. and Bates, T.E., University of Guelph. 1981. 167 Pp. (BLO)

114 Application of Ultraviolet Disinfection Technology in Ontario WPCP Effluents. Standard Biological Labs Ltd. 1981 \$40 800 (ER 54) [WQ]

115 Assessment of the Potential for Dissemination of Environmental Contaminants by Treatment of Waste Water in Lagoon Systems. Mr. Neil, Limnos Ltd. 1982 \$5 800 (ER 57) [WQ]

Environmental Significance of Sewage Lagoons in Ontario. Neil, J.H. and Kamaitis, G., Limnos Ltd. 1982. 42 Pp. (BLO)

116 Removal of Selected Hazardous Contaminants In a WPCP. Mr. R. Rush, Canviro Consultants Ltd. 1982 \$58 600 (ER 65) [WQ]

Removal of Hazardous Contaminants in the Hamilton WPCP. Rush, R., Canviro Consultants Ltd. 1987. 82 Pp.

117 Development of an Efficient Protocol for Routine Analyses of Organic Trace Contaminants in Municipal Raw Sewage and Final Effluents. Ms. C. Chan, Mann Testing Laboratories Ltd. 1984 \$180 000 (ER 96) [WQ]

118 Evaluation of Data of Project ER 28 - "Effects of Hydraulic Characteristics and Effluent Chlorination on the incidence of Microorganisms of Public Health Significance in Receiving Waters", Mr. M. Palmer, Gore & Storrie Ltd. 1984 \$26 900 (ER 105) [WQ]

Evaluation of Data on the Effects of Hydraulic Characteristics and Effluent Chlorination on the incidence of Micro-Organisms of Public Health Significance in Receiving Waters. Palmer. M., Gore & Storrie Ltd. 1988. 64 Pp. (LQO)

119 Development of an Artificial Marsh Treatment Facility at Listowel, Ontario. Mr. Fisher, Town of Listowel. 1984 \$31 500 (ER 128) [WQ]

Town of Listowel - Artificial Marsh Project. Fisher, Town of Listowel. 138 Pp.

120 Update of Storm Water Management Model. Dr. Wisner, University of Ottawa. 1984 \$45 000 (ER 132) [WQ]

121 Biological Phosphorus Removal. Dr. B. Jank, Canadian Centre for Inland Waters. 1984 (1) \$20 000 (ER 137) [WQ]

122 The Fate of Hazardous Organic Compounds in Municipal Water Pollution Control Plants. Dr. J. Henry, University of Toronto. 1984 (3) \$60 000 (ER 149) [WQ]

A Model of Organic Chemical Fate in a Biological Wastewater Treatment Plant. Clark, B., Mackay, D., Tasfi, L, Henry, G.L.H and Salenieks, S., University of Toronto. 1989.45 Pp. (RAC)

123 Development of a Toronto Urban Runoff Prediction and Control Evaluation Model. Dr. Osmond, Gartner Lee Associates Ltd. 1984 \$49 800 (ER 160) [WQ]

124 Comprehensive Analysis of Activated Sludge Aeration Devices including Health-Related Factors. Mr. J. Ganczarczyk, Ganczarczyk and Associates. 1984 \$9 300 (ER 181) [WQ]

125 Grit Removal at Sewage Treatment Plants Using a Low Pressure Hydrocyclone. Dr. J. Boadway, Queen's University. 1985 \$27 000 (ER 184) [WQ]

A Special Hydrocyclone Designed for Sewage Treatment. Boadway, J.D., Queen's University. 1988. 58 Pp. (BLQ)

126 Pre-Feasibility Study on Expansion and Upgrading of Port Dover Sewage Treatment Plant. Mr. C. Papadopol, MacLaren Plansearch. 1985 \$30 000 (ER 185) [WQ]

Municipal Waste Recycling Through Forest Plantation Technology for Port Dover, Ontario. Papadopol, C.S., MacLaren Plansearch. 1985. 47 Pp. (BLQ)

127 Continuous Emission Monitoring for Total Hydrocarbon at Sewage Sludge incinerators. Mr. J. Kosch, Amco Consultants. 1985 (1) \$3 000 (ER 190) [WQ]

128 Evaluation of Native Marsh Plant Species for Treatment of Domestic Sewage. Mr. J. Neil, Limnos Ltd. 1985 \$61 200 (ER 205) [WQ]

The Evaluation of Native Marsh Plant Species for the Treatment of Domestic Sewage. Neil, J.H. and Graham, J.T., Limnos Ltd. 1988. 48 Pp. (RAC)

129 Sewage Sludge Compost. Dr. J. Eggens, University of Guelph. 1985 (4) \$70 100 (ER 218) [LSW]

130 Demonstration of the Phoredox Process at Lakeview WPCP. Mr. J. Timko, South Peel Water and Sewage Systems. 1986 (1) \$25 000 (ER 243) [LSW]

131 Treatment of Municipal Sewage Lagoon Effluent by Means of Rapid infiltration at Markdale. Mr. E. Foy, Village of Markdale. 1986 (1) \$25 000 (ER 262) [LSW]

132 Improvements to the "OPTSOR" Program for Determining Optimum In Storage Requirements in Overloaded Sewer Systems. Dr. S. Zemell, MacLaren Plansearch. 1986 (1) \$21 000 (ER 266) [WQ]

Optstor User's Manual. Zemell, S.H., MacLaren Plansearch Inc. 1988.37 Pp. (RAC)

133 Characterization of the Fecal indicator Bacterial Flora of Sanitary Sewage with Application to identifying the Presence of Sanitary Waste in Storm Sewers. Dr. P. Seyfried, University of Toronto. 1986 (2) \$176 800 (ER 274) [WQ]

Characteristics of the Fecal indicator Bacterial Flora of Sanitary Sewage with Application to identifying the Presence of Sanitary Waste in Storm Sewers. Seyfried, P. and Bleier, T., University of Toronto. 1991. 329 Pp. (RAC)

134 Klebsiella pneumoniae Membrane Filtration Procedure. Dr. P. Seyfried, University of Toronto. 1986 (1) \$62 800 (ER 276) [AMID]

Klebsiella pneumoniae Membrane Filtration Procedure. Seyfried; P.L. and Desjardins, R.M., University of Toronto. 1988. 51 Pp. (RAC)

135 Development of a Control Strategy to Manage Dynamic Fluctuations in Trace Contaminants In Sewage Treatment Plants' Effluents. Mr. Melcer, Canviro Consultants Ltd. 1986 (1) \$60 000 (ER 284) [LSW]

136 Disposal of Hauled Sewage Under Part VII, E. P. Act. Mr. J. Mangione, Oliver Mangione McCalla. 1987 (2) \$63 000 (ER 345) [LSW]

137 The Design and Evaluation of *in situ* Bioremediation Methods for Treatment of Sludges and Soils at Waste Disposal Sites. Dr. J. Barker, University of Waterloo. 1987 (1) \$40 300 (ER 369) [LSW]

The Design and Evaluation of in situ Bioremediation Methods for the Treatment of Sludges and Soils at Waste Disposal Sites. Barker, J.F. and Mayfield, C.I., University of Waterloo. 1989. 14 Pp. (RAC)

138 Effectiveness of the Greenhill Combined Sewage Storage Facility. Mr. F. Guillaume, Proctor and Redfern Group. 1988 (1) \$31 750 (ER 415) (LSW)

INDUSTRIAL AND INSTITUTIONAL WASTES AND EFFLUENTS

1991/92 Projects

139 Applications of Microwave Induced Catalysis to Some Environmental Problems: Reduction of SO₂ and NO_x and Dehalogenation of Hydrocarbons

Dr. Catherine Depew

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The feasibility of microwave induced catalysis as a method for the decomposition or removal of several airborne environmental contaminants was successfully demonstrated. Applications studied included the decomposition of SO₂ and NO_x and the dehalogenation of several model aromatic and aliphatic hydrocarbons such as chlorobenzene and dichloromethane. Appropriate selection of microwave power and a suitable catalyst led to the formation of such breakdown products as oxygen, nitrogen, carbon dioxide, methane, ethylene and metal sulfides. The demonstrated flexibility of the technology should allow its use in a wide range of applications.

4/1988 (3) \$104 000 (ER 400) [AQ]

Applications of Microwave induced Catalysis to some Environmental Problems: Reduction of SO₂ and NO_x and Dehalogenation of Hydrocarbons. Depew, C.W. and Wan, K.S., Queen's University. 1991. 20 Pp. (PUB)

140 Recycling of Textile Dyebath Effluent

Dr. Anne Wilcock

(416) 824-4120

Department of Consumer Studies
University of Guelph
Guelph, Ont. N1G 2W1

Testing of the efficacy of commercially available electrochemical cells for the purification of environmentally hazardous textile dyebath effluents has been featured in this project. Substantial economic savings could be made if the expensive dyes and other chemicals in such effluents could be precipitated and reused.

6/1988 (3) \$55 000 (ER 421) [LSW]

INDUSTRIAL AND INSTITUTIONAL WASTES AND EFFLUENTS....

141 Removal of Chlorophenols from Wastewaters by the Photolysis of Hydrogen Peroxide Using Ultraviolet Light and Sun-Simulated Light

Dr. James Bolton
(519) 661-2170
Department of Chemistry
University of Western Ontario
London, Ont. N6A 3K7

This project was an examination of the feasibility of hydrogen peroxide (H₂O₂) photolysis for the removal of such organic pollutants as phenols and chlorophenols from wastewater streams. Mechanisms and rates of photodegradation were determined by flash photolysis followed by the analysis of intermediate and final reaction products using high pressure liquid chromatography. This technique appeared very effective in elucidating the detailed reaction sequence of aqueous photochemical reactions. A practical system based on H₂O₂ photolysis would be an attractive technology for organic pollutant destruction. Hydrogen peroxide is a readily available industrial chemical with no known adverse effects on the environment.

5/1990 (1) \$42 500 (ER 487) [WQ]

Final Report Received (REV)

142 Solid Waste Management Land Based Rainbow Trout Culture

Mr. Peter Chisholm
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The modelling and monitoring of the production of non-filterable solid wastes produced during normal operation of land based rainbow trout culture systems is the focus of this study. At each stage of fish growth over the 10 to 300 gram range, the following design variables are considered: surface area retention time; depth efficiency of settling zones; surface area, retention time maximum concentration of thickened solids in thickening zones; and the return of soluble phosphorous from thickened solids to effluent from thickening zones. This information will be interpreted to determine system design details to achieve objectives for suspended solids and phosphorous in the effluent from land based rainbow trout culture.

4/1991 (2) \$28 800 (ER 516) [WQ]

143 Removal of Selenium from Copper Refinery Waste Streams

Dr. Sydney Brownstein
(613) 993-2785
Brownstein Consultants Inc.
2036 Woodcrest Rd.
Ottawa, Ont. K1A 0R6

The development of methodology based on tailoring a suitable polymer resin for the removal, and subsequent recovery in a concentrated useful form, of selenite from the acidic waste stream from a copper refinery is the objective here. As selenium has industrial applications in photo-voltaics and glass manufacture, a successful method would minimize pollution and result in a saleable product

9/1991 (2) \$78 350 (ER 538) [LSW]

144 Development of a Novel Procedure to Disinfect Biomedical Waste

Dr. Patricia Seyfried
(416) 978-3732
Department of Microbiology
University of Toronto
Toronto, Ont. M5S 1A8

This study is an evaluation of the efficacy of the disinfectant VSBF in conjunction with a novel volume reducing (Bio-Nurbel 100) crushing machine as a means of reducing both the microbial content and volume of glass, metal and plastic biohazardous waste. Viral, bacterial, fungal and amoebic indicators are all considered with special emphasis being placed on a comparison of the cost and efficacy of VSBF with sodium hypochlorite. This procedure has particular potential for use in small medical and veterinary hospitals as the Bio-Nurbel machine is smaller than existing alternatives and VSBF is safer for the environment than such agents as sodium hypochlorite.

6/1991 (1) \$41 000 (ER 544) [LSW] .

145 New Process for the Recovery of Chromium from Electroplating Wastes Using Liquid Membrane Pertraction

Dr. Mark Pritzker
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Department of Chemical Engineering
University of Waterloo
Waterloo, Ont. N2G 3L1

An evaluation of the technical and economic feasibility of liquid membrane pertraction for the recovery, recycling and reuse of chromium from electroplating wastes is the purpose

INDUSTRIAL AND INSTITUTIONAL WASTES AND EFFLUENTS....

of this project. The effect of feed composition, strip solution composition, nature of the membrane support and modes of operation are all considered. This membrane process shows promise in reducing toxic Cr(VI) content of electroplating wastes to permissible discharge levels without generating any solid waste. At the same time, it would allow the recovery and concentration of sufficient Cr(VI) for reuse in the electroplating facility.

6/1991 (2) \$78 683 (ER 545) [LSW]

146 Development of a Novel Photocatalytic Reactor for Mineralization of Water Pollutants

Dr. Hugo de Lasa
(519) 661-2144
Dept. of Chemical and Biochemical Engineering
University of Western Ontario
London, Ont. N6A 3K7

Photocatalytic processes are potentially one of the most suitable means of mineralizing the water pollutants that result from various petrochemical and chemical processes. This research program is a consideration of the technical feasibility of a novel reactor for such photocatalytic reactions. The reactor is based on a new concept where various design characteristics of the reactor (fluid dynamics, illumination, catalyst loading) are optimized in order to develop a unit configuration with unique prospects for achieving high yields of converted pollutants.

5/1991 (1.5) \$114 775 (ER 557) [WQ]

147 Mechanisms of the Photodegradation of Organic Pollutants from Wastewaters In Homogeneous and Heterogeneous Systems Using Ultraviolet Light

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Department of Chemistry
University of Western Ontario,
London, Ont. N6A 3K7

UV photolysis is an attractive alternative technology because pollutants can be almost completely destroyed with few, if any, adverse effects on the environment. This project is an examination of the primary photoprocesses in the photodegradation of organic pollutants by direct photolysis, by homogeneous photocatalysis in the presence of H₂O₂, and by heterogeneous photocatalysis in the presence of TiO₂, utilizing the technique of spin trapping with electron paramagnetic resonance detection. A second study utilizes the technique of flash photolysis with HPLC detection to follow the reaction sequence in the photolysis of various pollutants with and without the presence of H₂O₂.

5/1991 (1.5) \$147 230 (ER 560) [WQ]

148 Strategies for the Detoxification of Cyanide Containing Waste Waters

Dr. Alpha Charles
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Department of Biology
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Current methods for the treatment of wastewaters containing cyanide appear to be inadequate or expensive. This investigation will focus on the optimization of conditions for the growth of bacterial species recently found to be capable of utilizing cyanide as the sole source of nitrogen, and the identification of the biochemical mechanisms operative in the metabolism of this cyanide. The intention is to develop an efficient and affordable biological process for the detoxification of cyanide wastes of industrial origin. This inexpensive alternative would be very useful if the proposed process is proven at the research stage and could be scaled up to production size.

5/1992 (3) \$121 450 (ER 623) [WQ]

Previous Projects

149 Province-wide quantity/location Inventories and emission/discharge inventories for specified chlorinated and aromatic hydrocarbons. Dr. Denison, ACRES Inc. 1978 \$188 100 (ER 11)

150 The Chemical Destruction of Hazardous Polychlorinated Organic Compounds: A Feasibility Study. Dr. J. Smith, University of Waterloo. 1979 \$18 100 (ER 25) [LSW]

The Chemical Destruction by Sodium Naphthalenide of Polychlorinated Biphenyls Present as Contaminants in Transformer Oil. Smith, J.G., University of Waterloo. 1980. 14 Pp. (BLO)

151 Hazardous Waste Handbook. Mr. Glenn, Pollution Probe. 1980 \$65 900 (ER 38) [LSW]

152 The Measurement of Total Organic Chlorine in Industrial Wastes. Dr. A. Benedek, McMaster University. 1980 \$78 800 (ER 39) [LSW]

The Measurement of Total Organic Chlorine in Industrial Wastes. Bancsi, J.J., Behmann, J. and Benedek, A., McMaster University. 1982. 87 Pp. (BLO)

INDUSTRIAL AND INSTITUTIONAL WASTES AND EFFLUENTS....

153 Water Quality Analysis of Trout Farm Effluent. Dr. J. Hilton, University of Guelph. 1983 \$16 400 (ER 94) [WQ]

Trout Farm Effluent Study. Hilton, J.W. and Slinger, S.J., University of Guelph. 1984. 26 Pp.

154 Determination of Volatilization Rates of Organic Compounds of Public Health Concern. Dr. T. Gowda, Gore & Storrie Ltd. 1983 \$24 000 (ER 106) [WQ]

Volatilization Rates for Organic Chemicals of Public Health Concern. Gowda, T.P., Halappa and Lock, J.D., Gore & Storrie Ltd. 1984. 30 Pp. (LQO)

155 Contaminant Mobilization and Uptake from Mine Tailings at Cobalt, Ontario. Mr. J. Hanna, J.E. Hanna Associates Inc. 1983 (2) \$57 900 (ER 108) [WQ]

Heavy Metal Mobilization and Bioavailability Cobalt Mine Tailings. Hanna, J.E., J.E. Hanna Associates Inc. 1984. 52 Pp. (BLQ)

156 Effects of Metals from Mine Tailings on the Microflora of a Marsh Treatment System. Dr. P. Seyfried, University of Toronto. 1983 \$49 000 (ER 109) [WQ]

Effect of Metals from Mine Tailings on the Microflora of a Marsh Treatment System. Seyfried, P.L, University of Toronto. 1986. 164 Pp. (BLO)

157 Wet Oxidation of Cheese Whey. Mr. McCorquodale, Kenox Corporation. 1984 (1) \$20 000 (ER 166) [WQ]

Demonstration of Kenox Process for Wet Oxidation of Whey. McCorquodale, Kenox Corporation. 1986.35 Pp. (LQO)

158 Nature of Substrates In industrial Wastes Relative to Elemental Leachability. Dr. J. Kramer, McMaster University. 1984 \$30 000 (ER 187) [LSW]

159 A Full Scale Study of the Effect of Wastewater Variable on the Efficacy of Ultraviolet Disinfection. Mr. G. Whitby, Trojan Technologies Inc. 1985 (1) \$73 700 (ER 202) [LSW]

160 Proposal to Prepare a Case History of Cheese Whey Concentration by Reverse Osmosis. Mr. F. Tonelli, Zenon Environmental Inc. 1985 (1) \$23 900 (ER 204) [WQ]

Evaluation of Reverse Osmosis Technology for Cheese Whey Concentration. Jakubiec H.R., Zenon Environmental Inc. 1986. (BLO)

161 Waste Management Planning for Pharmaceutical Industry. Dr. R. Stairs, Trent University. 1985 (3) \$58 180 (ER 209) [LSW]

162 The Feasibility of Biomass Removal in Shallow Impoundments as a Means of Reducing Nutrient Loading. Dr. J. Fitchko, Beak Consultants Ltd. 1985 (1) \$26 000 (ER 229) [WQ]

163 Development of Polysulphide Technology for Treatment of Concentrated Spent Cyanide Liquors. Dr. J. Ganczarczyk, University of Toronto. 1986 (1) \$33 000 (ER 233) [LSW]

Development of Polysulfide Technology for Treatment of Concentrated Spent Cyanide Liquors. Ganczarczyk, J.J., Bilevicius, S.R. and Tang, G., University of Toronto. 1988. 62 Pp. (LQO)

164 Sinter Plant Stack Opacity Preconditioned Spray System. Mr. D. Grieve, Stelco Inc. 1986 (1) \$30 000 (ER 285) [AQ]

165 Nature of Substrates in Industrial Wastes Relative to Elemental Leachability. Dr. J. Kramer, McMaster University. 1986 (3) \$97 400 (ER 290) [LSW]

166 To Conduct a Study on the Structure of the Liquid Waste Management (Transportation) Sector In Ontario. Dr. A. Donner, ARA Consultants. 1987 (1) \$32 300 (ER 293) [ESE]

The Transport of Liquid Industrial Waste in Ontario. Donner, A., ARA Consultants. 1987. 71 Pp.

167 A Study of the Economic Factors Relating to the Implementation of Resource Recovery, Recycling or Zero Discharge Waste Reduction Technology for Heavy-Metal Generating industries In Canada. Dr. B. Fleet, University of Toronto. 1987 (2) \$76 480 (ER 316) [ESE]

168 Nature of Substrates in industrial Wastes Relative to Elemental Leachability. Dr. J. Kramer, McMaster University. 1987 (1) \$34 200 (ER 361) [LSW]

169 Phase Partitioning at industrial Waste Land Treatment Sites Under Nonsteady-State Conditions. Dr. W. Snodgrass, McMaster University. 1987 (1) \$14 000 (ER 363) [LSW]

170 A Preliminary Study to Determine the Feasibility of Medium Pressure Mercury Lamps for Disinfecting Low Quality Wastewaters. Mr. G. Whitby, Trojan Technologies Inc. 1987 (1) \$53 310 (ER 380) [WQ]

171 Sampling Biomedical Waste incinerators. Dr. S. Viswanathan, Clayton Environmental Consultants. 1988 (2) \$400 000 (ER 388) [AQ]

172 ACPOP Aqueous Organic Pollutant Mineralizer. Mr. M. Robertson, Nutech Energy Systems Inc. 1988 (2) \$350 000 (ER 391) [AMID]

173 Fish Waste Production - Rainbow Trout Culture. Mr. P. Chisholm, University of Guelph. 1988 (2) \$22 950 (ER 394) [WQ]

174 Test of a Chemical Mechanical Process for the Decontamination of Non-Anatomical Biomedical Waste. Mr. P. Gamble, Hospital Council of Metropolitan Toronto. 1988 (1) \$95 000 (ER 409) [LSW]

AQUATIC BIOLOGY AND TOXICOLOGY

1991/92 Projects

175 An Examination of the Chronic Toxicity of Thiocyanate to Freshwater Fish for the Development of a Water Quality Criterion

Dr. George Dixon

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Department of Biology
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The evaluation of the chronic toxicity of thiocyanate to freshwater fish has been the focus of this project. Results from laboratory studies with rainbow trout and fathead minnow will provide the basis for establishing a water quality criterion for thiocyanate, and provide biochemical indicators for the *in situ* assessment of thiocyanate impact in feral fish populations. It Will also provide insight into the consequences of short-term pulse exposure of fish to thiocyanate and provide information applicable to the assessment of the impact of spills and the management of mixing zones. A preliminary assessment of the impact of thiocyanate on actual aquatic systems using the developed parameters is included in the study.

4/1987 (3) \$111 700 (ER 320) [WQ]

176 Monitoring Exposure and Effects of Organic Substances in the Huron-Erie Corridor

Dr. Doug Haffner

(519) 253-4232

Great Lakes Institute
University of Windsor
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This study consists of five interactive projects with the following objectives: 1) establishment of protocols for a statistically sound network of biomonitoring stations in the Huron-Erie corridor; 2) determination of foodweb exposure routes (water or in-place pollutants); 3) calibration of organisms of both the benthic and pelagic foodchains in order to determine water and sediment concentrations; 4) determination of whether bioaccumulation or bioconcentration regulates residue levels in sport fish; and 5) assessment of indigenous vertebrate species as monitors of the environmental impacts of contaminants in the corridor.

10/1988 (3) \$600 000 (ER 424) [WQ]

177 Carcinogenicity Testing of industrial Effluents Using a Rainbow Trout Assay

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The development and use of a carcinogenicity assay using rainbow trout for the monitoring of complex industrial effluents is the purpose of this project. Initially, emphasis in the study was placed on the development of techniques for the preparation of effluent extracts, and the development of methods for exposing trout to the extracts. The trout cancer assay along with trout enzyme induction assays and *in vitro* Salmonella assays are now being used to determine the mutagenic and cancer promoting activity of compounds extracted from bleached kraft mill effluent, the industrial effluent selected as a model for study.

5/1989 (3) \$128 730 (ER 429) [WO]

178 Standardized Rearing Materials and Procedures for *Hexagenia*, a Benthic Bioassay Organism

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This project has involved the development and testing of a synthetic sediment suitable for rapid growth of *Hexagenia* mayflies, organisms recommended for use in sediment-bioassay and ecotoxicological studies. Also under development in the study are rapid culture techniques for rearing contaminant-free organisms and the determination of methods for minimizing inter-individual variations in development. These factors reduce the statistical power to detect effects in bioassay and toxicokinetic studies, and limit the comparability of sediment toxicokinetic, bioassay and biomonitoring studies.

5/1989 (3) \$48 283 (ER 450) [WQ]

179 PCB Dynamics In Pottersburg Creek

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Despite remedial measures in the 1980's, subsequent monitoring had revealed significant PCB recontamination of creek sediments and continuously high PCB residues in biota at Pottersburg Creek. The objective of this research is to determine the factors that account for the current concentrations of PCBs in biota at this site and to estimate the time required for PCB residues to decline to acceptable levels. Results to date suggest that biomagnification is a significant mechanism responsible for these high contaminant levels. Such major food sources as chironomids and worms ingest contaminated sediment and serve as vectors for the transfer of PCBs to fish. Similarly, filamentous algae can rapidly sorb PCBs from the water and in turn are a food source to snails and crayfish.

10/1989 (2) \$27 000 (ER 460) [WQ]

180 Abiotic Factors involved in Predicting Trace Metal Levels in Freshwater Bivalves

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The goal of this study is to develop a deterministic model of general applicability, based on sound geochemical and biological principles, capable of predicting the bioaccumulation of cadmium by the freshwater bivalve, *Anodonata grandis*. The model uses concepts derived from the free-ion activity theory of Metal-organism interactions and surface complexation theory to relate measured cadmium concentrations in the bivalve to those measured in the water or in the surficial sediments. This methodology is a promising alternative to empirical approaches which have proven disappointing in their ability to predict metal bioaccumulation by benthic organisms.

6/1990 (1) \$22 056 (ER 469) [WQ]

181 Assessment of Environmental Genotoxin Sediment Contamination In the Niagara River Watershed

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The impact of sediment bound teratogens on the frequency of mentum (labial plate) deformities in chironomids from industrial and agricultural areas of two Ontario rivers has been evaluated in this project. Samples taken before and after replacement of coal tar (i.e. polyaromatic hydrocarbon) contaminated sediments in the Niagara River watershed indicated that the frequency of mentum deformities in chironomids has been significantly reduced as a result of this 'clean-up' of sediments. Greater numbers of deformed chironomids were also sampled downstream of a steel company (where sediments contained elevated levels of such heavy metal levels as chromium and nickel) in the Welland River in comparison, to an upstream control site

11/1989 (2) \$23 100 (ER 472) [WQ]

182 Verification Studies of a Body Burden Based Model for Predicting the Sublethal Toxicity of Fluctuating Contaminant Exposures to Fish

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A body residue model of toxicity as a means of assessing the effects of fluctuating toxicant exposures on small fish has been examined in this study. Whole body toxicant residues have been found to be a good surrogate of dose and predictive of the effects of time variable exposures to three chlorinated organic compounds in acute studies with fathead minnows. Modification of standard test protocols using fathead minnows, to account for differences in feeding and density related effects on growth, significantly improves the sensitivity of the system for detecting toxicity related growth decreases.

5/1990 (1) \$28 444 (ER 486) [WQ]

183 Causes of Pollution-Associated Neoplasms in Fish in Lake Ontario

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This project has involved the evaluation of the influences of naturally occurring liver diseases on the susceptibility of white suckers to environmental carcinogenic polyaromatic hydrocarbons (PAHs), especially benzo(a)pyrene. Studies indicate that while white suckers and other bottom-dwelling species possess an efficient biliary excretion mechanism based on hepatic glutathione S-transferase activity for the detoxification of PAHs, a chronic inflammatory disease of bile ducts associated with particular parasitic protozoa, digenetic flukes and larval nematodes interferes with this process. The hypothesis that multiple factors are involved in the susceptibility of white suckers to pollution-associated carcinogenesis has important implications for efforts to monitor carcinogens in the Great Lakes by tumour surveys in fish.

6/1990 (2) \$110 810 (ER 492) [WQ]

184 impact of Bleached Kraft Mill Effluent on Reproductive, Biochemical and immunological Characteristics of White Sucker and Whitefish

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Further studies on the effects on fish of exposure to Bleached Kraft Mill Extract and the effectiveness of secondary treatment of effluent in reducing environmental impacts were featured in this project. Results revealed that the activity of a biochemical indicator, mixed function oxygenase (MFO), remained elevated in fish exposed to treated effluent. This suggests that two years of secondary treatment of effluent has not reduced chronic reproductive effects in fish in receiving waters. However, during a maintenance shutdown at the source mill, MFO levels in fish returned to normal and steroid levels began to recover. This suggests that those compounds that induce this increase in MFO activity are not persistent in the environment.

4/1990 (1) \$44 108 (ER 494) [WQ]

Impact of Bleached Kraft Mill Effluent (BKME) on Fish Populations near Terrace Bay, Ontario. McMaster, M.E., University of Waterloo. 1991. 98 Pp. point report with ER 463] (RAC)

185 Development and Validation of a New, Rapid and Economical Surrogate Bioassay for industrial Contaminants

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This project involved the development of a protocol for a sub-lethal toxicity assay for pure compounds and industrial effluents using, as an indicator, the chemotactic behavioral response of the ciliated protist, *Tetrahymena vorax*. Following application of this protocol to four standard reference toxicants (zinc, sodium chloride, 4-chlorophenol and cadmium), industrial effluents from several industries, namely, pulp and paper, metal casting, iron and steel, and organic chemical were considered. Four of the 11 effluents tested yielded results comparable with standard (lethal) bioassays that use *Daphnia magna* or rainbow trout. Future work is aimed at improving the sensitivity of the test. Successful development of such a microbial bioassay would address the need for more inexpensive, simple and rapid tests for assessing the impacts of toxicant mixtures on freshwater biota.

6/90 \$47 915 (ER 511) [WQ]

Development and Validation of a New, Rapid and Economical Surrogate Bioassay for industrial Contaminants. Gilron, G.L., Lynn, D.H., Hattie, S. and Holtze, K.E., BOREAUS Environmental. Consulting Inc. 1991.46 Pp. (PUB)

186 Development of Hepatic Micronucleus Assay in Fish

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The development of a piscine hepatic micronucleus assay which could be used to evaluate the genotoxicity of complex environmental mixtures is the objective here. Two assay protocols have been developed in which rainbow trout are exposed to the genotoxic compounds before or after the proliferation of liver hepatocytes (the target cell population) is stimulated by a regenerative response following exposure to allyl formate. This methodology has produced, positive responses with both direct- and indirect-acting clastogens and is being extended to other genotoxic chemicals including benzo(a)pyrene. Eventually, the practical application of the assay will be tested with complex mixtures of environmental

contaminants.

12/1990 (2) \$30 000 (ER 521) [WQ]

187 Development and Testing of a Body-Burden Based Model for Estimating the Toxicity of Mixtures of Organic Contaminants in Fish

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Development and validation of a dynamic model employing a whole-body-residue based first order kinetic approach to predict the cumulative toxicity to fish of mixtures of organic contaminants is the focus of this project. Studies include the generation of a complete database for a number of organic chemicals using standard acute toxicity studies, modelling mixtures of 2, 3 and 4 chemicals with the same and different modes of action, and running mixture toxicity experiments in order to validate the model. The resulting model will be capable of estimating the potential impacts of multiple-toxicant exposure (complex effluents) on aquatic biota.

5/1991 (1.5) \$79 264 (ER 566) [WQ]

188 Relative Value of Fishmarkers, *in vitro* Chemical Assays and Waterborne AOX Measurements for Evaluating Toxicity of Pulp Mill Effluents

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This investigation is an examination of such physiological biomarkers as hepatic mixed function oxygenase induction and serum steroid levels in fish downstream from 10 Ontario pulp mills with the objective of determining the prevalence of biological impacts of mill effluent. Facilities considered in the study include kraft, TMP and sulfite mills and embrace mills both with and without secondary treatment systems. This study is the first wide scale assessment of pulp mill effluent impacts in Ontario. It will also allow an evaluation of the effectiveness of secondary treatment in eliminating significant effects on aquatic resources and may confirm the value of such biomarkers as measures of physiological stress.

5/1991 (1.5) \$50 000 (ER 567) [WQ]

189 Mercury Flux and Bioconcentration

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This project is an assessment of the relative impacts of variations in food-web structure, and lake chemistry and geochemistry on the concentrations, flux rates, activity pathways and rates of bioconcentration of mercury in fish and plankton in a number of lakes in Dorset area. The study comprises both between-lake comparisons and whole-lake manipulations. Through consideration of lakes with different food-web structures, it will be possible to assess the relative differences in rates and paths of bioaccumulation that are attributable to physical, bottom-up factors (watershed, geochemistry) and to biological, top-down factors (different species and abundances of piscivores and planktivores).

6/1991 (3) \$125 280 (ER 576) [WQ]

190 Chromium In Lakes of Ontario

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The objective of this project is to determine the principal redox processes and pathways that regulate the distribution of Cr(III) and Cr(VI) in lakes. Hydrogen peroxide, a compound now widely used by industry in the treatment of industrial and sewage effluent, is also being assayed because of its ability to catalyze the oxidation of Cr(III) to Cr(VI). The measurement of dissolved versus particulate forms as well as the Cr(VI):Cr(III) ratios in precipitation, the major source of chromium input into lakes, are also included. Data from the study will have particular significance as Cr(VI) is significantly more toxic than Cr(III).

6/1991 (3) \$59 400 (ER 580) [WQ]

191 Benthic Invertebrates as Indicators of the Efficacy of a Heavy Metal Contaminants Cleanup

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The objective of this project is to map the distribution of abnormal invertebrates as it relates to heavy metal contamination levels in the sediments in an area of concern from upstream and downstream of the Atlas Speciality Steels Ltd. clean-up area in the Welland River. The review employs the sediment chironomid abnormality and species diversity techniques developed previously (see ER 472). Establishment of the efficacy of this technique for assessing sediment toxicity would assist remedial action programs in delineating areas of contaminated sediments. The study could also be used to evaluate the possible synergistic impact of heavy metals on the frequency of chironomid labial plate deformities.

6/1991 (3) \$56 900 (ER 586) [WQ]

192 Comparative Study of Mercury Bioaccumulation in Plankton Communities of Softwater Lakes

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Mercury is the major contaminant that results in the restriction of consumption of sport and commercial fish in inland Ontario lakes. The primary objective of this study is to quantify rates of mercury uptake by herbivorous zooplankton in three lakes of various food-web structures, and to assess changes in uptake rates induced by manipulations of relative abundances of planktivores and piscivores in two other lakes of dissimilar food-web structures. This information will become part of a large database on which 'supply-demand' food-web modelling will be performed to assess the relative contributions of biotic and abiotic factors on mercury bioaccumulation originating from wet deposition.

5/1992 (3) \$94 800 (ER 606) [WQ]

193 Methods to Determine the Bioavailability and Toxicity of Sediment-Sorbed Pesticides to Benthic Biota

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Few studies address the question of the bioavailability/toxicity of sediment-sorbed pesticides to benthic organisms. This project will use four species of benthic invertebrates with various behavioral and feeding regimes in spiked sediment bioassays to determine the chronic effects of pesticides on survival, growth and/or reproduction of sediment-dwelling organisms. The habitat preference and feeding regimes of the four species will provide an ideal comparison of how biological behaviour and chemical distribution may affect both bioavailability and toxicity of sediment-sorbed pesticides.

5/1992 (1) \$16 200 (ER 630) [PR]

Previous Projects

194 Bioaccumulation Rates, Acute and Chronic Effects of Five New Dielectric Fluids on American Flagfish (PCB Substitutes).

Dr. A. Smith, Lakehead University. 1977 \$222 000 (ER 03) [WQ]

Bioaccumulation Rates, Acute and Chronic Effects of New Dielectric Fluid Products on Fish. Smith, A.D., Orr, D.E. and Ozburn, G.W., Lakehead University. 1979. 31 Pp. (BLQ)

195 Chemical Identification and Biological Assay of Airborne and Waterborne Mutagens (Carcinogens). Dr. M. Katz, York University. 1977 \$370 000 (ER 10) [WQ]

Chemical identification and Biological Assay of Airborne and Waterborne Mutagens. Katz, M., Heddle, J.A. and Salamone, M.F., York University. 1981. 33 Pp. (BLO)

196 Effects of pH on Mercury Accumulation in Fish. Dr. Watson, MacLaren Plansearch. 1978 \$45 400 (ER 22) [WQ]

The Uptake of Methylmercury by Walleye (Stizostedion vitreum) Through a Simulated Ecosystem as a Function of Selected pH Regimes. Smith, J.D., James F. MacLaren Ltd. 1980. 60 Pp. (BLO)

197 Increased Disease Susceptibility After PCB Exposure. Dr. Gaudie, McMaster University. 1979 \$107 600 (ER 26) [WQ]

198 Review of Literature and Biological Testing Protocol Required for Multiple Evaluation Pertaining to Hazardous Organic Compounds. Dr. G. Ozburn, Lakehead University. 1981 \$10 900 (ER 48) [WQ]

Aquatic Toxicity of Multiple Organic Compounds 2,4,6-trichlorophenol. Ozburn, G., Lakehead University. 1983. 43 Pp. (BLQ)

199 Aquatic Toxicity Studies of Multiple Organic Compounds. Dr. G. Ozburn, Lakehead University. 1981 \$68 300 (ER 49) [WQ]

Aquatic Toxicity of Multiple Organic Compounds. Ozburn, G.A., Lakehead University. 1981. 16 Pp. (BLO)

200 Suppression of immune Defences by Halogenated Aromatic Hydrocarbons. Dr. Clark, McMaster University. 1981 \$62 200 (ER 50) [WQ]

201 Chemical identification and Biological Assay Studies of Environmental Mutagens, Promoters and inhibitors. Dr. J. Heddle, York University. 1981 \$452 800 (ER 55) [WQ]

Chemical identification and Biological Assay Studies of Environmental Mutagens, Promoters and inhibitors. Katz, M., York University. 1983. 70 Pp. (BLO)

202 Literature Searches Regarding the Potential Genotoxic Hazards of Specific Environmental Contaminants. Dr. Nutzenberger, York University. 1982 \$23 400 (ER 59) [WQ]

Mutagens in the Environment. Streb, J.A. and Logan, D.M., York University. 1983. 208 Pp. (BLO)

203 The Development of a Freshwater Fish Test to identify Aquatic Toxic Contaminants. Dr. I. Smith, University of Guelph. 1982 \$37 500 (ER 64) [WQ]

204 Revised Monitoring Scheme for Persistent and Toxic Organics in Great Lakes Sports Fish. Dr. J. Coburn, Zenon Environmental Inc. 1982 \$130 000 (ER 67) [WQ]

Revised Monitoring Scheme for Persistent and Toxic Organics in Great Lakes Sports Fish. Coburn, J.A., Zenon Environmental Inc. 1985. 42 Pp. (BLQ)

205 Collaborative Study on Short-Term Tests for Genotoxicity and Carcinogenicity. Dr. D. Logan, York University. 1982 (2) \$49 000 (ER 84) [WQ]

206 A Biological Model for Partitioning of Mercury, Lead, and Cadmium in Aquatic Systems. Dr. P. Welbourn, University of Toronto. 1983 \$15 600 (ER 87) [WQ]

207 Suppression of Immune Defences by Halogenated Aromatic Compounds. Dr. Clark, McMaster University. 1983 (ER 90) [WQ]

208 Chemical identification and Biological Assay Studies of Environmental Mutagens, Promoters and Inhibitors. Dr. M. Katz, York University. 1983 (ER 91) [WQ]

209 Aquatic Toxicity Studies of Multiple Organic Compounds. Dr. G. Ozburn, Lakehead University. 1983 (ER 92) [WQ]

210 Comparison of the Ames Test and the Replicative Killing Assay as Detectors of Mutagenicity In Chemical Compounds and Environmental Samples. Dr. D. Logan, York University. 1983 \$13 000 (ER 112) [WQ]

211 Effects on the Muscle of Young Fish and Rats of Exposure to Lead, Cadmium and Mercury. Dr. D. Nicholls, York University. 1984 \$48 900 (ER 114) [WQ]

Effect on the Tissue of Young Fish and Rats of Exposure to Lead, Cadmium and Mercury. Nicholls, D.M., York University. 21 Pp. (BLQ)

212 Growth Lipid Deposition Relationships In Juvenile Cypripinids and Yellow Perch. Dr. J. Hilton, University of Guelph. 1984 (1) \$2 000 (ER 125) [WQ]

Evaluation of the Relationship between Growth and Lipid Deposition in Juvenile Fishes. Beak Consultants Ltd. 1987. 12 Pp. (BLO)

213 Aquatic Toxicity Studies of Multiple Organic Compounds. Dr. G. Ozburn, Lakehead University. 1984 (1) \$25 000 (ER 139) [WQ]

214 Development of Predictive Organic Contaminant Structure - Property - Toxic Relationships for Aquatic Organisms. Dr. D. Mackay, University of Toronto. 1984 (3) \$57 000 (ER 150)

215 Elimination of Solvent Effects In *in vivo* Mutagenicity Assays. Dr. D. Logan, York University. 1984 \$53 200 (ER 155) [WQ]

216 The Assessment of a Point Source Discharge of Suspected Mutagenic and Carcinogenic Contaminants: an Epidemiological Approach. Dr. I. Smith, University of Guelph. 1985 (2) \$54 000 (ER 157) [WQ]

217 Aquatic Toxicity Studies of Multiple Organic Compounds. Dr. G. Ozburn, Lakehead University. 1984 (2) \$90 000 (ER 159) [WQ]

218 Development of a Methodology for Use of Freshwater Clams as a Biological Response System to Monitor the Nearshore Environment of the Lower Great Lakes. Dr. R. Green, University of Western Ontario. 1984 (3) \$73 400 (ER 162) [WQ]

219 Fish Samples in Support of Project ER 67 'Revised Monitoring Scheme for Persistent and Toxic Organics in Great Lakes Sports Fish'. Mr. Neil, Limnos Ltd. 1984 (1) \$9 400 (ER 174) [WQ]

220 Sampling and Coring Program for Evaluating Spatial Distribution and Approximate Mass of Pollutants in the Sediments of the Humber Marsh, Toronto. Dr. P. Seyfried, University of Toronto. 1985 \$17 400 (ER 182) [WQ]

Sediment and Pollution Accumulation in the Humber River Marsh, Toronto. Weninger, J.M., University of Toronto. 1988. 54 Pp. (LQO)

221 Pathogenesis of Neoplastic Diseases Afflicting Feral Fish. Dr. I. Smith, University of Guelph. 1985 \$11 500 (ER 192) [WQ]

222 *In situ* Assessment of Mixed Copper and Zinc impacts on White Sucker (*Catostomus commersoni*) Populations in Several Northern Ontario lakes: and Evaluation of the Environmental Health Assessment to Validating Water Quality Criteria. Dr. G. Dixon, University of Waterloo. 1985 (ER 193) [WQ]

In situ Assessment of Copper and Zinc impacts of White Sucker Populations of the Manitowadge Chain of Lakes. Munkittrick, K.R., University of Waterloo. 1989. 208 Pp. (RAC)

223 Regional and Evaluative Level III Fugacity Models Describing the Multimedia Environmental Partitioning, Reaction and Transport of Organic Chemicals. Dr. D. Mackay, University of Toronto. 1985 (3) \$116 800 (ER 194) [AQ]

Regional and Evaluative Level III Fugacity Models Describing the Multimedia Environmental Partitioning, Reaction, and Transport of Organic Chemicals. Mackay, D. and Paterson, S., University of Toronto. 1988. 25 Pp. (BLQ)

224 Validation and a Possible Reassessment of Clam Caging Experiments Using *Elliptico complanatus* as Biomonitor for Toxic Contaminants in Water. Dr. P. Hebert, University of Windsor. 1985 \$18 700 (ER 196) [WQ]

225 Bioaccumulation of Mercury by Yellow Perch. Dr. D. McQueen, York University. 1988 \$29 000 (ER 199) [WQ]

Bioaccumulation of Mercury By Young-of-the-Year Yellow Perch: A Bioenergetics Approach. Post, J.R., University of Wisconsin. 1988. 12 Pp. (BLQ)

226 Monitoring Environmental Genotoxicity Using Sister Chromatid Exchange in Mice. Dr. M. Petras, University of Windsor. 1985 (3) \$127 900 (ER 212) [WQ]

227 Biological indicator System to identify Genotoxicity of In-Place Pollutants. Dr. J. Fitchko, Beak Consultants Ltd. 1986 (1) \$10 000 (ER 215) [WQ]

228 Development and Validation of a Methodology for Assessing the Relative Environmental Hazards of Chemical Contaminants. Dr. R. Willes, Cantox Inc. 1985 (2) \$200 000 (ER 226) [AQ]

Vector Scoring System for the Prioritization of Environmental Contaminants, Vol. 1. Willes, R., CanTox Inc. 1988. 75 Pp. (RAC)

Vector Scoring System for the Prioritization of Environmental Contaminants, Vol. 2. Willes, R., CanTox Inc. 1988. 35 Pp. (RAC)

229 Development of a Standard Clam Biomonitoring Methodology for the Detection of Trace Contaminants within Waters of the Ontario Great Lakes Region: Assessment of Available Clam Stocks. Mr. A. Melkic, Integrated Explorations. 1986 (1) \$51 147 (ER 231) [WQ]

Development of a Standard Biomonitoring Methodology for the Detection of Trace Contaminants within the Waters of the Ontario Great Lakes Region. Melkic, A., Integrated Explorations. 1991. 76 Pp. (RAC)

230 The Use of Various Bacterial Short-Term Tests In the Screening of industrial Effluent for Mutagenic Activity. Dr. D. Logan, York University. 1986 (1) \$12 000 (ER 237) [WQ]

231 Assessment of Contaminant Migration from Industrial and Landfill Sources In the Twelve Mile Creek and Welland River Watersheds and their impact as in-place Pollutants in Sediments. Dr. I. Brindle, Brock University. 1986 (1) \$180 000 (ER 240) [WQ]

232 The Use of Aquatic Vegetation and invertebrates to Monitor Chlorinated Hydrocarbons in the Lake Huron - Lake Erie Corridor. Dr. P. Hebert, University of Windsor. 1986 (3) \$250 000 (ER 241) [WQ]

The Use of Aquatic Vegetation and invertebrates to Monitor Chlorinated Hydrocarbons in the Lake Huron - Lake Erie Corridor. Haffner, D., Gobas, F. and Hebert, P., University of Windsor. 1991. 169 Pp. (RAC)

233 Toxicity of Pentachlorophenol to Zooplankton: Fate and Effects. Dr. N. Kaushik, University of Guelph. 1988 (1) \$15 100 (ER 242) [LSW]

Acute and Chronic Toxicity to Zooplankton of Pure Pentachlorophenol and a Technical Formulation: Laboratory and Field Studies. Stephenson, G.L and Kaushik N.K., University of Guelph. 1991. 54 Pp. (RAC)

234 Studies on the Dynamics of Metal Uptake by *Cladophora glomerata* at Selected Sites in the Niagara River. Dr. P. Welbourn, University of Toronto. 1986 (1) \$7 000 (ER 248) [WQ]

The Uptake and Depuration of Cadmium, Lead and Mercury Concentrations in Cladophora in the Niagara River. Rang, S. and Stokes, P.M., University of Toronto. 1988.25 Pp. (LQO)

235 Bioassessment of Contaminated Sediments with Special Reference to Impact on the Microorganisms of the Receiving Waters. Dr. C. Nalewajko, University of Toronto. 1986 (1) \$11 000 (ER 249) [WO]

Bioassessment of Contaminated Sediments with Special Reference to Impact on the Microorganisms of the Receiving Water. Nalewajko, C., Olaveson, M., and Ewing, C., University of Toronto. 1988.56 Pp. (RAC)

236 Pathogenesis of Neoplastic Diseases Afflicting Feral Fish. Dr. I. Smith, University of Guelph. 1986 (1) \$64 700 (ER 251) [WO]

Pathogenesis of Neoplastic Diseases Afflicting Feral Fish. Hayes, M.A. and Smith, I.R., University of Guelph. 1987. 58 Pp. (LQO)

237 Application of the Fugacity Model to Predicting the Behaviour of Arsenic In the Environment. Dr. D. Mackay, University of Toronto. 1986 (3) \$45 875 (ER 259) [WQ]

238 Accumulation and Pathways of Mercury In Benthic Invertebrates. Dr. P. Welbourn, University of Toronto. 1986 (2) \$45 000 (ER 260) [WQ]

239 The Influence of Dissolved Organic Matter in the Cycling of Hydrophobic Organic Pollutants in the South Central Ontario Lakes. Dr. H. Harvey, University of Toronto. 1986 (1) \$14 365 (ER 263) [WQ]

240 Factors influencing Trace Metal Levels In Zooplankton In Ontario Lakes. Dr. G. Mackie, University of Guelph. 1986 (1) \$30 000 (ER 269) [WQ]

Factors influencing Trace Metal Levels in Zooplankton in Lakes in Ontario. Mackie, G.L., University of Guelph. 1989. 96 Pp. (BLO)

241 An Ecosystem Approach to the Monitoring of Organic Aquatic Contaminants in the Muskoka-Haliburton Region. Dr. C. Metcalfe, Trent University. 1986 (3) \$245 500 (ER 275) [WQ]

An Ecosystem Approach to the Monitoring of PCB's in Pristine Lakes in Ontario. Metcalfe, C.D. and Macdonald, C.R., Trent University. 1990. (RAC)

242 Availability of Zinc to Benthic Organisms from Sediment Fractions. Dr. J. Fitchko, Beak Consultants Ltd. 1986 (1) \$42 500 (ER 277) [WQ]

Availability of Zinc to Benthic Organisms From Sediment Fractions. Fitchko, J., Beak Consultants Ltd. 1988. 25 Pp. (BLO)

243 Methods of Measurement and Speciation of Mercury In Natural Waters. Dr. P. Welbourn, University of Toronto. 1986 (2) \$149 369 (ER 286) [WQ]

244 Quantitative Structure-Activity Relationships for Organic Compounds and their Mixtures. Dr. G. Ozburn, Lakehead University. 1987 (3) \$134 900 (ER 317) [WQ]

245 The Long Term Effects of Acute and Sub-Chronic Pentachlorophenol Exposures on the Growth and Lipid Reserves of Centrarchid Fishes. Dr. P. Johansen, Queen's University. 1987(2) \$19 313 (ER 318) [WQ]

The Long Term Effects of Acute and Sub-Chronic Pentachlorophenol Exposures on the Growth and Lipid Reserves of Centrarchid Fishes. Samis, A.J.W., Colgan, P.W. and Johansen, P.H., Queen's University. 1990. 32 Pp. (LQO)

246 To Investigate, Evaluate and Recommend Organisms as Biomonitoring Tools for Procedures Development for Monitoring of Site Specific industrial and Municipal Discharges and Non-Point Sources. Mrs. C. Jefferson, Curry Jefferson Environmental Services. 1987 (1) \$13 400 (ER 319) [WQ]

The investigation, Evaluation, and Recommendations of Biomonitoring Organisms for Procedures Development for Environmental Monitoring. Jefferson, C., Curry Jefferson Environmental Services. 1988.65 Pp. (RAC)

247 Biomonitoring Protocols for Adult Aquatic Insects. Dr. J. Ciborowski, University of Windsor. 1987 (2) \$76 900 (ER 322) [WQ]

Biomonitoring Protocols for Adult Aquatic Insects. Kovats, Z.E., Ciborowski, J.H., and Corkum, LD., University of Windsor. 1991. 121 Pp. (LQO)

248 In situ Assessment of Mixed Copper and Zinc impacts on White Sucker (*Catostomus commersoni*) Populations in Several Northern Ontario Lakes: An Evaluation of the Environmental Health Assessment Approach to Validating Water Quality Criteria. Dr. G. Dixon, University of Waterloo. 1987 (1) \$108 900 (ER 331) [WQ]

249 Plant Bioassays for the Detection of Environmental Mutagens in an Aquatic Environment. Dr. Grant, York University. 1987 (2) \$149 000 (ER 342) [WQ]

250 Metal Contamination of Wetland Food Chains in the Bay of Quinte, Lake Ontario. Dr. A. Crowder, Queen's University. 1987 (2) \$48 352 (ER 343) [WQ]

251 Analysis of Provincial Fisheries Mercury Data Phase 1: Identification of Temporal, Spatial and Species Relationships. Dr. C. Wren, BAR Environmental. 1987 (1) \$26 400 (ER 353) [WQ]

Relationship of Mercury Levels in Sportfish with Lake Sediment and Water Quality Variables. Wren, C., BAR Environmental. 1991. 36 Pp. (RAC)

252 Geochemical Characterization, Size Fractionation and Bio-Availability of Trace Metal-Particulate Associations in the Don River. Dr. A. Zimmerman, University of Toronto. 1987 (2) \$31 400 (ER 355) [WQ]

253 Assessment of Contaminant Migration for Industrial and Landfill Sources in the Twelve Mile Creek and Welland River Watersheds and their Impact as in-place Pollutants in Sediments. Dr. I. Brindle, Brock University. 1987 (2) \$155 200 (ER 357) [WQ]

254 Causes of Pollution Associated Neoplasms in Fish In Lake Ontario. Dr. M. Hayes, University of Guelph. 1987 (2) \$140 500 (ER 358) [WQ]

Carcinogenic Responses of Wild Fish from Polluted Sites in Lake Ontario. Hayes, M.A., University of Guelph. 1990. 11 Pp. (BLO)

255 Recent Trends and Historical Changes In Water Quality of Lake Muskoka. Dr. M. Rybak, ARECO Canada Inc. 1987 (2) \$39 700 (ER 381) [WQ]

Recent Trends and Historical Changes in Water Quality of Lake Muskoka. Rybak, M., ARECO Canada Inc. 40 Pp. (RAC)

256 A Study of the Partitioning of Organic Chemicals in Aquatic Systems. Dr. D. Mackay, University of Toronto. 1988 (1) \$23 000 (ER 395) [AMID]

257 Use of Pisidiidae Clams for Monitoring Toxicity of Contaminated Sediments. Dr. G. Mackie, University of Guelph. 1988 (1) \$28 620 (ER 397) [WQ]

258 Validation of Spottail Shiner Daily Otolith Rings. Mr. P. Powles, Trent University. 1988 (1) \$7 450 (ER 399) [WQ]

259 Verification Studies of a Bioconcentration-Based Model for Predicting Pulse-Exposure Toxicity of Organic Contaminants to Fish. Dr. G. Dixon, University of Waterloo. 1989 (1) \$40 164 (ER 447) [WQ]

260 Review of Established Regulatory Policies Using Genotoxicity Tests, Current Capability and Recommendations for Future Developments. Dr. E. Nestmann, Cantox Inc. 1989 (1) \$59 675 (ER 459) [MMCB]

261 Impact of Bleached Kraft Mill Effluent (BKME) on White Sucker Populations near Terrace Bay, Ontario. Dr. G. Dixon, University of Waterloo. 1989 (1) \$38 640 (ER 463) [WQ]

Impact of Bleached Kraft Mill Effluent (BKME) on Fish Populations near Terrace Bay, Ontario. McMaster, M.E., University of Waterloo. 1991. 98 Pp. [Joint report with ER 494] (RAC)

262 Geochemical Characterization and Size Fractionation of Metal/particulate Discharges to the Don River. Dr. A. Zimmerman, University of Toronto. 1990 (1) \$19 060 (ER 493) [WQ]

ACID RAIN AND ACIDIFIED LAKES

1991/92 Projects

263 An investigation of the Potential of Zygnemataceae Zygosporos as Paleo-indicators of Recent Lake Acidification

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Increased growth of zygnematacean zygosporos in lakes during the early stages of lake acidification suggested their possibility for use as paleoindicators of early acidification. Based on observations on sediment cores from 11 lakes, however, it was apparent that zygosporos of this family occurred in concentrations too low for practical use. However, it was concurrently determined that fossil cysts of the dinoflagellate *Peridinium* and coenocysts of the green alga *Pediastrum* may be useful for this purpose. These species contain sporopollenin which are very resistant to decay and persist in sediments for millions of years. They are also abundant in sediments of softwater lakes in the Canadian shield.

10/1989 (1) \$35 454 (ER 464) [WQ]

Extraction of Zygnematacean Zygosporos from Lake Sediments and their Potential as Paleo-Indicators of Lake Acidification. Zippi, PA, Yung Y.K., Welbourn, P.M., Norris, G. and McAndrews, J.H., Trent University. 1991. 47 Pp. (RAC)

264 Zooplankton Communities and Water Chemistry of Sudbury Lakes: Changes Related to pH Recovery

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Erindale College, University of Toronto
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The focus of this study has been a survey of zooplankton species composition and water chemistry in 47 lakes in the Sudbury region. This data has been combined with that from 45 other area lakes for comparison with similar data collected from these lakes in the 1970's thereby allowing an evaluation of the effect of recovering lake pH on zooplankton species composition. Results indicate that zooplankton species richness has increased in these lakes since the

ACID RAIN AND ACIDIFIED LAKES

1970's, most likely as a result of recolonization by acid-sensitive species. Eight species previously identified as acid sensitive were found to occur in more lakes in the 1990's than they did in the 1970's. Despite this improvement, species richness, like pH, is still low in many lakes.

6/1990 (1) \$24 100 (ER 468G) [WQ]

Previous Projects

265 Monitoring Fish Populations in Acid Stressed Lakes of the Haliburton Region. Dr. H. Harvey, University of Toronto. 1979 \$183 800 (ER 24) [WQ]

Monitoring Fish Populations in Acid Stressed Lakes in the Haliburton Region. Zimmerman, A.P., University of Toronto. 1979 35 Pp. (BLO)

266 Field Evaluation of Event Precipitation Samplers for Use in the Acidic Precipitation In Ontario Study. Mr. Stevens, Concord Scientific Corporation. 1979 \$53 600 (ER 35) [AQ]

Precipitation Sampler Comparative Study. Stevens, Concord Scientific Corporation. 1980. 63 Pp. (BLO)

267 Controlling Sulphur Dioxide Emissions: What are the Costs? Dr. A. Grima, University of Toronto. 1982 \$56 200 (ER 56) [AQ]

Abatement of Sulphur Dioxide Emissions: What are the Costs?. Paine, R.L. and Grima, A.P., University of Toronto. 1984. 67 Pp. (BLO)

268 Preliminary Evaluation of Plume Tracker In Remote Sensing of Stack Emissions of Sulphur Dioxide. Dr. S. Jain, Moniteq Ltd. 1984 \$13 000 (ER 158) [AQ]

Feasibility of Determining SO₂ Mass Emission Fluxes by Stackscanning. Jain, S.C., Moniteq Ltd. 1985. 40 Pp. (BLO)

269 Monitoring the Chemical and Biological impact, as Measured by Physiological Stress in Fishes, of Episodic Events of Acid Precipitation and Snow Melt. Dr. H. Harvey, University of Toronto. 1985 (2) \$40900 (ER 197) [WQ]

270 Contribution to the Understanding of the Sulphur Cycle in the Dorset Watershed. Dr. P. Fritz, University of Waterloo. 1986 (1) \$26 300 (ER 228) [WQ]

An Isotopic investigation Into the Sulphur Cycle in the Plastic Lake Watershed, Dorset, Ontario. Van Stempvoort, D.R., University of Waterloo. 1987. 21 Pp. (LQO)

271 Determining SO₂ Mass Emission Fluxes by Stack Scanning: Phase II. Dr. S. Jain, Moniteq Ltd. 1986 (1) \$42 000 (ER 232) [AQ]

272 Study of Some Factors Contributing to the Abundance and Persistence of Green Filamentous Algal Mats in Acidic Lakes. Dr. P. Welbourn, University of Toronto. 1986 (3) \$89 836 (ER 282) [WQ]

273 Fossil Chrysophycean Cyst Assemblages as Paleo-indicators in Acidified Lakes. Dr. M. Rybak, ARECO Canada Inc. 1987 (1) \$26 500 (ER 301) [WQ]

274 Detectability of Step Trends in the Rate of Atmospheric Deposition of Sulphate. Dr. E. McBean, University of Waterloo. 1987 (1) \$15 200 (ER 309) [AQ]

275 Sulphur and Oxygen Isotope Composition in Aqueous Sulphate in a Dorset Watershed and their Role in the Acid Rain Sulphur Cycle. Dr. P. Fritz, University of Waterloo. 1987 (1) \$64 840 (ER 338) [WQ]

276 Survey to investigate the Frequency of Filamentous Algal Mats in Ontario Shield Lakes in the Context of their Relationship with the Absence of Macro-Faunal Grazers. Dr. P. Welbourn, University of Toronto. 1988 (1) \$17 530 (ER 398) [WQ]

277 Sequential Sampling, Amphipod Abundance, and Lake Acidification: Development of a Simple and Ubiquitous Biomonitoring Tool. Dr. R. France, W.D.N.R.G. Limnetics Ltd. 1989 (1) \$5 200 (ER 470) [WQ]

Use of Sequential Sampling of Amphipod Abundance to Classify the Biotic integrity of Acid-Sensitive Lakes. France, R., W.D.N.R.G. Limnetics Ltd. 1991.21 Pp. (RAC)

AGRICULTURAL IMPACTS ON RURAL WATERWAYS

1991/92 Projects

278 The Effects of Agricultural Drainage on Sediment and Water Quality Loadings

Dr. Edgar Watt

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This project focussed on the development, calibration, verification and application of TILE, a physically based hydrologic model designed to simulate the effects of agricultural land use and drainage on the sediment and water quality loadings to receiving streams. Inputs into the model include field characteristics, soil parameters and precipitation and temperature time series. The model, applicable to both field and (with additional inputs) small-basin scale, could be used to identify water quality problems and assist in the development of remedial measures.

4/1987 (3) \$90 000 (ER 321) [WQ]

Impacts of Tile Drainage on Water Quality. Paine, J.D. and Watt, W.E., Queen's University. 1991. 133 Pp. (RAC)

279 In situ Determination of Fecal indicator Bacteria Survival In Agriculturally impacted Watersheds

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Identification of pollution sources in rural watersheds is essential for the successful targeting of remedial efforts. This project has involved the documentation and investigation of seasonal variations in bacterial survival in both bottom sediments and water columns of various rural watersheds. This survival data can be used to develop a hydrologic transport model and to assess the contribution of individual inputs from agricultural sources to rural beach pollution.

8/1987 (3) \$164 500 (ER 344) [WQ]

280 Tillage and Event Based Soil and Phosphorus Loss

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Using low and high intensity rainfall simulations, seasonal variations of sediment and phosphorus loss for different tillages, landscape slope positions and soil type combinations have been investigated. Results from recent trials indicate that total soil and phosphorus loss are higher in ploughed plots compared with those receiving no cultivation. However, water runoff is more than double in unfilled plots. In all experimental plots, however, a significant interaction between scale of measurement and measured losses has been observed. This suggests that it may be difficult to define effective hydrologic variables that will represent the behaviour of a heterogeneous hillslope. Physical models based on effective (average) hillslope properties may therefore have limited predictive value.

6/1988 (3) \$202 500 (ER 396) [WQ]

281 Assessment of Fecal Pollution Transport In Agriculturally Impacted Watersheds Using a Biotracer

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Bacterial transport time is an essential input into the development of simple models for evaluating source inputs and transport of pollutants in rural watersheds, and establishing remedial action strategies. This study has focussed on the development of methodology for Monitoring instream bacterial movement and sediment bacterial transport in rural watershed using a naladixic acid resistant *Escherichia coli* biotracer.

5/1988 (2) \$60 370 (ER 416) [WQ]

282 The Relative Effect of Individual Environmental Factors on Indicator Bacterial Survival

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Utilizing controlled laboratory experiments, this project has examined the effects of such water quality variables as dissolved phosphates, nitrates, nitrites, ammonium and dissolved organic carbon (DOC), and such biological factors as predation and competition, on the survival of faecal coliform bacteria. The survival of *Escherichia coli* and *Pseudomonas aeruginosa* has been observed to be particularly heightened by elevated levels of DOC and especially so at warmer temperatures (20°C). Reducing inputs that cause increased DOC levels in streams may therefore help to increase bacterial die-off, and lessen the pollution impact on downstream areas. More generally, such information on the survival of bacteria can be applied to the development of water quality models for evaluating pollution impacts.

11/1969 (1) \$46 000 (ER 462) [WQ]

283 Development of Reliable Treatment Systems for Milkhouse Wash Water

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The development of simple modifications to on-farm practices which will improve the reliability of septic tank-treatment trench systems for the disposal of milkhouse effluent is the objective of this project. Studies to date have shown that these disposal systems could last significantly longer if farmers were to divert residual milk from the pipeline to their calves before commencing the washing procedure. This reduced organic loading reduces clogging of the weeping bed, a primary cause of system failure. Reducing the amount of water used in the washing procedure also improves system reliability, presumably by allowing more efficient biodegradation of organic matter when water is not continuously ponded in the trenches. This latter practice also reduces hydro consumption and cleaning chemical use.

5/1990 (2) \$46 000 (ER 489) [WQ]

284 Flow of Manure Through Soli Macropores

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This study assessed the importance of soil macropores on the flow of liquid manure through two soil types. and the effect on it of tillage. More than 50% of effluent flow from 60 cm test columns was observed to occur in the first 5 hours following application of manure. While it appeared that some macropore flow occurred, it also seemed that raw manure was not flowing intact through the soil column, rather there was some dilution or displacement taking place. The quantity of effluent was not, however, significantly affected by soil type nor was there. any difference between no-till and conventional tillage treatments.

5/1990 (1) \$53100 (ER 495) [WQ]

Final Report Received (REV)

285 The Impact of Farm Liquid Waste Application on Receiving Water

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Natural and indicator faecal bacteria and various chemical components in tile drain water were measured following spreading of liquid manure on fields on 12 separate occasions. Manure application rates varied from 36,000L/ha to 159,000L/ha. Subsurface tile drains became contaminated with bacteria shortly following manure application for nine of the events monitored. On those occasions when contamination did not occur, soil conditions were so dry that tile drains were not flowing or the field had been cultivated just prior to manure application. The degree of tile water impairment was independent of soil type and application rate. Consideration of the specific field conditions prior to manure application might therefore be used to reduce the possibility of contamination of receiving waters.

5/1990 (1) \$77 000 (ER 512) [WQ]

The Effect of Farm Liquid Waste Application on Receiving Water Quality. Dean, D.M. and Foran, M.E., Ausable Bayfield Conservation Authority. 1991. 93 Pp. [Joint report with ER 430] (PUB)

286 To Develop a Reliable, Economical and Environmentally Safe Method of Milkhouse Effluent Disposal Using Pretreatment and/or Modified Leaching Bed Methods

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The development and evaluation at the pilot plant scale of an improved system for the treatment of milkhouse effluent has been the focus of this project. The system under consideration consists of a modified two compartment septic tank system which leads to a raised leaching mound. During operation, much of the non-soluble material from the waste is removed in the septic tank. The clarified effluent is then pumped to and filtered through the leaching mound which is composed of layers of soil, peat and sand. Remaining organic solids are adsorbed and oxidized in the mound with the research also assessing the capability of the selected peat soil used in the mound to adsorb phosphorus.

11/1990 (3) \$121 000 (ER 519) [WQ]

287 Movement of Agricultural and Domestic Waste Water Bacteria Through Soils

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Laboratory, field and modelling studies to investigate pathways and processes that contribute to bacterial movement through unsaturated soils arising from application of either liquid agricultural wastes or septic tank effluents are featured in this project. Special attention is placed on preferential flow through macropores. The first objective is to confirm the suitability of using a nalidixic acid resistant *E. coli* strain as a tracer. This micro-organism will subsequently be used as a tool to study sources and pathways of bacterial movement to surface and groundwater. The effect of application rates, soil characteristics, waste types and reworked layer on transport will be evaluated. This could contribute to improved guidelines regarding agricultural waste discharge and design of septic tank tile drain systems.

6/1991 (3) \$200 500 (ER 547) [LSW]

288 A Study of the Suspended Fluvial Sediments with Enteric Bacteria In Agricultural Drains

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The objective of this research is to determine the degree of colonization of suspended stream sediments by enteric bacteria, and the survivability and distance travelled by sediment sorbed faecal associated bacteria, in different watercourses impacted by agricultural waste. The concentration of such surface sediment associated nutrients as soluble carbon, nitrogen and phosphorus are also being analyzed. This information will have significance to the ministry's Rural Beaches Strategy Program. Such sediments may be a significant means of transport of contaminants into recreational waters.

5/1991 (1.5) \$35 000 (ER 558) [WQ]

289 Evaluation of a *Streptococcus faecium* subsp. *casseliflavus* Model to Assess Pollution Sources at the Kelso Conservation Area

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Monitoring of the concentrations of *Escherichia coli* (EC), *Streptococcus faecium* subsp. *casseliflavus* (SC) and other faecal bacteria in waterways exposed to animal pollution sources or such non-animal pollution sources as municipal sewage treatment plant effluent is the principal objective of this study. This consideration will allow an evaluation of the EC/SC ratio as an indicator of human versus animal pollution, and also provide water quality management personnel with data on the kinds and levels of bacterial indicators that are unique to wildlife.

5/1991 (1.5) \$37 000 (ER 562) [WQ]

290 Comparison of Liquid Manure Spreading Practices on Tile Drain Water Quality

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The focus of this study is a comparison of the effects of different methods (irrigation and injection) of liquid manure application, and field surface treatments prior to application, on the contamination of tile drain water and groundwater by such factors as bacteria, nutrients and suspended solids. This will identify economical methods of spreading liquid manure that reduce the transport of manure components to tile drains and the impact on receiving waters.

5/1991 (1.5) \$98 000 (ER 563) [WQ]

291 Spatial and Temporal Analysis of the Occurrence of Herbicide Residue in a Major Southern Ontario Agricultural Watershed

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This project addresses the effects of watershed scale and other relevant factors (land use, meteorology, physical watershed characteristics) on the occurrence, duration and concentration of the triazine herbicide group in agricultural headwaters and in whole watersheds. Through statistical analysis, empirical relationships and interdependencies will be identified which will be used to develop a set of guidelines for sampling herbicides, and for estimating the magnitude and timing of herbicide runoff. At the same time, the study will demonstrate the reliability and applicability of an immunoassay detection method for atrazine as a field screening technique and an alternative to gas chromatography.

7/1991 (1) \$54 080 (ER 579) [WQ]

292 An integrated NPS Model for Watershed Planning

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The development of an integrated non-point source model for the transport of sediment, nutrients and pesticides in surface and tile drained water, in particulate and solution form, from agricultural watersheds is the objective here. Such a model will be an advance over such existing versions as GAMES and GAMESP. These do not account for subsurface drainage and have limited capability with their primary focus on the management of sediment and particulate phosphorus. Use of the new model will lead to identification of physiographic conditions, land uses, and soil and crop management practices most likely to contribute to significant non-point source pollution from agricultural regions of Southern Ontario.

6/1991 (3) \$207 000 (ER 582) [WQ]

293 Economic Pay-Off of Sediment Reduction from Changes In Agricultural Production Practices

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The specific objectives of this study are to: 1) establish linkages between sediment loading in rural waterways and factors contributing to that loading such as farming practices, enterprise mix, soil and land characteristics, distance to streams and climatic happenings; 2) evaluate the off-farm economic damage of sediment loading; and 3) determine the societal economic pay-off of sediment control measures by various soil and land characteristics such as topography and texture, by soils varying in distance to streams, and by climatic happenings. This information will significantly assist in the identification of targeted policies which would ensure that scarce public funds are spent on those farms and farm practices with the highest potential socio-economic pay-off.

5/1992 \$79 625 (ER 609) [WQ]

294 Effect of Sediment Nutrient Levels on Fecal Bacteria Indicator Survival at a Beach and Agricultural Drain in Southwestern Ontario

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Previous studies have determined a wide variety of site specific bacterial survival rates, apparently a function of the levels of dissolved organic carbon, various phosphorous and nitrogen compounds, and micronutrients in the waterway. This study is designed to determine bacteria survivability at both a beach and upstream agricultural drain in southern Ontario to establish precisely the *in situ* survivability of *Escherichia coil* and *Enterococcus fecalis*. Sediments will be loaded with a range of nutrient concentrations encompassing extremely rich nutrient rich to levels at detection limits, and the effect on survival evaluated with respect to seasonal climatic conditions. This data will be used to predict the period of stream water recovery following remediation projects conducted as part of the ministry's Clean Up Rural Beaches Program.

7/1992 \$54 000 (ER 610) [WQ]

Previous Projects

295 Identification of Fecal Coliforms and Fecal Streptococci and Verification of Newer Tests' Ability to Differentiate Between Human and Non-Human Fecal Pollution. Dr. P. Seyfried, University of Toronto. 1983 \$23 200 (ER 113) [WQ]

Humber River Bacteriological Study. Seyfried, P.L. and Harris, E., University of Toronto. 1987. 62 Pp. (BLO)

296 The Effects of The Drainage and Open Ditches on Peak Flows and Dry Weather Flows. Dr. E. Watt, Queen's University. 1984 (3) \$70 600 (ER 152) [WQ]

Impacts of The Drainage. Paine, J.D. and Watt, W.E., Queen's University. 1989. 99 Pp. (RAC)

297 Humber River/Black Creek: Detailed Bacteriological Water Quality Study Examining the Impact of Sediment and Survival Times. Dr. P. Seyfried, University of Toronto. 1985 (1) \$98 000 (ER 198) [WQ]

Bacteriological Water Quality Study Examining the Impact of Sediment and Survival Times in the Humber River and Black Creek. Seyfried, P. and Harris, E., University of Toronto and Lake Simcoe and Region Conservation Authority respectively. 1990. 264 Pp. (RAC)

298 Sediment Transport Model Search and Implementation. Mr. M. Holloran, Gore & Storrie Ltd. 1986 (1) \$97 760 (ER 256) [WQ]

299 Assessment of the Current Waste Management Practices on Farm Operations In Perth County, Ontario. Dr. M. Haight, University of Waterloo. 1989 (1) \$3 000 (ER 428) [LWS]

300 The Effects of Agricultural Waste Management Practices on Receiving Water Quality with Respect to Bacteria, Phosphorous, Nitrogen and Sediment Loads. Mr. D. Balint, Ausable-Bayfield Conservation Authority. 1989 (1) \$92 416 (ER 430) [WQ]

The Effect of Farm Liquid Waste Application on Receiving Water Quality, Dean, D.M. and Foran, M.E., Ausable Bayfield Conservation Authority. 1991.93 Pp. [Joint report with ER 512] (PUB)

301 Practical Application of Fecal Coliform (FC) to *Streptococcus faecium subsp. casseliflavus* (SC) and Bifidobacterlum to SC Ratios to Determine Human and Animal Sources of Pollution. Dr. P. Seyfried, University of Toronto. 1989 (1) \$27 500 (ER 467) [AMID]

LAKES AND WATERWAYS

1991/92 Projects

302 Prediction of Rate of Oxygen Depletion In Recreational, Urbanized and Agricultural Lakes

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This project has involved the further development, calibration and field testing of a model relating the natural production and consumption of oxygen in lakes to phosphorous and dissolved organic carbon inputs. The model will provide a tool for developing fisheries-oxygen-phosphorus loading relationships, and be useful as a means of assessing the capacity of lakes for cottage development. It could also be used to assess the merit of such remedial measures as control of nutrient inputs and lake reaeration.

11/1986 (3) \$64 300 (ER 294) [WQ]

303 Regional Low Flow Analysis for the Central and Southeastern Regions of Ontario

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Accurate prediction techniques for estimating low flow characteristics of ungauged streams are essential as many industrial and municipal dischargers are limited to specific concentrations of effluent based upon the extreme value low flow of the watershed. The objective of this study was the evaluation and improvement of four existing techniques for estimating low flow characteristics for ungauged watersheds in the Central and Southeastern regions of Ontario. Generally, results suggest that regression equations based on physiographic and hydrometeorologic basin characteristics, index, area proration and isoline methods are all satisfactory for use in the Central region. For the Southeastern region, the method of mapped isolines appears to be the most consistent prediction technique.

10/1989 (1) \$52 500 (ER 445) [WQ]

Regional Analysis of Low Flow Characteristics Central and Southeastern Regions. Cumming Cockburn Ltd. 1991. 69 Pp. (PUB)

304 Statistical Assessment of Multivariate Ordination Techniques for Zoobenthic Communities and Water Chemistry for Lakes from Central Ontario

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Benthic invertebrates and water chemistry from 20 lakes in the Muskoka region were sampled to supplement existing data from an additional 19 lakes. From this data set, a multivariate measure (PROTEST) testing the concordance between benthic invertebrates, fish species compositions, water chemistry, lake morphometry, and spatial arrangement has been developed. PROTEST is a multivariate PROcrustean TEST based on a least-squares measure of the goodness-of-fit between two data sets with the subsequent probability determined using a randomization test.

10/1489 (2) \$14 614 (ER 461) [WQ]

305 Evaluation of the impact of Timber Management Practices on Lake Water using Satellite Remote Sensing Data

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This project was a remote sensing study to determine whether changes in suspended sediment concentration directly or indirectly related to logging activities can be detected and mapped using Landsat TM satellite imagery. Results indicate that it is feasible to detect areas of increased suspended sediment concentration by using a selection of digital enhancement procedures, in particular, band rationing, colour density slicing and chromaticity transformation. These three enhancement procedures may be incorporated in a semi-automated image processing program for detecting areas of high suspended sediment concentration on a routine operational basis.

7/1990 (1) \$32 943 (ER 490) [WQ]

Final Report Received (REV)

306 Regionalization of Low Flow Characteristics for the Northeastern and Northwestern Regions

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Many industrial and municipal dischargers are limited to specific concentrations of effluent based upon the extreme low flow of the receiving waters. The focus of this study is the testing and refinement of such methodologies as multivariate analysis, graphical and index method techniques for predicting low flows in ungauged streams in Northern Ontario. Such techniques could be used to provide input to the management of point and nonpoint sources of pollution and the spatial analysis of water quality, and have application in the determination of the impact of pollutant discharges on aquatic systems.

7/1991 (2) \$122 000 (ER 575) [WQ]

307 Development of a Geographic Information System Application for Water Quality Management and Policy Development

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The focus of this project is the development of an innovative geographic information (GIS) system application model for assessing the impact of current land use and changing land use on water quality. The GIS application model would be able to answer the question "what changes in water quality and quantity occur in streams if the land use in an area changes". It could carry out all necessary calculations and present the results in tabular form, calculate all statistics, and, in a thematic figure, highlight any particular noteworthy features. The developed model would be useful for the identification and management of environmentally sensitive areas and for input into policy development processes.

8/1991 (1) \$63 500 (ER 584) [WQ]

308 Three Dimensional Circulation and Pollutant Transport Modelling for the Toronto Waterfront

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The development of a 3-dimensional hydrodynamic/pollutant transport model for application to Lake Ontario and to its nearshore area of concern, the Metropolitan Toronto Waterfront, is the objective of this study. The final package of interactive hydrodynamic modelling software complemented by powerful graphic tools will permit the modelling of hydrodynamics of this specific location and other large waterbodies, assist in the assessment of the impact of pollutant discharges on nearshore area, and aid in the design and assessment of effective remedial options for the control of wastewater discharges.

5/1992 (2) \$79 940 (ER 607) [WQ]

309 An Independent Validation of the MOE Trophic State Model to Estimate Pre-Development Trophic Status of Lakes

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The overall goal of this study is to validate the ability of the ministry's Trophic State Model to estimate pre-development trophic status of lakes. An independent paleolimnological approach that is based on diatom and chrysophyte (aquatic algae) assemblages preserved in lake sediments will be used. This project will contribute towards better lakeshore development planning and protection of Ontario's water resources through establishment of water quality objectives based on the natural ("pre-development") conditions of individual lakes.

5/1992 (1) \$27 600 (ER 608) [WQ]

310 Wetland Restoration Using Selective Application of Triclopyr Amine to Control Purple Loosestrife (*Lythrum salicaria*)

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Cootes Paradise is 840 ha of wetland and woodland at the extreme western end of Lake Ontario. Like many coastal wetlands, the Cootes Paradise marsh has declined dramatically in the last 50 years. The presence of Purple loosestrife has been identified as being an important impediment to the establishment of desirable marsh vegetation and successful restoration of this area. The purpose of this project is to develop an integrated approach to improve current control techniques aimed at this species in an urban wetland, in particular focussing on the removal of Purple loosestrife colonies using Garlon 3A herbicide.

5/1992 (1) \$15 000 (ER 635) [PR]

Previous Projects

311 Ottawa River Nuclear Spill Contingency Model Development. Mr. M. Palmer, Gore & Storrie Ltd. 1984 \$30 400 (ER 111) [WQ]

Ottawa River Nuclear Spill Contingency Model Development. Palmer, M.D., Gore & Storrie Ltd. 1988.50 Pp. (LQO)

312 Study of Upper Humber River to Identify Pollutant Sources. Mr. McLean, Metropolitan Toronto and Region Conservation Authority. 1984 (ER 136) [WQ]

Humber River Water Quality Management Plan 1986. McLean, Metropolitan and Region Conservation Authority. 1986. 176 Pp. (BLO)

313 Feasibility of Plant Harvesting In Water Quality Amelioration and. Phosphorus Management In Shallow Impoundments. Dr. J. Fiticko, Beak Consultants Ltd. 1984 (1) \$8 000 (ER 167) [WQ]

314 The Measurement of TOC and its Relationship to BOD and COD. Dr. Evans, Trent University. 1985 (1) \$48 100 (ER 188) [AMID]

315 Stochastic Estimation of Ambient Water Qualities In Ontario Rivers to Identify and Manage Potential Water Quality Problems. Dr. V. Graham, University of Waterloo. 1985 (1) \$27 500 (ER 201) [WQ]

Probability and Stochastic Modelling of Water Quality Parameters in the Thames River. Graham, V.A. and Unny, T.E., University of Waterloo. 42 Pp. (BLO)

316 Effects of Rural and Suburban Development on Surface Water Quality In Five Selected SubWatersheds In the Upper Humber River. Mr. B. Hindley, Ontario Ministry of the Environment. 1985 (1) \$121 300 (ER 203) [WQ]

317 Ottawa River Nuclear Spill Contingency Model Development - Phase II. Mr. M. Palmer, Gore & Storrie Ltd. 1986 (1) \$40 000 (ER 235) [WQ]

Ottawa River Nuclear Spill Contingency Model Development Klose, S.R., Gore & Storrie Ltd. 1988.39 Pp. (LQO)

318 Development of an Expert System for Decision Making with Regard to Water Quality In Ontario Rivers. Dr. T. Unny, University of Waterloo. 1986 (2) \$55 000 (ER 250) [WQ]

An Expert System for Water Quality Assessment. Unny, T.E. and Allen, W.P., University of Waterloo. 1988. 197 Pp. (RAC)

319 A Method for Prevention and Mitigation of Nuisance Blue-Green Algal Blooms In Eutrophic Waters In Ontario. Mr. L. Molot, BAR Environmental Group. 1986 (1) \$18 900 (ER 264) [WQ]

Mitigation of Blue-Green Algae in Heart Lake and other Southern Ontario Lakes and Reservoirs. Molot, L.A., BAR Environmental. 1987. 85 Pp. (LQO)

320 Lake Water Quality Monitoring Based on Remotely Sensed Data: An interdisciplinary Study. Dr. J. Pitblado, Laurentian University. 1986 (1) \$95 000 (ER 267) [WQ]

Lake Water Quality Monitoring Based on Remotely Sensed Data. Pitblado, J.R., Laurentian University. 1987. 268 Pp. (LQO)

LAKES AND WATERWAYS

321 Trend Analysis Procedures for PWQMN Data Series. Mr. K. Hipel, McLeod - Hipel and Associates. 1987 (2) \$40 000 (ER 278) [WQ]

322 Regional Analysis of Low Flow Characteristics. Mr. H. Belore, Cumming Cockburn Ltd.

1986 (1) \$40 000 (ER 281) [WQ]

323 Development of an Expert System for Decision Making with Regard to Water Quality in Ontario Rivers. Dr. T. Unny, University of Waterloo. 1986 (1) \$27 500 (ER 332) [WQ]

An Expert System for Water Quality Assessment of Ontario Rivers. Unny, T.E. and Allison, W.C., University of Waterloo. 1989. 172 Pp. (RAC)

324 Control of Nuisance Blue-Green Algal Blooms In Eutrophic Waters Via Enhancement of Aerobic Microbial Respiration. Mr. L Molot, Molot Environmental Services Inc. 1987 (1) \$27 400 (ER 337) [WQ]

Algal Competition in Steady State Continuous Culture: Response of Anabaena and Scenedesmus to Variations in CO₂ and Iron. Molot, L. and Trick, C.G., Molot Environmental Services Inc. and University of Western Ontario respectively. 1989. 26 Pp. (RAC)

325 Study of the Discharge of Grey Water from Pleasure Boats. Mr. G. Aldworth, Beak Consultants Ltd. 1987 (1) \$87 700 (ER 341) [WQ]

Grey Water Disposal from Pleasure Boats. Aldworth, G.A., Beak Consultants Ltd. 1991. 60 Pp. (RAC)

326 Lake Water Quality Monitoring Based on Remotely Sensed Data: Phase II. Dr. J. Pitblado, Laurentian University. 1987 (3) \$123 000 (ER 354) [WQ]

The Mapping of Lake Surface Water Characteristics of Northeastern Ontario Using Satellite imagery. Pitblado, J.R., Laurentian University. 1992. 157 Pp. (RAC)

327 Assessment of Biologically Based Low Flow Analysis Technique. Mr. H. Belore, Cumming Cockburn Ltd. 1988 (1) \$22 990 (ER 408) [WQ]

Assessment of the Biologically Based Low Flow Analysis Technique. Belore, H.S., Cumming Cockburn Ltd. 1990. 170 Pp. (RAC)

328 Development of an Expert System for Decision Making with Regard to Water Quality In Ontario Rivers. Dr. T. Unny, University of Waterloo. 1989 (1) \$27 500 (ER 431) [WQ]

329 Multispectral Remote Sensing Techniques for Past, Present and Future Mapping of Chlorophyll. Mr. A. Kalinauskas, Moniteq Ltd. 1989 (2) \$49 181 (ER 452) [WQ]

ZEBRA MUSSELS

1991/92 Projects

330 Ecology and Control of the Biofouler *Dreissena polymorpha*, (Bivalvia: Dreissanidae), New to the Great Lakes

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This project is a comprehensive study of the biology, ecology and distribution of zebra mussels in Lake St. Clair and the Great Lakes. Observations indicate that zebra mussels from Lake St. Clair have a life span of up to 2.5 years, but most live 1.5 years, and rapid growth rates of up to 2.0 cm per year, atypical of any recorded European population. These and other apparent differences in reproductive behaviour have implications for the suitability and timing of appropriate control measures. Maximum shell lengths average 2.3 - 2.5 cm with maximum standing crops as high as 200,000/m². Heavy infestations of zebra mussels on native bivalve species, especially on the family Unionidae, are common and appear to be responsible for a decline in unionid populations.

5/1989 (3) \$122 694 (ER 443) [WQ]

331 Opportunistic Pathogenic Microorganisms as Potential Control Agents of the Zebra Mussel

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The investigation of various environmentally acceptable methods for the control of zebra mussels is the purpose of this study. Three approaches are considered: development of microbial pathogens for the mussels; development of environmentally safe coatings based on microbial metabolites which repel mussel larvae and prevent their settlement and metamorphosis; and the isolation and development of non-toxic microbial metabolites that induce young mussels to detach from substrata. If proven effective, such biological methods for controlling zebra mussels would be an attractive alternative to such current techniques as chlorination.

11/1991 (1) \$50 139 (US) (ER 592) [WQ]

332 Cycling of PCBs by Zebra Mussels in Relation to Depth in the Great Lakes

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A set of studies which utilize attributes of zebra mussels for examining the cycling of PCBs at various depths in the Great Lakes is the basis of this undertaking. Field studies will determine whether zebra mussels attached to chains of navigational buoys and to artificial substrates placed at different depths in the water column are suitable as biomonitors for determining the vertical distribution of contaminants in the Great Lakes. This could establish the species as a viable alternative to Unionidae for this purpose. The studies will also show to what extent zebra mussels are capable of removing PCBs by their filtering and biodeposition.

5/1992 (1) \$58 588 (ER 594) [WQ]

333 Zebra Mussel Control at Water intakes

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In this project, an experimental research station for zebra mussel control at water intakes is being established and operated in the pumping house of the Port Stanley, Ont. water intake. An electric-bubble system has been designed and deployed at the site, and small scale experiments are being conducted to quantify the effects of bubbles and electricity on the settling behaviour of zebra mussel veligers. Apart from zebra mussel control, such a system could also be useful in preventing ice blockages in the winter and, by acting as a fish repellent, minimize fish kills at such water intakes.

3/1992 (1) \$70 000 (ER 595) [WQ]

ZEBRA MUSSELS

334 Potential Use of Ultraviolet Radiation as an Alternate Means of Zebra Mussel Control: Laboratory and Field Studies

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Ultraviolet radiation is a tool which could potentially be used to control zebra mussels in water flow through systems. In the initial stage of this project, laboratory trials will be used to test the feasibility of using UV radiation on both juveniles and veliger larvae for zebra mussel control, and to optimize treatment protocols. Several power and wavelength values will be tested for a variety of intervals to determine dose response of the mussels. Subsequent field trials will focus on testing the most effective protocols on natural populations of zebra mussel larvae and juveniles in flow-through chambers to determine their applicability to existing systems.

5/1992 (1) \$96 548 (ER 598) [WQ]

335 Effects of Various Handling Procedures on Responses of Zebra Mussels In Bioassay Testing

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Currently, there is no accepted protocol for conducting bioassays with zebra mussels. This project involves five separate studies which will examine the effects of maintenance method (fed/unfed), size, rate of temperature acclimation, source location, and time of year on the mortality of zebra mussels exposed to chlorine and copper. The results from these studies could then be used to develop a standard protocol for bioassay testing with this species. This protocol would be useful for standardizing results among research laboratories, with the ultimate objective of assisting in the development of alternative treatment programs for industrial and municipal water users.

5/1992 (1) \$38 754 (ER 601) [WQ]

336 Effectiveness of Alum on Removal of Zebra Mussel Veliger Larvae from Raw Water Supplies

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Coagulation and flocculation are important processes in many water and wastewater treatment plants, and in industrial water clarification processes. However, the role of coagulants such as alum in the destruction and removal of zebra mussel veliger larvae is unknown. This project involves a series of field laboratory studies designed to determine both the effectiveness of alum for killing and/or removing veliger larvae from raw water supplies and the mechanism(s) of lethality and removal. Since some facilities pre-chlorinate the water before alum treatment, the studies will also look at the effect of chlorine on alum's effectiveness for this purpose.

3/1992 (1) \$36 995 (ER 615) [WQ]

MUNICIPAL WATER TREATMENT AND SUPPLY

1991/92 Projects

337 Slow Sand Filtration for Production of Drinking Water in Small Northern Communities

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Slow sand filtration (SSF) is a simple water treatment process that has potential for treating low turbidity raw water. This system offers substantial advantages for small communities where land is inexpensive including low operating costs and simple design, construction, operation and maintenance. The objective of this study has been to investigate the design, operation and maintenance of a SSF plant for the treatment of drinking water in small northern communities, and in particular, whether SSF can be used in combination with pre-treatment for colour removal.

11/1986 (5) \$150 000 (ER 296) [WQ]

338 Modelling Municipal Water Systems for Demand Management

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In Ontario, supply augmentation is the traditional approach to municipal water systems. With demand management, the need for expansion of water supplies and waste water treatment plants can be delayed. The aim of this project is to produce a computer model, with an interactive use interface, of the municipal water system that incorporates demand management options. The modelling effort to date has been concerned with the effect of price on demand and with such water using fixtures as toilets and shower heads. The installation of water saving fixtures and retrofitting of ordinary fixtures with water saving devices have also been included.

5/1989 (2) \$52 658 (ER 437) [ESE]

Previous Projects

339 Chloroform Reduction investigation Program at Belleville Utilities Commission. Mr. Simmons, Gore & Storrie Ltd. 1977 \$29 000 (ER 08) [WQ]

Chloroform Reduction investigation Programme at Belleville Utilities Commission. O'Connor, E.G. and Simmons, R.A.G., Belleville Utilities Commission and Gore & Storrie Ltd, respectively. 1979. 40 Pp. (BLO)

340 Organic Contaminants Removal from City of Brantford Drinking Water. Mr. Wilson, City of Brantford. 1978 \$37 000 (ER 21) [LSW]

341 Ozone Application as an Alternative to Chlorine for Drinking Water Disinfection. Mr. Murphy, Beak Consultants Ltd. 1979 \$224 600 (ER 27) [WQ]

Ozonation as an Alternative to Chlorination for Drinking Water Disinfection. Robertson, J.L., IEC Beak Consultants Ltd. 1983. 50 Pp. (BLO)

342 Biomonitoring of Public Water Supplies. Dr. Beak, Beak Consultants Ltd. 1979 \$214 400 (ER 29) [WQ]

Biomonitoring of Organic Compounds in Drinking Water. Fitchko, J., IEC Beak Consultants Ltd. 1981. 194 Pp. (BLO)

343 Characterization and identification of Organic Substances in Drinking Water. Dr. G. Thomas, ORTECH International. 1979 \$200 000 (ER 31) [WQ]

Characterization and Identification of Organic Substances in Drinking Water. Das, B.S. and Thomas, G.H., Ontario Research Foundation. 1980. 138 Pp. (BLO)

344 A new Potable Water Treatment Method for Trihalomethane Precursor and Synthetic Organic Removal. Dr. J. Bersillon, Zenon Environmental Inc. 1981 (1) \$30 000 (ER 53) [WQ]

345 Trace Organic Contaminant Removal from Drinking Water. Dr. J. Hilton, MacLaren Plansearch. 1984 (6) \$940 900 (ER 99) [WQ]

346 A Critical Study of the Status of Great Lakes Drinking Water. Dr. M. Cole, Health and Welfare Canada. 1984 \$100 000 (ER 120) [WQ]

347 Ozonation -Theoretical Study. Mr. W. Hargrave, Gore & Storrie Ltd. 1984 \$14 900 (ER 121) [WQ]

Ozone Treatment and Trace Organic Contaminants in Drinking Water. Hargrave, W.J., Gore & Storrie Ltd. 1984. 31 Pp. (BLO)

348 Analysis of Water Treatment Plant Chemicals for Contaminants. Dr. F. Karasek, University of Waterloo. 1984 \$25 000 (ER 127) [AMID]

Analysis of Trace Organic Constituents in inorganic Chemicals Using Gas Chromatography/Mass Spectrometry. Karasek, F.W. and Thompson, T.S., University of Waterloo. 170 Pp. (BLO)

349 Combined Ozone/Biologically Activated Carbon Treatment at Atikokan. Dr. Constantine, M.M. Dillon Ltd. 1984 \$70 000 (ER 168) [WQ]

Atikokan Pilot Test. Constantine, Dillon Consulting Engineers and Planners. 1985. 144 Pp. (BLO)

350 Applying New Technology for Defluoridation of Water Supply Systems. Dr. Halliday, Proctor and Redfern Ltd. 1985 (2) \$18 000 (ER 180) [WQ]

351 Computer Based Centralized Control Systems for Water Supply. Mr. T. Fowle, Simcoe Engineering Group Ltd. 1986 (1) \$20 000 (ER 236) [WQ]

Computer Based Centralized Control Systems for Water Supply and Sewerage Facilities. Fowle T., Simcoe Engineering Group Ltd. 1988. 42 Pp. (BLO)

352 Perception and Use of Water Demand Management Strategies in Ontario Municipalities. Dr. R. Kreutzwiser, University of Guelph. 1986 (2) \$8 800 (ER 273) [WQ]

353 Assessment of the Influence of Various Factors on Water Use Across Ontario - Stage I. Mr. L. Smith, Gore & Storrie Ltd. 1986 (1) \$15 000 (ER 279) [WQ]

354 Kirkland Lake Water Treatment Plant Alternative Process Research. Mr. D. Fisher, Proctor and Redfern Ltd. 1987 (1) \$69 000 (ER 289) [WO]

Town of Kirkland Lake Water Treatment Plant Alternative Process Research. Fisher, D.R., Proctor and Redfern Ltd. 1988. 26 Pp. (RAC)

355 Development of an Optimum System for the Application and Regeneration of Powdered Activated Carbon In Water Treatment Plant. Mr. A. Benedek, Zenon Environmental Inc. 1987 (2) \$330 125 (ER 379) [WQ]

AIR QUALITY

1991/92 Projects

356 Hamilton Air: Chemical Composition and Genotoxic Activity of Respirable Particulate and Organic Vapours

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The objectives of this study are to determine: 1) what levels of airborne mutagenicity can be detected on respirable particles in the Hamilton airshed as a function of season and meteorological conditions; 2) if a simple mammalian index of genotoxic hazard can be developed using a post-labelling technique which permits the quantitation of DNA adducts formed with activated carcinogens; 3) what chemical classes contribute to the mutagenicity of Hamilton air; 4) how total airborne mutagenicity relates to the air quality index.

2/1988 (3) \$370 396 (ER 386) [MMCB]

357 Development of Multivariate Analysis Procedures for Ontario Air Quality Data

Dr. Philip Hopke (315) 268-3861
Department of Chemistry
Clarkson University
Potsdam, NY 13699-5630

The ministry has a number of on-going air quality monitoring programs that produce large multivariate data sets. The objective of this study is to develop new methods that will provide improved analysis of such data and test existing methods as to their utility in providing useful information from the air quality data that are available. Improved multivariate statistical analysis methods will permit the maximum amount of useful information to be extracted from these data sets and aid in the development and implementation of air quality management plans to maintain or improve the air quality in Ontario.

5/1989 (3) \$59 200 (US) (ER 433) [AQ]

358 Determination of Residential Wood Combustion impact on Ontario Communities

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Downsview, Ont. M3H 2V2

Residential woodburning combustion (RWC) has been cited as a source of emissions impacting air quality yet its significance is presently largely undocumented. This study involved the characterization of emissions from locally available woodstoves and fuel types for both organic and inorganic compounds.

4/1991 (1) \$130 325 (ER 481) [AQ]

359 Analysis of Spatial and Temporal Distribution of Inhalable Air Particulates in Ontario

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This project has involved the collection and study of inhalable air particulates less than 10 microns in diameter to establish: a) their bulk elemental composition; b) the elemental distribution within individual particles; c) the chemical stage and reactivity of individual particles and aggregates of particles; d) their size distribution and physical characteristics; and e) the spatial and temporal distribution of particles across the province. The resulting data will be used in setting an inhalable particulate standard for Ontario.

5/1990 (2) \$117 100 (ER 482) [AQ]

360 Validation of Pulmonary Mutagenicity as an Index of Pulmonary Carcinogenicity

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The validation of two new assays (in the combined form called the Concurrent Assay) for inhaled carcinogens is the focus of this study. The assays, for gene mutations and chromosomal aberrations, measure the frequency of genetic events associated with carcinogenic initiation in lung cells. Specific objectives of the project are to establish rigorously the genetic nature of the events being detected in the Concurrent Assay; to investigate the influence of such important variables as age, species specificity and exposure rate; to extend the validation of the assay beyond the small number of potent mutagenic carcinogens studied to date to

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include carcinogenic and non-carcinogenic polycyclic aromatic hydrocarbons; and to investigate the quantitative correlation between mutagenic and carcinogenic effects of exposure.

1/1991 (3) \$197 304 (ER 522) [MMCB]

361 Measurements of Natural and Anthropogenic Volatile Organic Compounds In the Regional Atmosphere

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Measurements of the atmospheric concentrations of a number of key volatile organic compounds (VOCs) at appropriate rural and urban areas are being undertaken in order to evaluate the relative importance of biogenic and anthropogenic VOCs in the regional oxidant problem. This study, as part of the Canadian Oxidant Research Program (CORP), will also contribute to a better understanding of atmospheric chemistry in representative Canadian areas. An integral part of such a program is the critical evaluation and improvement of sample collection and handling techniques employed for the gas chromatographic analysis, of labile compounds and their oxygenated products.

6/1991 (3) \$265 000 (ER 530) [AQ]

362 Studies of Oxidant Formation In Rural Areas In Ontario

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The objective of phase 1 of the project is to develop and validate techniques for the measurement of NO_x oxidation products of the natural hydrocarbon, isoprene, organic nitrates and total peroxy radicals. This methodology will be used at Dorset, Ont to produce a comprehensive suite of data on inorganic reactants and organic and inorganic photochemical reaction products occurring under a variety of meteorological conditions. This data will then be used as input for a detailed modelling study to evaluate the nature of free radicals involved in NO/NO_x chemistry, the importance of isoprene and its oxidation products on ozone formation, and the role that PAN production/decay may have on this chemistry.

6/1991 (3) \$346 825 (ER 531) [AQ]

363 Development of a Computer Model to Determine Environmental Impact of Electric Vehicles In Ontario

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Although electric vehicles (EVs) do not emit air pollutants during operation, power plants that use fossil fuels to generate electricity do. This project involves the development and implementation of a computer model to estimate net changes in emissions of carbon monoxide, hydrocarbons, NO_x and SO₂ for different numbers and types of EVs introduced, and internal combustion engine vehicles replaced, in specific locations in Ontario. This data could be used to demonstrate the quantitative environmental benefits of the wide-scale introduction of EVs to fleet operators and the public, and to indicate which regions should or should not be encouraged to use Evs.

6/1991 (2) \$60 800 (ER 549) [ESE]

364 Biological Risk due to Mixtures of Hazardous Chemicals

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Vast amounts of data exist on the biological effects of individual chemicals. However, the natural environment contains mixtures of chemicals whose interactions cannot yet be predicted. This makes human risk assessment difficult. Previous research has shown that some pairwise and three component interactions in short term assays can be predicted mathematically under certain conditions by equations of the form:

$$\text{Response [A+B]} = [\text{Response A} + \text{Response B}] \times [1 + K_{AB} \text{Log A/B}]$$

The objective of this study is to test the general applicability of this approach by extending analysis to such other directions as mixtures of three or more components, which more realistically reflect 'natural' systems.

6/1991 (1) \$8 795 (ER 554) [MMCB]

365 Development of Multivariate Analysis Procedures for Ontario Air Quality Data

Dr. Philip Hopke

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Department of Chemistry
Clarkson University
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The ministry has a number of on-going air quality monitoring programs, including networks for acid species, volatile organic and toxic organic compounds, which provide large, high quality, multivariate data sets. This project continues the development and testing of state-of-the-art multivariate statistical analysis methods initiated previously (see ER 433) for deriving useful information from the available data. The goal is to develop means of extracting the maximal amount of information regarding the emissions and atmospheric processes that give rise to the observed values, and thus provide useful assistance in the development and implementation of air quality management strategies for the improvement of air quality in Ontario.

5/1992 (1) \$19 760 (US) (ER 602) [AQ]

366 Biogenic Hydrocarbon Emission Measurement

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Biogenic emissions of volatile organic compounds are believed to be a significant factor contributing to the formation of ozone in Ontario. In this study, biogenic hydrocarbon emissions produced by various tree species, including maple and spruce, in the Windsor-Quebec City condor will be measured. Environmental and phytological variables will be monitored in order to deduce, from the emission data, those parameters enabling the emission modelling of biogenic hydrocarbons generated in a territorial element containing a significant fraction of these species. This information can then be considered when planning control strategies for volatile organic compounds in general.

5/1992 (3) \$149 400 (ER 612) [AQ]

Previous Projects

367 A Study to Evaluate Urban Road Dust as a Source of Suspended Particulates. Mr. Hunt, Concord Scientific Corporation. 1979 \$177 000 (ER 32) [AQ]

An Assessment of Street Dust and Other Sources of Airborne Particulate Matter in Hamilton, Ontario. Hunt, Concord Scientific Corporation. 1982. 305 Pp. (BLO)

368 Surface Photochemistry of Pollutants. Dr. L. Johnston, University of Western Ontario. 1979 \$152 000 (ER 34) [AQ]

Surface Photochemistry of Adsorbed Organic Species. Johnston, L.J. and de Mayo, P., University of Western Ontario. 1982. 16 Pp. (BLO)

369 Bruce Hydroelectric Thermal Plume Definition Flights. Mr. Brumbaugh, Intertech Remote Sensing Ltd. 1980 \$14 000 (ER 41)

Bruce and Pickering Thermal Plume Definition Flights. Brumbaugh, Intertech Remote Sensing Ltd. 11 Pp. (BLO)

370 Monitoring Genotoxicity In the Atmosphere Using Sister Chromatid Exchange in Mice. Dr. M. Petras, University of Windsor. 1983 \$62 000 (ER 66) [AQ]

371 Experimental Modelling Studies of Hazardous Substances In Ontario. Dr. D. Mackay, University of Toronto. 1982 \$164 000 (ER 68) [AQ]

Environmental Modelling Studies of Hazardous Substances in Ontario. Cheung B., University of Toronto. 211 Pp. (BLO)

372 A Mass Spectrometric Study of Selected Air Pollutants. Dr. R. March, Trent University. 1982 \$43 600 (ER 69) [AMID]

A Mass Spectrometric Study of Selected Air Pollutants. March, R.E., Trent University. 1983. 43 Pp. (BLO)

373 Evaluation of Contaminated Water and Soli Sites as Sources of Airborne Hazardous Materials. Dr. Mackay, University of Toronto. 1982 \$51 000 (ER 74) [AQ]

374 Sampling and Analysis of Polycyclic Aromatic Hydrocarbon Derivatives In Urban Air Particulates. Dr. M. Quilliam, McMaster University. 1983 \$28 000 (ER 78) [AQ]

375 Chemical Speciation of Airborne Particulate Matter. Dr. D. Burgess, McMaster University. 1983 \$19 000 (ER 80) [AQ]

376 Methods for Sampling and Analysis of Asbestos Air Pollution in Ontario. Dr. D. Verma, McMaster University. 1982 \$30 300 (ER 83) [AQ]

Methods of Sampling and Analysis of Asbestos Air Pollution in Ontario. Verma, D.K., McMaster University. 1987. 25 Pp. (LQO)

377 Inhalable Particulate Sampling. Mr. J. Hicks, Ontario Ministry of the Environment. 1983 \$133 200 (ER 88) [AQ]

Inhalable Particulate Network - Standard Operating Procedures and Technical Manual. Hicks, J. and Steer, P., MacLaren Plansearch Inc. 1987. 28 Pp. (BLO)

378 Trace Organic Contaminants. Dr. H. Tosine, ORTECH International. 1983 \$140 900 (ER 93) [AQ]

379 Inhalable Particulate Sampling. G. Thomas, ORTECH International. 1983 \$29 600 (ER 98) [AQ]

380 Retrospective Correlation Spectroscopy and Its Application to Atmospheric Monitoring. Dr. G. Nicholls, York University. 1984 \$43 500 (ER 101) [AQ]

381 Gas Phase Photochemistry of Polychlorinated Biphenyls. Dr. N. Bunce, University of Guelph. 1983 \$34 200 (ER 107) [AQ]

Vapour Phase Photochemistry of Chlorinated Aromatic Hydrocarbons. Bunce, N.J., Landers, J.P. and Langshaw, J., University of Guelph. 27 Pp. (BLO)

382 To investigate the "Short Term Test" Mutagenicity and Chemical Composition of Benzene Extractable Fraction of Coke Oven Emissions. Dr. G. Thomas, ORTECH International. 1984 \$275 000 (ER 117) [AQ]

Investigation of "Short Term Test" Mutagenicity and Chemical Composition of Solvent Extractable Fraction of Coke Oven Emissions. Thomas, G.H., Horton, A.J. and Craigmile, J., Ontario Research Foundation. 61 Pp. (BLO)

383 Study of Conditions for Condensation and Desorption of Polychlorinated Dibenzodioxins and Furans on Particulate Matter Under Stack Sampling Conditions. Dr. F. Karasek, University of Waterloo. 1984 \$15 000 (ER 129) [AMID]

Study of Conditions for Condensation and Desorption of PCDD on Particulate Matter Under Stack Sampling Conditions. Karasek, F.W. and Dickson, L.C., University of Waterloo. 38 Pp. (BLO)

384 Experimentally Determined Mutation Rates in Lung and Bronchial Epithelia as a Primary Air Pollution Standard. Dr. J. Heddle, York University. 1984 \$198 000 (ER 142) [AQ]

385 The Quantitative Assessment of Toxicity of ingested and inhaled Halogenated Aromatic Hydrocarbons. Dr. G. Sweeney, McMaster University. 1984 \$139 100 (ER 165) [AQ]

Assessment of Toxicity of ingested and Inhaled Haloaromatic Hydrocarbons. Clark, D.A., Goddard, G. and Sweeney, G.D., McMaster University. 15 Pp. (BLO)

386 Chemical and Physical Characterization of Air Borne Particulates and their Sources through Multi-Element Analysis and Receptor Modelling. Dr. R. Jervis, University of Toronto. 1984 (2) \$49 800 (ER 171) [AQ]

387 The Exchange of Air Particulates Between the Inside and Outside of a Building. Dr. J. MacArthur, Queen's University. 1984 (2) \$39 700 (ER 172) [AQ]

388 CCT - Toxicology Operating Funds. Mr. Clarke, Can CTR-Toxic. 1984 \$150 000 (ER 178) [AQ]

389 Mutagenicity of Complex Mixtures of Polycyclic Aromatic Hydrocarbons in Ambient Air Particulate Matter. Dr. J. Heddle, York University. 1986 (2) \$207 600 (ER 220) [AQ]

The Mutagenic Activity of Complex Mixtures of PAH's Derived from Air Particulate Matter. Raj, A.S., York University. 1988. 91 Pp. (LQO)

390 Study of the Thermal Reactions of Polychlorinated Dibenzo-p-Dioxins of Flyash Particles Under incinerator Conditions. Dr. F. Karasek, University of Waterloo. 1986 (1) \$30 000 (ER 246) [AMID]

391 Investigate the Short Term Test Mutagenicity and Chemical Composition of Organic Solvent Extractable Fraction of Coke Oven Emissions Phase II. Dr. G. Thomas, ORTECH International. 1986 (1) \$109 400 (ER 255) [AQ]

392 A Study of High Temperature Photochemical Kinetics of SO₂ and NO_x for a Flue Gas Treatment Process. Dr. R. Caton, Concord Scientific Corporation. 1986 (1) \$227 500 (ER 268) [AQ]

393 Utilization of Established Air Pollution Monitoring Networks in Ontario Following Nuclear Incidents. Dr. J. Bond, AECL Research. 1987 (1) \$33 000 (ER 305) [AQ]

Utilization of Established Air Pollution Monitoring Networks in Ontario Following Nuclear incidents. Slade, J.A. and Laszlo, G., Atomic Energy of Canada Ltd. 1988. 68 Pp. (BLO)

394 An Evaluation of the Problem of Particulate Emissions from the Wood Products industry. Mr. M. Lepage, RWDI Consulting Engineers. 1987 (1) \$33 100 (ER 306) [AQ]

An Evaluation of the Problems of Particulate Emissions from the Wood Products industry. Lepage, M.F. and Davies, A.E., Rowan Williams Davies & Irwin Inc. 1988. 38 Pp. (LQO)

395 Development Of Multivariate Analysis Procedures For Ontario Air Quality Data. Dr. P. Hopke, University of Illinois. 1987 (2) \$57 400 (ER 311) [AQ]

Development of Multivariate Analysis Procedures for Ontario Air Quality Data. Hopke, P.K., University of Illinois at Urbana-Campaign. 1990. 52 Pp. (RAC)

396 Modelling the Photochemical Decomposition of Chlorinated Phenols by Sunlight. Dr. N. Bunce, University of Guelph. 1987 (2) \$21 200 (ER 312) [AQ]

397 Development of Ambient Air Monitoring Methodologies for Dioxins and Furans. Wellington Environmental Inc. 1987 (3) \$50 890 (ER 346) [AQ]

398 Critical Evaluation of Atmospheric Pollutant Parameterization from Satellite imagery. Dr. N. O'Neill, University of Sherbrooke. 1987 (1) \$18 000 (ER 349) [AQ]

Critical Evaluation of Atmospheric Pollutant Parameterization from Satellite imagery. O'Neill, N.T., Royer, A. and Hubert, L., Sherbrooke University. 1990. 75 Pp. (RAC)

399 Experimentally Determined Mutation Rates In Lung and Bronchial Epithella as a Primary Air Pollution Standard. Dr. J. Heddle, York University. 1987 (1) \$97200 (ER 351) [AQ]

400 Development of Monitoring Methods for Odorous Organics in Ambient Air. Ms. C. Chan, Mann Testing Laboratories Ltd. 1987 (1) \$185 000 (ER 373) [AQ]

Method Development for the Monitoring and Analysis of Odorous Organics in Ambient Air Analysis of Aliphatic Amines. Mann Testing Laboratories Ltd. 1988. (LQO)

401 Mutagenicity Studies and Risk Estimation of Complex Mixtures of Organic Airborne Contaminants. Dr. D. Logan, York University. 1988 (1) \$195 000 (ER 390) [AQ]

402 Atmospheric Measurements of Natural Hydrocarbons Using Gas Chromatography/Mass Spectrometry: Dr. H. Niki, York University. 1988 (3) \$256 458 (ER 401) [AQ]

403 Development of Standard for Safe Gas Composition Limits and of a System to Eliminate or Shorten the De-Energization [Outage] of Electrostatic Precipitators in Cement Plants During Explosive Conditions. Dr. I. Inculet, University of Western Ontario. 1988 (2) \$61 500 (ER 402) [AQ]

Development of Standards for Safe Gas Compositions in Cement Plants. Wick, M.L., University of Western Ontario. 1990. (BLO)

404 An Evaluation of Methods to Determine the impact of Residential Wood Burning on Ambient Air Quality. Dr. C. Davis, Concord Scientific Corporation. 1989 (1) \$34467 (ER 426) [AQ]

Evaluation of Methods to Determine the impacts of Residential Woodburning on Ambient Air in Ontario. Yandle, M.E., Davis, C.S., and Dougherty, D.L., Concord Scientific Corporation. 1989. 150 Pp. (RAC)

405 A Study of the Peak Ozone Levels In the Toronto Area. Mr. L. Shenfeld, The MEP Company. 1990 (1) \$11 925 (ER 474) [AQ]

A Study of the Peak Ozone Levels in the Toronto Area, 1990. The MEP Company. 1990.40 Pp. ((RAC)

DISPERSION OF GASES AND AIR POLLUTANTS

1991/1992 Projects

406 Modelling Higher Moments In the Concentration Probability Distribution (Concentration Fluctuations)

Dr. E. Alp

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A mathematical modelling system to predict the magnitude and frequency of peak concentrations which make up the averaged mean concentration was developed and evaluated under field conditions. The system uses dispersion and meteorological parameters calculated via the Clean Air Program GAS model to drive the Empirical Gaussian Model to estimate concentration intensity and plume intermittency. These results are used to determine 'quasi' instantaneous concentrations at various percentile levels.

5/1989 (1) \$70 000 (ER 389) [AQ]

Modelling Concentration Fluctuations in the Atmosphere. Ciccone, A. and Alp, E., Concord Environmental Corp. 1991. 134 Pp. (PUB)

407 Testing Atmospheric Dispersion Model Performance and Developing Codes to Include Deposition into the Model

Ms. Elizabeth Robertson

(613) 584-3311

Atomic Energy of Canada Ltd.
Chalk River Nuclear Laboratories
Chalk River, Ont. K0J 1J0

The focus of this project is a validation of the ministry's regulatory Model 308 using the same monitoring data from Sudbury as were applied to the Chalk River dispersion model. This will improve confidence in the use of Model 308 for regulatory purposes and possibly reveal aspects of it which require further research. A second objective is to develop and test submodels so that depositional processes can be included in the Chalk River dispersion code. This will enable the ministry to better predict the loading of vegetated and aquatic surfaces by atmospheric pollutants by local sources and the effect of decreasing emissions.

8/1989 (1) \$22 000 (ER 451) [AQ]

408 Dense Gas Dispersion Modelling Including Topography

Dr. Stephen Ramsay

(519) 661-3338

EnviroTech Research Ltd.
1386 Hastings Dr.
London, Ont. N5X 1B1

The improvement of dense gas dispersion modelling in the presence of topography using the GASTAFI model as the basis for development is the objective of this study. The project is part of an ongoing effort to develop a model having capabilities in computing dense gas dispersion in the presence of buildings, obstacles and topography and suitable for operational emergency management (see ER 528)

6/1990 (2) \$41 612 (ER 479) [AQ]

409 Dense Gas Dispersion Modelling Including Buildings and Obstacles

Dr. Stephen Ramsay

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The effect of buildings and obstacles are known to be important for calculating the dispersion of dense gas, yet they have not been satisfactorily quantified or incorporated into a dispersion model of any generality to date. This project involves the further development and evaluation of an improved dense gas dispersion model incorporating such effects using the GASTAR model as the basis for development (see ER 479). Although the current GASTAR dense gas dispersion model has limited capabilities for computing dense gas dispersion influenced by buildings and obstacles, this project addresses the considerable additional work that is required to develop a model suitable for operational emergency management.

9/1991 (1) \$33 925 (ER 528) [AQ]

410 A Long Range Transport Model with a Nested Fine Resolution Grid - Phase 2

Dr. Michel Niewiadomski

(416) 477-0870

The MEP Company
Unit 4, 410 Bentley St.
Markham, Ont. L3R 9T2

In this project, a nested mesoscale modelling system consisting of a long range transport model (ADOM), a meteorological mesoscale model (Gesima) and a mesoscale version of ADOM developed previously, is being refined and applied to the simulation of several case studies of small scale properties of air pollution in Southern Ontario. Emphasis is placed on oxidant issues. The goal of these simulations is both the understanding of the particular cases studied and the testing and validation of the model itself.

7/1991 (1) \$73 766 (ER 529) [AQ]

411 Physical Model Simulation of Concentration Fluctuations

Dr. Anton Davies

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650 Woodiawn Rd. W.
Guelph, Ont. N1K 1B8

While concentration averaging periods of tens of minutes to hours are sufficient for many ambient air quality monitoring programs, there are a number of applications for which shorter term concentrations are important. Among these are effects on health and safety such as short term toxicity and explosive concentrations, and odour assessment. This study involves a comparison of short-term gas concentration fluctuations in a wind tunnel, physical model with data collected by the ministry's mobile air monitoring unit. These wind tunnel simulations and comparisons will demonstrate the applicability of physical modelling to a number of areas where short term concentrations are important, and also provide confidence limits for the application of wind tunnel simulations in such instances. 5/1992 \$76 000 (ER 533). [AQ]

412 A Long Range Transport Model with a Nested Fine Resolution Grid: Phase III

Dr. Michal Niewiadomski

(416) 477-0870

The MEP Company
Unit 4, 401 Bentley St.
Markham, Ont. L3R 9T2

As part of this ongoing project (see ER 529), a nested regional/mesoscale modelling system for transport, transformation and deposition of atmospheric pollutants had been previously developed. This phase of the project will incorporate refinements in the design of the model with regard to cloud parameterization, a further reduction in resolution to a grid size down to 2 to 5 km and utilization of

the model for determining the impact on ozone, acid deposition and toxic pollutant concentrations on various control scenarios. The resulting model will significantly improve on currently available models which do not simulate ozone production accurately because their spatial resolution is too coarse.

5/1992 (1) \$76 782 (ER 604) [AQ]

Previous Projects

413 A Study of Atmospheric Mercury Deposition in Ontario. Dr. Steele, ORTECH International. 1978 \$52 000 (ER 14) [AQ]

Mercury in the Atmosphere. Ontario Research Foundation. 1978.94 Pp. (BLO)

414 The Dispersal of Airborne Particulates on a Short and Long Term Scale. Dr. M. Depew, Queen's University. 1983 \$390 000 (ER 100) [AQ]

415 The Deposition of Aerosols on Cylinders and Fitters In Turbulent Crossflow. Dr. P. Douglas, Queen's University. 1984 \$18 000 (ER 164) [AQ]

A Fundamental Study on the Deposition of Aerosols on Cylinders in Turbulent Cross Flows. Ilias, S. and Douglas, P.L, Queen's University. 20 Pp. (BLO)

416 Portable Computing System for Use In Toxic Gas Emergencies. Dr. Tam, Ontario Ministry of the Environment. 1986 \$25 000 (ER 183) [AQ]

A Portable Computing System for Use in Toxic Gas Emergencies. Diamond, G.L *et al.*, Air Resources Branch, Ontario Ministry of the Environment. 1988. 20 Pp. (BLO)

417 Measurement of Atmospheric Constituents by Tunable Diode Laser Absorption Spectrometry. Dr. H. Schiff, Unisearch Associates. 1985 \$20 000 (ER 189) [AQ]

418 Building Wake Study of Darlington. Dr. G. Orgram, C.C. & C. Computer Systems. 1986 (1) \$44 000 (ER 221) [AG]

419 Study of the Spatial Distribution of the Impact of Sudbury Smelting Emissions. Dr. E. Bean, University of Waterloo. 1986 (1) \$10 900 (ER 254) [AQ]

420 identification of Long Range Aerosol Sources at the Dorset Environmental Station. Dr. J. Drake, McMaster University. 1986 (2) \$74 400 (ER 272) [AMID]

421 Scale Model Studies and Development of Prediction Procedures for Heavy Gas Dispersion in Complex Terrain. Dr. P. Irwin, Rowan Williams Davies & Irwin Inc. 1987 (2) \$242 000 (ER 310) [AQ]

Scale Model Studies and the Development of Prediction Procedures for Heavy Gas Dispersion in Complex Terrain. Irwin, PA., Rowan Williams Davies & Irwin Inc. 1990. 64 Pp. (PUB)

422 Physical and Chemical Processes Affecting Long Range Transport of Air Pollution and Acid Rain. Dr. H. Cho, University of Toronto. 1987 (3) \$291 600 (ER 313) [AQ]

423 Atmospheric Trace Gas Measurements Using a Tunable Diode Laser Absorption Spectrometer. Dr. D. Hastie, York University. 1987 (3) \$611 500 (ER 314) [AG]

Atmospheric Trace Gas Measurements Using A Tunable Diode Laser Absorption Spectrometer. Hastie, D.R. and Schiff, H.I., York University. 1991. 16 Pp. (BLO)

424 Determination of Source-Receptor Links by Size-Specific Multi-elemental Inorganic Component Determination and Modelling. Dr. R. Jervis, University of Toronto. 1987 (3) \$93 400 (ER 347) [AQ]

425 Eulerian Model Evaluation Study. Dr. M. Alvo, University of Ottawa. 1987 (3) \$63 500 (ER 348) [AQ]

426 Digital image Analysis of Particles In a Turbulent Wind. Dr. J. Keffer, University of Toronto. 1987 (2) \$140 184 (ER 372) [AQ]

427 Modelling of the Fluctuations of Air Pollutant Concentrations. Ms. E. Robertson, Atomic Energy of Canada Ltd. 1988 (1) \$6 000 (ER 403) [AQ]

428 The Development of a Long Range Transport Model with a Nested Fine Resolution Grid. Dr. M. Niewiadomski, The MEP Company. 1990 (1) \$75 680 (ER 475) [AO]

The Development of a Long Range Transport Model with a Nested Fine Resolution Grid. Niewiadomski, M. and Shenfeld, L 1991. 141 Pp. (RAC)

CLIMATE CHANGE

1991/92 Projects

429 CO₂ Production and Carbon Cycling In Precambrian Shield Watersheds

Dr. Sherry Schiff

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This study has evaluated carbon fluxes between the main carbon pools, atmospheric and soil CO₂, dissolved inorganic carbon and dissolved organic carbon, involved in the carbon cycle in two forested watersheds located in the Precambrian Shield. Both isotopic (¹³C and ¹⁴C) and chemical tools are used. Knowledge of the magnitude and pathways of carbon fluxes in these ecosystems is important in the quantification of the natural and anthropogenic sources and sinks of carbon with regard to the global carbon budget and the generation of alkalinity to neutralize the effects of acidic precipitation.

10/1989 (1.5) \$66 240 (ER 465) [WQ]

430 Ozone Depletion by CFCs and UVB increases over Ontario

Dr. Wayne Evans

(705) 748-1622

Environmental and Resource Studies
Trent University
Peterborough, Ont. K9J 7B8

Through an analysis of ozone records and model calculations, the objective of this study is to determine present and predict future levels of ozone depletion over Ontario due to the activity of chlorofluorocarbons and methyl chloroform. On the basis of this information, it will then be possible to model and quantify how much additional UVB radiation the Ontario population has been exposed to in the past, and allow an estimate of future UVB radiation damage. This data can be used to approximate future increases in skin cancer in Ontario due to past and future exposure to these elevated radiation levels. A realistic assessment of future health costs in Ontario due to this anthropogenic damage could then be made.

6/1991 (3) \$69 000 (ER 5.32) [AQ]

431 Efflux of Trace Greenhouse Gases from Agricultural Sites into the Atmosphere

Dr. George Thurtell

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Department of Land Resource Science
University of Guelph
Guelph, Ont. N1G 2W1

This study applies tunable diode laser technology to the measurement of nitrogen oxide compounds and methane fluxes into the atmosphere from various agricultural sites. Different locations including livestock feedlots and the influence of such factors as soil type, climate, fertilizer additions, manure application and cropping history are included. In combination with that from other studies, this data could lead to increased efficiency in the use of applied nitrogen for crop production, less nitrate transfer to groundwater, a decrease in the transfer of nitrogen oxides to the atmosphere (thus lessening the impact on ozone production and destruction) and reduced input of greenhouse gases into the atmosphere.

6/1991 (3) \$282 080 (ER 534) [AQ]

432 Dendrochronological Reconstruction of Ontario's Past Climates Using *Thuja occidentalis* from Niagara Escarpment Cliffs

Dr. Douglas Larson

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University of Guelph
Guelph, Ont. N1G 2W1

An abundant supply of exceptionally old living and dead *Thuja occidentalis* is present on cliffs of the Niagara Escarpment. This project will develop a fully cross-dated tree-ring index for these cedars covering an extended period of time (at least 1500 and possibly over 2900 years). Based on the growth response of cedars to various temperature and/or precipitation patterns for the 110 years for which actual climate data have been measured, this index could then be used as a proxy data set for past climates in eastern North America. This reconstruction of long-term climatology will permit an evaluation of the rate and extent of current global warming within the context of normal climatic fluctuations.

5/1992 (2) \$112 600 (ER 600) [AQ]

433 Carbon Cycling In and Carbon Export from Wetlands in Muskoka Watersheds, Ontario

Dr. Ramon Aravena

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Department of Earth Sciences
University of Waterloo
Waterloo, Ont. N2L 3G1

This study will investigate carbon cycling in wetlands in forested catchments on the Canadian Shield in Central Ontario. A detailed evaluation of the main carbon pools (peat carbon, methane, carbon dioxide, dissolved organic and inorganic carbon) will be carried out in two representative wetlands with ecological and Geochemical tools being used to estimate carbon accumulation rates and carbon sources for methane, and dissolved organic and inorganic carbon. Knowledge of the source and sink carbon dynamics of wetlands in this area is important in predicting the role of these systems as sources or sinks of greenhouse gasses to the atmosphere, their relationship to global carbon budget and climatic changes.

5/1992 (2) \$78 490 ER 622 [WQ]

434 Measurements of Emissions from Landfills and Natural Gas Distribution Systems

Dr. Harold Schiff

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Unisearch Associates Inc.
222 Snidercroft Rd.
Concord, Ont. L4K 1B5

In this project, a method based on tunable diode laser absorption spectroscopy will be developed and applied to the measurement of methane emissions from natural gas transmission and distribution systems, and various landfill sites. As well as demonstrating the abilities of the instrument itself, this will allow an assessment of Ontario's contribution to global warming by methane from these sources. The study will also provide methane emission data for inclusion in provincial oxidant production models and provide information on such other questions as the efficiency of landfill methane recovery systems.

5/1992 (2) \$79 700 (ER 628) [AQ]

**PHYTOTOXICOLOGY
AND ECOTOXICOLOGY**

1991/92 Projects

435 Response of Sugar Maple Seedlings (*Acer saccharum*) to Aluminum Stress as Measured by Acid Phosphatase Activity, Rhizosphere pH (Al Avoidance) and Root Organic Acid Content (Al Detoxification)

Dr. Magda Havas

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The purpose of this study is to 1) compare the relative tolerance of *Acer saccharum* (sugar maple), *Picea rubens* (red spruce), *Picea abies* (Norway spruce) and *Abies balsamea* (balsam fir) seedlings to Al; 2) to determine the degree to which Al-tolerant plants are able to take up Ca, P and such trace nutrients as Cu, Mn and Zn in the presence of Al; and 3) to investigate possible mechanisms of Al tolerance including the ability of plants i) to increase rhizosphere pH and thus precipitate Al, ii) to release organic acids and thus chelate Al and, iii) to produce acid phosphatase during periods of P deficiency.

2/1988 (3) \$96 860 (ER 350) [AQ]

436 Relationship of Sugar Maple Decline and Corresponding Chemical Changes in Sap Composition (Carbohydrates and Trace Elements)

Dr. Dibyendu Roy

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University of Toronto
Toronto, Ont. M5S 1A4

Chemical analysis of the xylem sap of healthy and declining sugar maple trees including seasonal effects is the focus of this study. Various differences in sap content of healthy and declined trees have been identified to date. For example, total sugar content and pH, and levels of calcium, potassium and boron are lower in declined trees while levels of aluminum, manganese and iron are higher. The ultimate objective is to correlate these chemical differences with a physical assessment criterion of decline. This chemical index could indicate the onset of the decline syndrome in advance of the appearance of physical symptoms (see project ER 524).

11/1987 (3) \$53 750 (ER 352) [AQ]

437 Determination of Dose-Response for Tissue Contamination, and Growth of Vegetable Crops, Exposed to Chronic Levels of Organic Environmental Contaminants Originating from industrial Processes

Dr. Beverley Hale-Marie

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While a large amount of data is available on the uptake and accumulation of agricultural organic chemicals by vegetation, there is a lack of such information for industrial organic chemicals. This project is an integrated study evaluating the effects of chronic concentrations of naphthalene on root, leafy and fruit vegetables by comparing the roles of the pathway of exposure through root and foliage on phytoaccumulation in various plant parts, as well as injury and growth suppression. The toxicity dose response models for naphthalene produced from these results will contribute to a better understanding of how these industrial contaminants are partitioned in the terrestrial environment, leading to better human and ecological risk assessment.

4/1988 (3) \$108 151 (ER 405) [AQ]

438 Phytotoxicity of Uranium

Dr. Stephen Shephard

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There are conflicting reports in the literature as to the possibility of uranium toxicity to plants. In this study, which utilized plant germination, growth and phosphatase activity parameters, and earthworm survival tests, significant toxic effects of uranium were not evident at concentrations below 300 mg/kg soil, this level being well above that found in most areas contaminated by industry. It is suggested that in any areas where levels as high as this are found, other contaminants such as arsenic, which are often found in concert with high levels of uranium, will pose more important hazards. A second part of the project compared two biological (plant and earthworm) and two chemical extraction methods as indices of the bioavailability of uranium.

4/1990 (1) \$29 723 (ER 476) [AQ]

Final Report Received (REV)

439 interpretation of Sugar Maple (*Acer saccharum*) Ring Chronologies from Central and Southern Ontario Using a Mixed Linear Model

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The development of a statistical model relating climate to the growth rate of sugar maple in Southern and Central Ontario is the objective of this study. This growth rate data (tree ring widths) was previously collected from over 1000 trees in three Ontario regions representing high, moderate and low levels of atmospheric pollution. Once the influence of climate and (where possible) such other non-pollutant factors as insect and disease infestations is removed, it will be possible to determine whether the observed recent decline in the growth rate of maples in some areas can be attributed to the increased atmospheric pollution levels that have occurred in the last 45 years.

5/1990 (1) \$8 717 (ER 478) [AQ]

440 The Significance of Metabolic Changes in Eastern White Pine Seedlings for Early Diagnosis of Fluoride Injury

Dr. Janusz Zwiazek

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This project is examining the effects of low doses of gaseous hydrogen fluoride on various metabolic parameters of eastern white pine seedlings with a view to determining their suitability for early diagnostic detection of fluoride injury. One such early effect of fluoride exposure observed is an increase in membrane permeability measured as electrolyte leakage. Plasma membranes isolated from fluoride treated plants also show a number of alterations in composition including changes in sterol content and ATPase activity. This implicates disruption of cell plasma membranes in the development of fluoride injury and suggests that such membrane changes may be useful in determining early effects of fluoride on plants.

4/1990 (2) \$59 539 (ER 483) [AQ]

441 Development of a Video Image-Based Maple Decline Index

Dr. Doug King

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The completion of development of a comprehensive and operational aerial video-based methodology for the assessment of sugar maple decline is the objective of this project. Using this system, both spectral (degree of chlorosis) and textural (changes in leaf orientation or leaf fall) images could be objectively quantified and used to provide an accurate assessment of the extent of decline. This technique would be an alternative to the existing ground-based method. The ground based method is expensive and difficult to perform objectively because estimates of decline symptoms are made visually from below the tree crown while decline usually progresses downwards from the top of the crown.

1/1991 (1) \$25 000 (ER 518) [AQ]

442 interaction of Polycyclic Aromatic Hydrocarbons with Higher Plants: Bioconcentration, Phytotoxicity and Development of a Phytotoxicity Assay

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This study has involved an examination of the extent and kinetics of assimilation of six representative polycyclic aromatic hydrocarbons (PAHs) by plants, and the investigation of the photoinduced toxicity of these PAH compounds. The aquatic higher plant *Lemna gibba* has been used as the model system. Strikingly, PAH photoproducts have been found to be more toxic to *Lemna* than their parent compounds. Since current environmental loads of PAHs are based entirely on the intact chemicals, the severity of PAH effects are very likely to be underestimated. More generally, the results show that photoprocesses cannot be ignored when evaluating the impacts of a potentially hazardous contaminant

12/1990 (1) \$38 310 (ER 520) [MMCB]

443 Sugar Maple Decline and Corresponding Chemical Changes In Major Polymers In the Stem Tissue (Carbohydrates, Lignins and Trace Elements)

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The investigation of the possible relationship of sugar maple decline and consequent chemical changes in sap and wood composition, which might correlate with the degree of decline, is the purpose of this study. By comparing healthy trees with maples suffering various degrees of decline (as quantified using the ministry's physical decline index), a chemical index can be developed in relation to decline status. This index could be related to known indices of climatic, site, atmospheric and biological variables in a cause-effect manner and might become a useful diagnostic assay for "early warning" of decline syndrome in maple stands. Appropriate management strategies could then be implemented in timely fashion.

6/1991 (3) \$88 950 (ER 524) [AQ]

444 Development of Bioassay Protocols for Toxicants In Soil

Dr. Stephen Sheppard

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AECL Research
Whiteshell Laboratories
Pinawa, Man. R0E 1L0

Based on a review of existing protocols, several bioassay protocols addressing the various levels of biology (plants, animals and micro-organisms) will be selected. This will most likely involve short-life-cycle plants, earthworms and soil enzyme analyses. These protocols will be implemented and perturbed to reveal robustness to changes in such operating parameters as temperature. Once the operating procedures are well established, the sensitivity of the test protocols will be evaluated against a discrete set of toxicants including selected heavy metals.

8/1991 (2) \$93 663 (ER 525) [AQ]

445 Analysis of Photooxidation of Polycyclic Aromatic Hydrocarbons (PAHs) Under Environmentally Relevant Conditions and Interactions of Photomodified PAHs with Higher Plants

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Waterloo, Ont. N2L 3G1

This study is a continuation of work on the interaction of polycyclic aromatic hydrocarbons (PAHs) with higher plants (see ER 520). The project has three aspects: 1) PAH photomodification in simulated solar radiation (kinetics and initial identification of products); 2) assimilation of selected photooxidized PAHs by the aquatic higher plant, *Lemna gibba*; and 3) toxicity of specific PAH photomodification products to higher plants. The data obtained from this study will be useful for criteria concerning PAHs in ecotoxicological settings and for evaluating entry of modified contaminants in to the food chain. In addition, the study further develops the technology for use of *Lemna* as a model system for studying phytotoxicology.

6/1991 (1) \$40 270 (ER 555) [MMCB]

446 Review of the Toxicity of Diazinon to Birds

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This project will result in a comprehensive summary of the incidences of diazinon-related waterfowl kills associated with turfgrass management in both Canada and the USA. The study objectives are to: ascertain the locations, frequency and extent of waterfowl poisoning events; perform a literature search and review and assess the data available on the effects of liquid and granular formulations of diazinon on birds; compare and contrast poisoning incidents in Ontario versus the USA in light of such variables as chemical formulation, methods, rates and timing of application, and species affected, and; discuss the implication of this assessment on current use patterns of diazinon in Ontario.

11/1991 (1) \$10 606 (ER 590) [PR]

447 Review of the Fate and Effects of TBTO

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Tributyl tin oxide (TBTO), while banned for use in aquatic environments, continues to be used as a preservative of wood. The objective of this study is to review the primary literature and assess the fate and effects of TBTO in the environment and its hazard to human health. Included in the assessment is the consideration of the sources, occurrence and characteristics of TBTO; its persistence, fate and dissipation in terrestrial and aquatic environments; the potential for bioaccumulation, bioconcentration and biomagnification; the toxicity of TBTO to non-target terrestrial and aquatic organisms; and the identification of human health concerns.

11/1991 (1) \$8 990 (ER 591) [PR]

448 Photooxidation of Polycyclic Aromatic Hydrocarbons (PAHs) Under Environmentally Relevant Conditions: Kinetics and identification of Products

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This project continues work on the photoinduced toxicity of polycyclic aromatic hydrocarbons (PAHs) (see ER 520 and ER 555) by investigating the production of photooxidized PAHs. The project has two components: 1) kinetics of PAH photomodification under simulated and natural solar radiation, and 2) identification of the photodegradation products. The data will be useful for establishing policies concerning PAHs in ecotoxicological settings, identifying PAH derivatives that are likely to exist in the environment and classifying the PAH photoproducts that are hazardous.

5/1992 (1) \$25 200 (ER 621) [AQ]

449 The Modification of a Carbofuran Specific Enzyme immunoassay for Use on Honey Bees (*Apis mellifera*)

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Carbofuran is applied to sweet corn in an effort to control both corn rootworm and corn earworm. In recent years, substantial numbers of honey bee colonies have been killed due to exposure to this insecticide. This project will attempt to modify a magnetic particle-based solid-phase enzyme immunoassay, developed initially for carbofuran detection in water, to allow its use in the detection of this insecticide in honey bees. Such a method would be less expensive and results generated faster than the traditional gas chromatographic techniques presently utilized in pesticide residue laboratories.

5j1992 (1) \$15 000 (ER 636) [PR]

450 Fungicide Bioassay and Biodegradation in Turfgrass

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This project continues the refinement of a previously developed soil/thatch/grass-agar bioassay technique for the detection of fungicide residues. The bioassay would be a quick and efficient technique to detect fungicide residues, their occurrence, persistence, mobility and biological significance in the environment. Included in the study is an adaptation of the bioassay for use in distinguishing different fungicides in samples which have been treated with multiple fungicides. The project also entails an investigation of the organisms involved in the biodegradation of the commonly used fungicide benomyl, and the use of the bioassay to follow its uptake and rate of degradation through the grass-thatch-soil profile.

5/1993 \$10 000 (ER 646) [PR]

Previous Projects

451 Environmental Assessment Study on Uranium and Other Elements In Plants Around Ontario Uranium Mines.

Dr. E. Nieboer, Laurentian University. 1978 \$19 900 (ER 19) [LSW]

The Levels of Uranium and Other Elements in Lichens and Mosses Growing in the Elliot Lake and Agnew Lakes Areas, Ontario, Canada. Richardson, D.H.S., Nieboer, E. and Beckett, P.J., Laurentian University. 1979. 71 Pp. (BLO)

452 Phase II of an Environmental Assessment Study on Uranium and Other Elements in Lichens and Mosses from Elliot Lake, Ontario.

Dr. E. Nieboer, Laurentian University. 1980 \$89 600 (ER 43)

Lichens and Mosses as Monitors of industrial Activity Associated with Uranium Mining in Northern Ontario, Canada, Vol. 1. Boileau, L.J.R. et al., McMaster University. 1982. 15 Pp. (BLO)

Lichens and Mosses as Monitors of industrial Activity Associated with Uranium Mining in Northern Ontario, Canada, Vol. 2. Beckett, P.J. et al., McMaster University. 1982. 16 Pp. (BLO)

Lichens and Mosses as Monitors of industrial Activity Associated with Uranium Mining in Northern Ontario, Canada, Vol. 3. Nieboer, E., McMaster University. 1982. 11 Pp. (BLO)

453 Production of Ozone insensitive Field Bean Varieties.

Dr. T. Micheals, University of Guelph. 1982 \$38 000 (ER 70) [AQ]

454 Ozone Early Blight interaction of Potato: implication and Disease Control.

Dr. T. Micheals, University of Guelph. 1982 \$20 000 (ER 72) [AQ]

Dose Response Relationship of O₃ and Yield in Potato and Peanut. Hofstra, G. et al, University of Guelph. 1985. 13 Pp. (BLO)

455 Sweet Corn and Green and Wax Bean Response to Air Pollution in Southern Ontario.

Dr. T. Micheals, University of Guelph. 1982 \$62 000 (ER 73) [AQ]

Sweet Corn, Cabbage, Cauliflower and Rutabaga Responses to Air Pollution in Southern Ontario. Ormrod, D.P., University of Guelph. 1985. 22 Pp. (BLO)

456 To Determine Dose-Response Relationships for Food Crops Due to the Effects of Airborne Gaseous and Particulate Pollutants. Dr. D. Ormrod, University of Guelph. 1984 \$89 700 (ER 144) [AQ]

Dose-Response Studies of the Effects of Gaseous and Particulate Pollutants on Food Crops. Ormrod, D.P., Petite, J.M. and Marie, B.A., University of Guelph. 83 Pp. (BLO)

457 Plant Bioassays for the Detection of Environmental Mutagens. Dr. W. Grant, York University. 1984 \$119 400 (ER 169) [WQ]

Plant Bioassays for the Detection of Environmental Mutagens. Grant, W.F., York University. 1987. 22 Pp. (BLO)

458 The Effects of pH, Aluminum and Drought on Sugar Maple Seedlings. Dr. M. Havas, University of Toronto. 1986 (1) \$27 400 (ER 271) [AID]

Effect of Drought, Aluminum, and Low pH on Growth and Chemical Composition of Sugar Maple Seedlings. Havas, M. et al, University of Toronto. 1989..140 Pp. (RAC)

459 Production of Ozone insensitive White Bean Varieties. Dr. T. Michaels, University of Guelph. 1986 (3) \$11 400 (ER 292) [AO]

460 A Study of the Status of Root Systems and Mycorrhizal Association in Healthy and Declining Sugar Maple. Dr. T. Hutchinson, University of Toronto. 1988 (1) \$35 320 (ER 404) [AQ]

461 World Wildlife Fund - Wildlife Toxicology Funded Projects. Ms. P. Dover, World Wildlife Fund Canada. 1988 (3) \$150 000 (ER 417)

462 Salt Spray Injury Study. Mr. C. Chong, Ontario Ministry of Agriculture and Food. 1988 (1) \$15 000 (ER 419) [AQ]

463 Genetic Differences Between Damaged and Healthy Sugar Maples Throughout Ontario. Dr. P. Knowles, Lakehead University. 1989 (1) \$21 250 (ER 435) [AQ]

Genetic Differences Between Damaged and Healthy Sugar Maples. Knowles, P., Lakehead University. 1990. (RAC)

HUMAN HEALTH EFFECTS AND RISK

1991/92 Projects

464 Chemical Exposure Pathways In Ontario

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Previously, a multi-media fugacity based environmental model which estimates prevailing concentrations in various media had been developed and validated for a number of chemicals in Southern Ontario. The focus of this present study is the extension of various concepts of the model to assess the exposure to these and additional chemicals by a typical Southern Ontario family through air inhalation and food and water consumption, as well as human physiological distribution and body burden. The models ultimately will provide a protocol for the screening of a large number of chemicals with a view to predicting multimedia environmental concentrations, possible ranges of human exposure and human tissue burdens.

8/1988 (3) \$136 500 (ER 423) [MMCB]

465 Psychosocial impacts in Populations Exposed to Solid Waste Facilities

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Psychosocial effects are defined as the complex of distress, dysfunction and disability manifested in a wide range of psychological, social and behavioural outcomes as a consequence of actual or perceived environmental contamination. The focus of this study has been the psychosocial impacts to populations exposed to three solid waste disposal facilities in southern Ontario: the Solid Waste Reduction Unit in Hamilton, the Hamilton-Wentworth Regional landfill in Glanbrook and the Halton Regional Landfill in the Town of Milton. A supplementary case study on the Hagersville Tire Fire has also been included.

3/1990 (3) \$206 605 (ER 473) [ESE]

466 Health Effects of Air Pollution Assessed Using Ontario Health Survey Data

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The objective of this project is to determine if a portion of the variability of health of Ontario residents can be attributed to differences in air quality, using data from the Ontario Health Survey (OHS) and the ministry's Air Quality Index (AQI), and controlling for confounding variables. The OHS surveyed approximately 1200 people in each of the 42 provincial Public Health Units (PHUs), more than half of which lie within a few kilometres of AQI sites. Using analysis of variance and stepwise linear regression analysis, it will be possible to determine the relative strength of air pollution variables in accounting for the distribution of disease among PHUs.

6/1991 (1) \$45 000 (ER 527) [AQ]

467 Soil ingestion: Model Parameters for Multimedia Assessment of Heavy Metals

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This project is a series of directed, scenario-driven experiments which will result in an improved specification of the parameters needed to assess the impact of inadvertent soil ingestion from hands or food products. These parameters will include estimates of the quantity of soil on skin and food products, with some modifiers to describe the effect of cleaning; estimates of the concentration enrichment of heavy metals on the soil based on the differences in characteristic between the ingested soil and the bulk soil; and estimates of the bioavailability of the heavy metals on the ingested soil relative to the same intake of metals in normal food products.

7/1991 (2) \$122 845 (ER 551) [MMCB]

468 Homeowner Exposure Study in the Use of Insecticides in the Home Garden for Landscape Pest Control

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Very little information is available on the exposure of homeowners and the general public to pesticides, and even less is known about bystander exposure under use conditions. This project will address exposure of homeowner applicators as well as bystanders to professional applicators of the organophosphorous pesticide chlorpyrifos under conditions of use as a turf insecticide. A consideration of the use of a weed and fertilizer formulation of chlorpyrifos and the benefits of protective clothing are included. Results from the study will be useful in determining if there is a need for additional advice to applicators and/or the public, and if any regulatory action is needed.

5/1992 (1) \$10 000 (ER 637) [PR]

469 Exposure Studies in the Use of Pesticides in Greenhouse Chrysanthemum Production Using Fluorescent Tracers and Video imaging

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This project is the second year of a study designed to determine the potential hazards to applicators and bystanders (greenhouse workers) associated with current pesticide use in greenhouse chrysanthemum production. The study utilizes fluorescent tracers/video imaging and biological monitoring to determine dermal and inhalation exposure to pesticides during and/or following application at various times of the year. Those body regions of greatest potential exposure will be defined, and such methods of reducing exposure as using different application methods and changes in the design and use of protective clothing examined.

5/1992 (1) \$18 000 (ER 641) [PR]

470 Effect of Insect, Disease and Weed Stress on Glycoalkaloid (Solanine and Chaconine) Content in Potatoes (*Solanum tuberosum*)

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Solanine and chaconine are toxic alkaloid compounds that act as natural pesticides in many plants of the Solanaceae family. Commercial potato varieties normally contain 1-15 mg of glycoalkaloids, below the acceptable level of 20 mg/ 100 g of tissue. While certain environmental conditions are known to raise glycoalkaloid levels, very little is known about the effects of plant pests on the levels of these compounds. The goal of this study is to examine the effects of insect defoliation, fungal (early blight) infection and weed competition on glycoalkaloid levels in potatoes under field and growth room conditions. Such "stresses" may induce increases in glycoalkaloid content to levels that are of concern to human health.

5/1992 (1) \$26 000 (ER 652) [PR]

Previous Projects

471 Detection, Enumeration and Interpretation of Levels of Virus In Drinking Water and Bathing Waters. Dr. Sattar, University of Ottawa. 1977 \$53 600 (ER 04) [WQ]

472 The Spread of St. Louis Encephalitis Through Avian and Rodent Reservoirs. Dr. Brown, University of Toronto. 1977 \$7 900 (ER 06) [WQ]

473 Radiation Control Measures in Elliot Lake. Dr. Eaton, AECL Research. 1978 \$1 200 000 (ER 07) [AQ]

474 An Investigation of the Health and Welfare Effects on Noise in Ontario. Hemingway, SNC/ GECO Canada Inc. 1979 \$65 000 (ER 15) [AQ]

A Report on Environmental Noise in Ontario and Its Description with Reference to Health Related Effects. Weinstein, W., SNC/GECO Canada Inc. 1980. 300 Pp. (BLO)

475 A Study on the Relationship Between Hospital Admission Rates for Acute Respiratory Illness and Air Quality In Several Ontario Cities. Dr. Stopps, University of Toronto. 1978 \$1 200 (ER 17) [AQ]

476 Epidemiological Study to Determine the Health Effects of Particulates and SO₂ Levels (and Other Gases) In Air. Dr. D. Pengelly, McMaster University. 1978 \$516 300 (ER 20) [AQ]

The Hamilton Study: The Effect of Environmental Factors on The Respiratory Health of School Children. Kerigan, A.T., Pengelly, L.D., Goldsmith, C.H. and Garside, B.K., McMaster University. 1983. 264 Pp. (BLO)

477 The identification of "Abnormal" Values of Lead and Cadmium In Autopsy Material of Occupationally Exposed Individuals. Dr. W. Cherry, University of Waterloo. 1979 \$99 000 (ER 33) [AQ]

Lead and Cadmium in Human Disease Processes. Cherry, W.H., University of Waterloo. 1982. 20 Pp. (BLO)

478 Effects of Ambient Air Pollution (Assessed by Personal indoor and Outdoor Monitoring) on Humans. Dr. F. Silverman, University of Toronto. 1980 \$123 200 (ER 40) [AQ]

479 Continuation of Funding for the Virology Component of the University of Toronto Epidemiology Study of Bathing Beaches and Recreational Waters. Dr. P. Seyfried, University of Toronto. 1980 \$17 000 (ER 45) [WQ]

480 Investigation of Sleep Disturbance Effects of Road Traffic Noise. Mr. S. Wilson, S.S. Wilson and Associates. 1981 \$153 000 (ER 47) [AQ]

Sleep Disturbance Effects of Road Traffic Noise. Wilson, S.S., S.S. Wilson and Associates. 1984. 38 Pp. (BLO)

481 The Epidemiology of Swimming-Related Illness at Selected Conservation Areas. Dr. P. Seyfried, University of Toronto. 1982 \$15 000 (ER 60) [WQ]

482 Development of a Methodology for the Concentration and Detection of Rotaviruses and Hepatitis A Virus In Environmental Samples. Dr. F. Doane, University of Toronto. 1982 \$49 000 (ER 61) [LSW]

483 Development of a Strategy for Predicting the Impact of Fast Food Restaurants on the Surrounding Community. Dr. Gnyp, University of Windsor. 1983 \$6 000 (ER 71) [AQ]

484 Epidemiological Study of Disease Incidence and Recreational Water Quality at Selected Conservation Areas In Southern Ontario. Dr. P. Seyfried, University of Toronto. 1983 \$175 000 (ER 89) [AMID]

Supplementary Analysis of Novel Data Collected During a Survey of Rivers and Beaches in 1983. Seyfried, P, University of Toronto. 1987. 412 Pp. (BLO)

485 Toronto Junction Triangle Health Study. Dr. W. Spitzer, Metropolitan Toronto. 1983 \$25 000 (ER 95) [AQ]

A Study of the Health Status of Residents of the Junction Triangle, Toronto. Spitzer, W.O., McGill University. 1984. 74 Pp. (BLQ)

486 Survey of Blood Lead Levels in School Children. 1983 \$70 000 (ER 115) [WQ]

487 Analysis of Data from the Study, 'Respiratory Health of School Children in Hamilton'. Dr. D. Pengelly, McMaster University. 1984 \$80 400 (ER 119) [AQ]

Role of Environmental Factors in the Development of Chronic Lung Disease in Smoking and Non-Smoking Adolescents. Kerigan, A.T. and Pengelly, L.D., McMaster University. 1986. 79 Pp. (LQO)

488 Review of Preliminary Report on Epidemiological Studies. Dr. W. LeRiche, University of Toronto. 1984 \$2 000 (ER 140) [WQ]

Environmental Epidemiology. Le Riche, W.H., University of Toronto. 1984. 37 Pp. (BLO)

489 An integrated Approach to the investigation of Lung Response of Sensitive Subjects to Diverse Air Pollutants. Dr. F. Silverman, University of Toronto. 1984 \$75 000 (ER 173) [AQ]

An Integrated Approach to the investigation of Lung Function Responses of Sensitive Subjects to Diverse Air Pollutants. Silverman, F. and Corey, P., University of Toronto. (BLO)

490 The Hamilton Study: Effect of Environmental Factors on the Respiratory Health of School Children. Dr. D. Pengelly, McMaster University. 1985 \$5 000 (ER 179) [AQ]

The Hamilton Study: The Effect of Environmental Factors on the Respiratory Health of School Children. Kerigan, A.T. and Pengelly, LD., McMaster University. 1985. 13 Pp. (BLO)

491 Uptake, Distribution and Clearance of Soluble Aerosols In the Human Respiratory System. Dr. W. Megaw, York University. 1985 (1) \$15 000 (ER 206) [AQ]

492 Dose Response for Selected Environmental Air Pollutants on Selected Populations. Dr. F. Silverman, University of Toronto. 1985 (3) \$189 000 (ER 219) [AQ]

Dose Response for Selected Environmental Air Pollutants: A Study on Runners. Silverman, F., Urch, R.B., Corey, P. and Shephard R.J. 1991. 95 Pp. (RAC)

493 Reproductive Outcomes in Southwestern Ontario, 1980 to 1985. Dr. J. Robertson, University of Western Ontario. 1986 (1) \$65 000 (ER 245) [WQ]

494 Sound Levels at a Distance from industrial Plants. Mr. T. Kelsall, Hatch Associates Ltd. 1986 (1) \$28 500 (ER 258) [ESE]

495 Respiratory Health of a Cohort of Young People. Dr. D. Pengelly, McMaster University. 1986 (2) \$145 000 (ER 283) [AQ]

496 Completion of Data Gathering in Period V of the Hamilton Study: Effects of the Environment on Respiratory Health of Young People. Dr. D. Pengelly, McMaster University. 1987 (1) \$60 000 (ER 302) [AQ]

497 The Psychosocial Impacts of Exposure to Environmental Contaminants in Ontario (Feasibility Study). Dr. M. Taylor, McMaster University. 1987 (1) \$46 000 (ER 365) [ESE]

The Psychosocial impacts of Exposure to Environmental Contaminants in Ontario. Taylor, S.M., McMaster University. 1989. 256 Pp.

498 Long-Term Effects of SO₂ and Aerosols on Children with Asthma. Dr. D. Pengelly, McMaster University. 1989 (1) \$46 235 (ER 436) [MMCB]

499 Survey of Community Acceptance of Air Conditioner Noise. Mr. W. Heeley, HRAI Technical Services Division. 1989 (1) \$10 000 (ER 458) [MMCB]

Survey of Outdoor Air Conditioner Noise. Bradley, J.S. National Research Council and HRAI. 1991. 52 Pp. (RAC)

PESTICIDE REDUCTION

1991/92 Projects

500 Behaviour Ecology of the Eastern Subterranean Termite In Ontario as a Basis for Control

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Subterranean termites are serious structural pests which cause significant economic losses. This study has focussed on describing the population demographics and foraging ecology of the eastern subterranean termite in southern Ontario by a systematic examination of colony growth and development, foraging patterns, intercolony interactions, chemically-mediated interactions with vegetation, and the effect of microclimate on colony development and foraging activities. These biological findings are the basis for development of a Trap-Treat-Release control strategy for subterranean termites (see ER 553), particularly through their application to the improvement of aggregation trap designs and trap efficiencies.

3/1989 (3) \$194 760 (ER 427) [ESE]

501 Novel Approach for the Development of Transgenic Plants Resistant to Pathogens: An Alternative to Reduce the use of Chemical Pesticides

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Using two genetic manipulation strategies, the objective of this project is to develop potato and tomato cultivars resistant to a range of economically important viruses. The first approach involves engineering cultivars to express a viral coat protein. The expression of the coat protein within the cells of the plant confers resistance to a number of closely related viruses through the mechanism of cross-protection. The second method is the development of viral resistant plants using a Ribozyme system. This strategy involves engineering the plant to express an RNA containing a self splicing signal complementary to an essential viral gene. The expression of such an RNA is intended to interfere with the expression of viral genes essential for infection and replication.

12/1990 (3) \$96 750 (ER 513) [MMCB]

502 Development of the Trap-Treatment-Release Techniques for Pesticide-Minimized Termite Colony Control

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The focus of this research is the development of a Trap-Treat-Release technique for killing whole colonies of subterranean termites. The method involves the trapping and exposure of termites to various treatments including irradiation, chemical materials, insect growth regulators or biocontrol agents. This induces delayed mortality and, upon release, transmission of the control agents back into the colony. Such a technique would be the first method for killing whole colonies and thus the first real management tool for suppression of urban termite infestations. It would also substantially reduce or eliminate the need for use of persistent termiticides in close proximity to human habitation.

6/1991 (1) \$50 000 (ER 553) [MMCB]

503 Effect of Using Insecticide for Rootworm Control on Risk In Subsequent Years

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One question relating specifically to the problem of corn rootworm, and more generally to other instances, is how the history of pesticide use in a location affects current and future risk of damage. The objectives of this study are to determine: 1) whether or not using rootworm insecticides on a significant acreage of corn is likely to influence risk of damage the next year, 2) from historical data whether or not the recent reduction in acreage of corn treated with rootworm insecticide has affected the severity of the rootworm problem; and 3) if the history of pesticide use in a field influences whether a specific infestation of eggs will cause damage.

5/1992 (1) \$21 600 (ER 631) [PR]

504 importation of the Parasite *Lathrolestes nigrilcolli* for Control of the Birch Leafminer *Fenusa pusilla* in Ontario

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The birch leafminer is a serious pest of ornamental birches in Ontario causing discoloration or scorching of the leaves. An ichneumoid parasite of the miner, *Lathrolestes nigrilcolli*, has become established in Newfoundland, Quebec and parts of the north-eastern United States. In this project, parasites from several locations will be imported under permit into Ontario. After screening in quarantine for hyperparasites, the parasite will be released and its establishment and impact on populations of the birch leafminer in Ontario monitored. Successful introduction of the parasite would support the objective of reducing the use of pesticides for cosmetic purposes.

5/1992 (1) \$20 000 (ER 632) [PR]

505 Efficacy of Oils as Fungicidal Alternatives for the Control of Powdery Mildew of Grapes

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The efficacy of paraffinic and glyceridic plant oils for the control of powdery mildew and other fungal diseases of wine and table grapes will be determined in this study. The objective is to find comparatively priced alternatives to current fungicides which are either expensive, or leave unwanted residues (e.g. sulphur) that impair wine quality or the appearance of table grapes. This phase of the work will determine the relative efficacy of several oils on potted grape plants, the best surfactant for emulsification in water, and the optimum concentration and frequency of use. Initial vineyard tests will evaluate the safety of the oils and their effect on bunch, shoot and leaf development.

5/1992 (1) \$9 000 (ER 633) [PR]

506 Localization and Characterization of Nematicidal Factors In Cruciferous Plants

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Extracts from some crucifer cultivars appear to hold promise as a sustainable alternative to chemical soil fumigants for the control of nematodes. Allyl isothiocyanate (AITC), produced by the hydrolysis of glucosinolate (sinigrin), is believed to be the active component although this has yet to be proven. The main objectives of this study are to determine: 1) glucosinolate profiles in various organs (roots, stems and leaves, and seeds) of several crucifers; 2) changes in glucosinolate concentration with increasing maturity of plant organs; and 3) LD50's of glucosinolate-derived AITC or other ITC's against root-lesion nematodes. This information will help establish the efficacy and application of this biological control system.

5/1992 (1) \$10 000 (ER 634) [PR]

507 Vegetation Control In Drainage Ditches

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This study continues the evaluation of glyphosate application with a hand-held carpet wick wiper for cattail and phragmites control in the bottom of drainage ditches, and all unwanted vegetation on ditchbanks. Two machine mounted wipers will be designed, constructed and tested for this purpose. Application of glyphosate using wipers is more efficient as only targeted plants are hit, and is safer due to the elimination of particle drift and reduction of vapour drift. A second part of the project continues trials on the cutting and flooding of cattails in ditches as a means of their control.

5/1992 (1) \$10 000 (ER 638) [PR]

508 Energy Efficiency of Alternative Weed Management Systems

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Although various alternative approaches to integrated weed management and reduction in herbicide inputs have been applied, little is known about the energy efficiency of these strategies. This project will review the literature on energy inputs (e.g. cultivation, pesticides), and calculate the energy efficiency for 27 Ontario farms (employing either conventional, low-input or organic weed management systems) and for experimental reduced herbicide trials. This analysis of inputs and the effect of alternative weed control methods (e.g. herbicide reductions, cover crops, crop rotations) should provide a good comparison of the energy efficiency of different weed management systems.

5/1992 (1) \$18 000 (ER 640) [PR]

509 Selection of Elite Maize for Ontario for Rootworm Resistance

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Recently, a biochemical basis of rootworm resistance in corn was discovered to be the presence of a group of four hydroxyamic acids in roots that induce larval mortality and delay insect development, and act as feeding deterrents. This second year of field trials will confirm that the root damage rating previously determined under field conditions is related to hydroxyamic acid content of roots and affirm the exceptional resistance identified in several elite genotypes. Biochemical screening based on hydroxyamic acid content will also be used to screen Ontario inbreds for rootworm resistance, and the genetics of the biochemical resistance studied to assist future breeding strategies.

5/1992 (1) \$18000 (ER 642) [PR]

510 Improved IPM for Lettuce by the Development of a Specific, Field-Applicable and Rapid Diagnostic Assay for the Aster Yellows Pathogen

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Aster yellows disease is caused by the aster yellows mycoplasma-like organism and transmitted by the aster leafhopper. An assay utilizing specific DNA probes and the Polymerase Chain Reaction has been developed and found to be sensitive enough to detect the pathogen in individual leafhoppers. In this project, the assay will be field tested to assess its reliability and to study the distribution and dynamics of aster yellows disease. Modifications to the assay will be made if necessary to reduce its cost and time. This ability to monitor the infectivity of leafhoppers as well as their abundance would significantly assist in determining the necessity and timing of insecticide application, and greatly improve the recommendations of the lettuce IPM program for aster yellows.

5/1992 (1) \$18 000 (ER 643) [PR]

511 Non-chemical Alternatives for Weed Control In Turf

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This study is the second year of an ongoing program. The objective is to determine methods to reduce the use of herbicides on lawns and other turf areas by enhancing the competitive/interactive advantage of turf grasses through modified cultural practices. These practices include various types of fertility, watering and mowing regimes as well as the use of new cultivars of Kentucky blue grass, perennial rye grass, and the tall and fine-leaved fescues that have a better competitive ability than old cultivars of these species.

5/1992 (1) \$15 400 (ER 644) [PR]

512 Factors Influencing the Effectiveness of the Onion Insect Pest Management Program In Ontario

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The onion maggot (*Delia antiqua*) management program was one of the first reduced pesticide management programs introduced in southern Ontario. During the last few years, however, the effectiveness of this program has decreased. This project is a continuation of a study investigating factors responsible for this decline. A second year of data will be obtained on the impact of environmental conditions, pest occurrence, efficacy and persistence of recommended insecticides, and resistance development on the effectiveness of the onion maggot management program. In addition, four experimental insecticides showing promise for onion maggot control will be further evaluated for efficacy and cross resistance to currently recommended insecticides.

5/1992 (1) \$17 BOO (ER 645) [PR]

513 Acute and Chronic Toxicity of Margosan-O(R), a Product of Neem, to Selected Target and Non-Target Aquatic Invertebrates

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Margosan-O^(R) is a pesticide registered for use in the U.S.A. for insect pests of foliage and ornamental plants. The active ingredient, azadirachtin, is extracted from the seeds of the neem plant and is biodegradable and of very low toxicity to birds and mammals. This, coupled with its effects on a large variety of insects, nematodes and fungi, makes it apparently highly suitable for widespread use in Canada. However, virtually no information is available on its toxicity to aquatic invertebrates. This project, through laboratory and mesocosm studies, aims to determine acute and chronic toxicity of this pesticide to *Daphnia magna* (cladoceran), *Hyalella azteca* (amphipod), and three species of insects; *Chironomus tentans*, *Culex pipiens* and *C. restuans*.

5/1992 (1) \$17 000 (ER 647) [PR]

514 Evaluation of Impact of Alternative Methods of Vegetable Production

Dr. G. McLeod

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Agriculture Canada
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Focussing on yield and quality, this project is a continuation of a multi-year comparison of the production of five vegetables (sweet corn, snap bean, cabbage, tomato and Spanish onion) using conventional and "organic" techniques. Organic production methods utilized are in compliance with the Production and Processing Standards proposed by the Organic Crop Improvement Association allowing produce to be certified "organic". Secondary objectives of the study include: the monitoring of changes in populations of pest and beneficial insects; the monitoring of changes in soil organisms, processes, structure and fertility; the measurement of pesticide residues in soils and crops; and the comparison of production costs for each system.

5/1992 (1) \$25 000 (ER 648) [PR]

515 A Critical Comparison of the Rearing Requirements and Efficacy of Two Species of Pirate Bug: *Orius insidiosus* and *O. tristicolor*

Dr. Jonathon Schmidt

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Western Flower Thrips, and the Tomato Spotted Wilt Virus which they transmit, are important threats to greenhouse floricultural and vegetable production. Two species of Orius are promoted as biological control agents for these thrips, however, there remains considerable confusion concerning the relative efficacy and cost effectiveness of the two species. This project extends research on mass-rearing to a comparison of the two species with respect to their rearing requirements, reproductive capacity, cost, storage mortality and predatory efficacy in both lab and field settings. The resulting data will be used to make recommendations to Orius producers, Integrated Pest Management consultants and growers concerning the relative merits of both species.

5/1992 (1) \$9 300 (ER 649) [PR]

516 impact of the Predatory Stink Bug, *Perillus bioculatus*, on populations of Colorado Potato Beetle

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The goal of this research is to integrate mortality from release or natural augmentation of a predator with cultural and conventional techniques for the control of Colorado potato beetle on potatoes. Mortality to beetle populations by the two spotted stink bug, *Perillus bioculatus*, will be assessed in laboratory feeding experiments and in field releases. Efficient and economical rearing methods will be evaluated in order to determine the costs involved with releasing sufficient numbers of stink bugs for a level of control comparable to that using currently available insecticides. The effects of some insecticides, especially the bacterial endotoxins produced by *Bacillus thuringiensis tenebrionis* and *B. t sandiego*, and other compounds on survival of stink bugs will also be assessed.

5/1992 (1) \$12 000 (ER 650) [PR]

517 Off-Host Biology as Related to Control of the Northern Fowl Mite, *Ornithonyssus sylverium*, In Poultry Houses

Dr. Gord Surgeoner

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The Northern fowl mite is the number one pest problem in the egg and poultry breeding industries of Ontario. It causes reduced egg production and possibly condemnation of carcasses because of scabbing when the flocks are slaughtered. Once a barn is infested, there is a high probability that the next flock of birds placed in the barn will also be infested. The goal of this research program is to identify the origin of the mites that initiate these infestations on new birds. Sources under evaluation include new pullets entering barns, inanimate objects in the barn, rodents or wild birds, infested egg containers and the trucks used to move pullets into barns. Based on this information, effective prevention strategies could then be formulated.

5/1992 (1) \$17100 (ER 653) [PR]

518 Methods for Efficient Application of Biocontrol Agents to Manage Botrytis Diseases In Onion, Strawberry and Raspberry

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Guelph, Ont. N1G 2W1

Particular microfungi appear promising as biocontrol agents for botrytis diseases in strawberries, raspberries and onions. Most currently available spray application methods waste large amounts of inoculum through deposition on soil and other nontargets. Marked improvements in the means of application are needed to improve the economic and environmental perspective of this method. This project continues studies on the effectiveness of honeybees for applying control inocula to flowers of strawberry and raspberries, a method previously demonstrated to be a promising alternative. Accompanying this is an evaluation of special applicators for the application of inocula for the control of botrytis leaf blight in onions.

5/1992 (1) \$21 400 (ER 654) [PR]

519 Response of Soil Microfauna, Microflora and Structure to Agricultural Practices in Corn, Soybean and Cereal Rotations

Dr. Alan Tomlin

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Current cropping and tillage systems used in Ontario, including reduced and zero-till methods, usually require substantial herbicide input for weed control. However, the effect of continuous herbicide treatments on soil fauna and flora, the biotic component that is partly responsible for soil microfabric and soil structure, has not been investigated on Ontario foodlands. This study is the final year of a three year evaluation of the effects of herbicide treatments, crop rotations and tillage practices on soil microfloral and microfaunal properties, and soil structure. Improved understanding of these soil biota-herbicide interactions with soil structure could lead to more rational herbicide use including reduced application rates.

5/1992 (1) \$8000 (ER 655) [PR]

520 Efficacy Studies for Long-Term Industrial Weed Control

Mr. Frederick Vaughn

(519) 740-8739

Vaughn Agricultural Research Services Ltd.
96 Inverness Dr.
Cambridge, Ont. N1S 3P3

Control of unwanted vegetation on the stone ballast under railroad tracks and at transformer stations has conventionally been achieved using periodic (every 2-3 years) high rate applications of herbicide. This approach poses environmental risk due to potential runoff problems. Now in its third year, this current study is evaluating the efficacy of an alternative approach to achieving total vegetation control, that of annual lower rate applications of combinations of herbicides (hexazinone, tebuthiuron, diuron and bromacil). If some of these mixtures can be shown to provide control of unwanted vegetation equal to or better than the single high-rate application, their use would result in lower rates of herbicide application to non-crop land and less risk of environmental damage.

5/1992 (1) \$11 500 (ER 656) [PR]

Previous Projects

521 Development of Non-Chemical Approaches to Pest Control (Sterile Male Onion Maggot Technique). Dr. F. McEwen, University of Guelph. 1981 \$237 500 (ER 42)

522 integrated Pest Management on Field Corn: a Feasibility Study. Mr. Roberts, Ontario Ministry of Agriculture and Food. 1984 (4) \$378 100 (ER 138) [WQ]

ECONOMIC AND SOCIAL PERSPECTIVES

1991/92 Projects

523 Environmental Valuation Research

Dr. Jack Knetsch

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Department of Economics
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Burnaby, B.C. V5A 1S6

The main objectives of this continuing series of individual experimental and survey studies are to improve the basis for economic valuation of environmental changes; to investigate assessment and policy implications of large disparities between willingness-to-pay and compensation-demand measures of economic values; to study preference and choice behaviour of people with respect to alternative environmental policies; to examine various legal sanctions; and to further examine the development and use of economic experiments for research in these areas. This will lead to improved assessments of environmental values and a more reliable and credible empirical basis for designing and implementing environmental policies.

5/1988 (3) \$75 400 (ER 418) [ESE]

524 Reassessment of the Efficiency of Market Policies for Pollution Control

Dr. Donald Dewees

(416) 978-4964

Department of Economics
University of Toronto
Toronto, Ont. M5S 1A1

The environment is not perfectly mixed. Once this is recognized, the theoretical advantage of effluent charges and marketable effluent rights in minimizing pollution control casts drops substantially. Some studies have shown that these market policies may be more costly than traditional regulation. However, virtually all these evaluations assume a fixed target for environmental quality, and give no credit for environmental improvement beyond this target. This study explores the benefits that are generated when ambient pollution concentration is reduced below air quality standards, and evaluates the extent to which these benefits may offset the added casts imposed by applying a uniform market policy over an unmixed airshed.

5/1990 (2) \$13 920 (ER 507) [ESE]

525 Economy-Environment Linkages and Sustainable Development In Ontario

Mr. Ed Hanna

(416) 593-1470

VHB Research and Consulting Inc.
Suite 901, 2 Canton St.
Toronto, Ont. M5B 1J3

The main objective of this research project is to develop a framework that will provide a means of quantifying economy-environment linkages in Ontario and assist the examination of sustainability of development in Ontario through scenario analysis. The project applies the principle of 'materials/energy balance' by adapting an input-output model for the provincial economy to include resource utilization and the generation of wastes, and also incorporates a range of production technologies and the environmental protection sector.

5/1991 (2) \$216 900 (ER 509) [ESE]

526 Municipalities and the Environment, a One-Year Feasibility Study

Dr. Adele Crowder

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Queen's University
Kingston, Ont. K7L 3N0

This project was a one year feasibility study to investigate municipal decision-making about the environment in eastern Ontario, and to analyze municipal attitudes. Two activities, a regional workshop intended to initiate a discourse with municipalities and a study of responses to the first stage of the Bay of Quinte Remedial Action Plan Program were included. Together, these endeavours point towards new directions for sustainable development in the region, assist the ministry by providing analyses of attitudes, and generate stimuli for academic research and pragmatic policy planning at the regional level.

6/1991 (1) \$16 720 (ER 548) [ESE]

527 Capital Investment Cycles and Environmental Protection

Dr. Avery Shenfeld

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Ernst & Young Management Consultants
P.O. Box 251, Royal Trust Tower, TD Centre
Toronto, Ont. M5K 1J7

This study addressed various issues relating to the optimal timing of environmental protection investments. For example, what are the differences in environmental protection costs between new or substantially redesigned plants compared to retrofitting existing operations? Are there distinct capital investment cycles that could be monitored and taken into consideration in regulatory decisions? This information can be used to determine whether it is possible, for a given industry, to characterize and to identify particular time periods in which the economic impact of tougher control requirements is likely to be minimized because of the industry's position in an ongoing investment cycle.

6/1991 (1) \$52 450 (ER 550) [ESE]

Capital investment Cycles and Environmental Protection.
Ernst & Young. 1992. 67Pp. (PUB)

528 An Ontario Test Case of Economic instruments in Support of Environmental Protection Goals

Mr. Eric Cowan

(416) 944-8488

Apogee Research International Ltd.
159 Gerrard St. E.
Toronto, Ont. M5A 2E4

Economic instruments as an alternative or adjunct to traditional "command and control" approaches are one tool to achieve environmental protection. The focus of this study has been the design and assessment of a practical Ontario test case (using the Fanshawe Reservoir) of using economic instruments to achieving water quality goals. Preliminary conclusions are that the bulk of interesting economic instruments, i.e. those with economic efficiency objectives as opposed to just revenue generation objectives, are impractical to apply to just one watershed in the province. The practical implications of this in preparing a useful remediation strategy for the reservoir are under consideration.

7/1991 (1) \$45 975 (ER 587) [ESE]

529 Corporate Codes and the Principles of Sustainability

Dr. Max Clarkson

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The Centre for Corporate
Social Performance and Ethics
University of Toronto
Toronto, Ont. M5S 1A4

This study will result in a written report to the Ontario Roundtable on Environment and Economy which will assist the roundtable in its objective of encouraging the use of corporate codes as a means of realizing the principles of sustainability in Ontario industry. The study will outline the types of ethics, practice and conduct codes used in companies and analyze the extent to which codes are used in Canadian corporations. It will reveal how the ethics and values of sustainable development are expressed in extant codes and how the principles of sustainable development might best be incorporated into company codes.

9/1991 (1) \$5 000 (ER 588) [ESE]

530 Consequences of the Bill 220 Amendments to the Environmental Protection Act for Secured Lenders, Trustees In Bankruptcy and Municipalities

Ms. Glenna Ford

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Canadian Institute for Environmental Law and Policy
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The objectives of this research are to 1) study the extended potential liability under administrative orders created by the Bill 220 amendments to the Environmental Protection Act, particularly for members of the business community such as lenders, receivers and trustees in bankruptcy; and 2) make recommendations for policies and legislative amendments which should be adopted in issuing the administrative orders. The purpose of the recommendations is to assist the government in achieving the legislative goal of environmental protection and the underlying principle of sustainable development, in light of its concurrent and sometimes conflicting obligations to stimulate and manage the economy.

1/1992 (1) \$35 687 (ER 589) [ESE]

531 "Modal Shift to Transit" Project

Mr. Al Cormier

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Canadian Urban Transit Association
Suite 901, 55 York St.
Toronto, Ont. M5J 1R7

This project is intended to detail all short and long term measures which should be taken by municipal, provincial and federal governments to promote a modal shift toward public transportation in urban areas. The final report will detail the importance of a 'modal shift to transit' in the context of current and future air quality, summarize current public transit initiatives at all levels of government and identify strategies for attaining recommended transportation/environmental goals. A summary action plan for different urban centres showing an evaluation of the various strategy options in terms of their estimated cost, chance of success, public acceptability and effectiveness will also be presented.

1/1992 (1) \$23 000 (ER 593) [ESE]

Previous Projects

532 Assessment of the Availability and Cost of Providing Off-Site Third Party Liability Coverage Protection from Damage from Disposal Facilities. Mr. G. Scott, Scott & Associates. 1979 \$10 000 (ER 36) [LSW]

Study of Environmental Impairment Liability Insurance.
Scott, G.T.G., Scott & Associates. 1980. 15 Pp. (BLO)

533 To Evaluate Beach Use Benefits Related to Water Quality Improvements. Mr. M. Fortin, Ecologistics Ltd. 1987 (2) \$79 100 (ER 374) [ESE]

Benefits to Beach Users from Water Quality Improvements. Ecologistics Ltd. 1990. 63 Pp. (RAC)

ANALYTICAL METHODS AND INSTRUMENT DEVELOPMENT

1991/92 Projects

534 Flow Injection Sample Introduction for Inductively Coupled Plasma Atomic Emission and Mass Spectrometry

Dr. Eric Salin

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Department of Chemistry
McGill University
Montreal, Que. H3A 2T5

A high performance sample introduction system based on flow injection techniques has been developed for inductively coupled plasma atomic emission and mass spectrometry. The method capitalizes on the independent improvements in detection limits achievable with the preconcentration steps and reduction of matrix interferences of the flow injection system, and the efficiency of analyte transfer to the plasma torch possible with direct sample insertion. Using this technique, detection limits for such trace metals as lead and zinc may be lowered by as much as two orders of magnitude, providing the capability of detecting most elements of toxic or industrial significance at levels near natural background concentrations.

4/1988 (3) \$132500 (ER 414) [AMID]

Final Report Received (REV)

535 Development of an Expert System for Automated Analysis of Metals

Dr. Martin Stillman

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Department of Chemistry
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London, Ont. N6A 3K7

The overall goal of this project is to complete the large package of expert system modules that make up ACExpert. ACExpert is a rule-based expert system with a graphical user interface which has been designed to provide real-time assistance to the user in completing a required analysis. AAExpert for example, is a program that can control an atomic absorption spectrometer and associated instrumentation, analyze the quality of the analytical data measured and provide advice on corrective action to improve data quality. Other modules include ACSelect and

GC-MSexpert, each of which is capable of acting independently or as a module of the full system.

4/1989 (3) \$151 360 (ER 432) [AMID]

536 Investigations into the Analysis of Hydride-Forming Elements

Dr. Ian Brindle

(416) 688-5550

Department of Chemistry
Brock University
St. Catharines, Ont. L2S 3A1

This project will result in the development of improved extraction techniques (e.g. from air filters) and methodology based on a modified computer controlled continuous hydride generator for the analysis of hydride forming elements. An investigation of pre-concentration methods as a means of enhancing detection limits for such elements in rain and surface waters is included. The results of this study will be of value in acid rain monitoring programs and for the measurement of other toxic elements in the environment.

5/1989 (3) \$139 900 (ER 434) [AMID]

537 New Chemical and Test Methods for Determining Toxic PCDD, PCDF and PCB Cogeners in Fish, Sediments and Other Aquatic Media

Dr. Thomas Tieman

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3640 Colonel Glenn Highway
Dayton, OH 43435

The objective of this study is the development of new capillary gas chromatography columns which will have improved capabilities for resolving polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). To this end, a multidimensional computer model has been developed and applied to the identification of the optimum stationary phase for separation of the entire set of isomers. The 'DB-Dioxin' column already developed is the first capillary GC column which uniquely resolves 2,3,7,8-TCDD and 2,3,7,8-TCDF in a single analysis. Ultimately, all seventeen of the 2,3,7,8-chlorine substituted PCDD and PCDF isomers might be separated using this or a similar column.

5/1989 (2) \$107 134 (US) (ER 442) [AMID]

538 New Methods for Rapid Sample Digestion

Dr. Eric Salin

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Department of Chemistry
McGill University
Montreal, Que.. H3A 2K6

The focus of this work has been to develop a microwave digestion system specifically designed to enhance sample throughput in the laboratory. In the system under consideration, a coiled tube serves both as a sample container and a digestion vessel. This differs from conventional microwave methods that use a bomb or open vessel as the sample container. A sample plug (consisting of a water slurry mixed with an acid mixture) is pumped into the coil, the sample flow is stopped, the coil is sealed by timing off the input and output valves and microwave power is applied (typically two minutes) for sample digestion (see also ER572).

6/1989 (2) \$40 000 (ER 453) [AMID]

539 Standard Reference Materials for Trace Organic Analysis of Aqueous Environmental Samples

Dr. Glenys Foster

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Zenon Environmental Laboratories Inc.
5555 North Service Rd.
Burlington, Ont. L7L 5H7

Generator columns can be used to produce aqueous solutions of compounds at known concentrations so that the entire analytical scheme can be tested. The first phase of this study involved the use of such columns to develop standard reference aqueous solutions of such highly hydrophobic materials as hexachlorobenzene, aldrin and endosulfan I. The objective of the second phase now in progress is to demonstrate improved precision of samples taken from a single generator column using the pesticide mirex, a compound of much lower solubility in water. Also included is the preparation of generator columns for chlorinated dioxin and dibenzofurans (PCDD/DFs), and polychlorinated biphenyl congeners.

6/1989 (2) \$44 000 (ER 454) [AMID]

540 Basic and Applied Studies with a Trace Atmospheric Gas Analyzer

Dr. Raymond March

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Department of Chemistry
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This project is a collaborative study with the ministry of the use of a Trace Atmospheric Gas Analyzer (TAGA 3000). Fundamental research on gaseous ion/molecule reactions is combined with the optimization of analytical protocols for the detection and measurement of such compounds of interest or human concern as formaldehyde, acetaldehyde and chlorinated hydrocarbons. Emphasis is being given to the development of new techniques for chemical ionization of compounds deleterious to the environment, to the investigation of processes of ion fragmentation and ion cluster formation, and to the study of processes for the removal of specific compounds or classes of compounds.

5/1990 (3) \$153 150 (ER 480) [AQ]**541 Automatable Total Cyanide Analysis**

Dr. Donald Kirk

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Dept. of Chem. Engineering and Applied Chemistry
University of Toronto
Toronto, Ont. M5S 1A4

The primary goal of this study is the development of a method for total cyanide determination (in the presence of thiocyanate and other known interferences) which can be automated. The approach taken is to use selective ultraviolet irradiation in the sample pretreatment step to dissociate all of the environmentally important aqueous metal cyanide complexes to simple cyanide without affecting sulphur and thiocyanate species. Research to date suggests that good recovery of cyanides is possible provided pH and reducing conditions are optimized. This method would be an attractive alternative to current techniques which are time consuming and labour intensive, and suffer from a number of matrix interferences.

5/1990 (1) \$29 500 (ER 497G) [AMID]**542 Development of an Automated Batch Hydride Generator for the Determination of Arsenic and Selenium**

Dr. Ian Brindle

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Department of Chemistry
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St. Catharines, Ont. L2S 3A1

The batch system of hydride generation is inherently more sensitive for the determination of hydride-forming elements than continuous methods. Its major drawback has been the reproducibility of the determination since it depends on the skill of the analyst. This project has effectively removed these uncertainties by replacing all of the manual functions by a computer controlled system. Using chemistry developed over the last several years using L-cysteine in low acid solutions, a technique has been produced which is relatively insensitive to matrix elements, provides enhanced signals, and can be used for the determination of several hydride forming elements simultaneously (i.e. As, Sb, Ge, Sn and B).

5/1990 (1) \$40 000 (ER 498) [AMID]*Final Report Received (REV)***543 Supercritical Fluid Extraction of Polychlorinated Biphenyls and Polycyclic Aromatic Hydrocarbons from Adsorbent Materials**

Dr. Janusz Pawliszyn

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Waterloo, Ont. N2L 3G1

The main objective of this project is to evaluate supercritical fluid extraction (SFE) for the extraction of organic contaminants from various adsorbents. SFE is a promising technique for this purpose as it significantly simplifies analyses and shortens extraction time compared with Soxhlet extraction. Initial results show that polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) can be quantitatively recovered from several commercially available adsorbents with SFE, with even higher percent recoveries obtainable using a methanol or toluene modifier. Fractionation of PCBs from PAHs appears possible with Florisi TM adsorbent, using N₂O with methanol as a modifier, by varying the extraction conditions.

11/1990 (2) \$30 000 (ER 499) [AMID]

544 Development of an Enzyme immunoassay for the Rapid Detection and Quantification of Glyphosate

Dr. Claude Morin

(613) 731-9577

Paracel Laboratories Ltd.
Suite 100, 2319 St. Laurent Blvd.
Ottawa, Ont. K1G 4K6

This project involves the development of an enzyme immunoassay for the herbicide glyphosate (N-(phosphonomethyl)glycine) using polyclonal antibodies. The necessary first step in this was the synthesis of an immunogen consisting of the low molecular weight glyphosphate molecule attached to a larger carrier molecule, bovine serum albumin, as a prelude to the production, purification and characterization of antibodies, and the development of the competitive assay. The use of such an enzyme assay would shorten the time required for the analysis of glyphosate and its major metabolite, aminoethylphosphonic acid, allow the simultaneous analysis of many samples, and lower detection limits up to parts per quadrillion.

9/1990 (2) \$79 900 (ER 503) [AMID]

545 Development of Techniques and Methodologies for the Direct Analysis of Solids and Difficult Samples by ICP-AES and ICP-MS

Dr. Eric Salin

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McGill University
Montreal, Qué H3A 2T5

Further development and evaluation of two sample introduction techniques, Direct Sample Insertion (DSO and Electrothermal Vaporization (ETV), for the analysis of solid materials by ICP-AES and ICP-MS is the basis of this project. Initial evaluation of a pellet ETV-ICP system showed that while it appears suitable for the rapid screening of botanical samples, the accuracy is poor. More recent research has concentrated on the development and construction of a new ETV system that does not use pellets. This approach is specifically tailored to allow gases to be used as reactants to break down the sample and appears to offer much more potential for controlling the chemistry of sample breakdown for ICP-AES and ICP-MS.

5/1993 (3) \$117 000 (ER 504) [AMID]

546 Development of Procedures for Improved Data Quality for Monitoring Sewage Treatment Plants under the MISA Program

Dr. Peter Sly

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Canadian Association for Environmental
Analytical Laboratories Inc.
Suite 404C, 1 Nicholas St.
Ottawa, Ont. K1N 7B7

A series of research tasks including round-robin studies, documentation of reference material libraries, development of laboratory codes-of-practice documents and technology transfer activities were conducted. These activities, focussing on Ontario-based laboratories supporting MISA program monitoring activities for sewage treatment plants, provide valuable tools and associated criteria that can be used to establish and enhance the performance level of environmental laboratories. This will help meet the challenge of assuring high data quality for environmental analytical work and improve the competitiveness of private sector laboratories in the Canadian and U.S. markets.

8/1990 (2) \$213 000 (ER 514) [AMID]

Final Report Received (REV)

547 Review and Development of Methods for Measuring Mercury in Air and Precipitation

Mr. Doug Johnson

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ORTECH international
2395 Speakman Dr.
Mississauga, Ont. L5K 1B3

The development of a prototype precipitation sampler unit and analytical procedure for determining the mercury content of precipitation, and evaluation of its functional performance at the laboratory and field scale, is featured in this study. This methodology could be used to investigate the contribution of precipitation in the overall deposition of atmospheric mercury to land, vegetation and water surfaces. In conjunction with other input modes, such measurements would be useful in assessing the impacts of mercury in fish and other biota in the Great Lakes and other areas remote from known sources.

6/1991 (3) \$114 500 (ER 526) [AQ]

548 Development of a Surrogate Analyzer for Volatile Organic Compounds In Water

Dr. Gordon Hayward

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School of Engineering
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Guelph, Ont. N1G 2W1

The objective of this project is to develop surrogate analyzers for several volatile organic compounds (VOCs) including alcohols, light fatty acids and solvents which are found as water contaminants. The analyzers are based on selective membrane separation techniques coupled with sensitive detectors. They could be used to screen water samples for VOC content to determine whether further analysis and quantification by more expensive techniques such as gas chromatography/mass spectrometry is justified.

8/1991 (1.5) \$35 000 (ER 565) [AMID]

549 Development of Inductively Coupled Plasma-Mass Spectrometry for the Determination of Trace Metals In Environmental Samples

Dr. Diane Beauchemin

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Queen's University
Kingston, Ont. K7L 3N6

This research program is focussed on improving the analytical capabilities of inductively coupled plasma-mass spectrometry (ICP-MS) for trace metal analysis by using flow injection (FI) techniques. In particular, FI into a gas carrier (instead of water) as a means of further improving the advantages of coupling FI with ICP-MS for trace metal analysis is considered. Using a gas carrier could increase sensitivity by, for example, reducing the solvent load in the plasma thereby increasing the energy available for the various processes involving the analyte such as desolvation, vaporisation, atomization and ionization.

6/1991 (1) \$23 500 (ER 568) [AMID]

550 The Thermal Desorption of Solid Phase Extraction Columns for the Low Level Measurement of Organic Compounds In Water

Mr. Marc Charbonneau

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Suite 100, 2319 St. Laurent Blvd.
Ottawa, Ont. K1G 4K6

This study involves the development of a sensitive method for the quantification of polychlorinated biphenyls in water using solid phase extraction (SPE) and thermal elution directly into a gas chromatograph (GC). The increased sensitivity is due to all of the extracted analyte being used for analysis. The first stage of the project involves the development of a usable technique to directly introduce analyte from a SPE column to a GC and includes two major components, optimization of the recovery, and reduction of interferences. The second stage is a determination of the precision and accuracy of the overall method compared to traditional extraction methods using real samples.

6/1991 (1) \$70 000 (ER 569) [AMID]

551 Pilot Study for the Development of a Biological Certified Reference Material for Organochlorine Contaminants

Dr. Michael Siu

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National Research Council
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Certified reference materials (CRMs) play a crucial role in analytical method validation, quality assurance and legislative support relating to pollution. Currently, no biological CRMs exist for polychlorinated biphenyls, and no CRMs of any sort exist for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). This project is a pilot study for the development of a biological CRM for such organochlorine contaminants. This involves the selection of candidate material, the development of appropriate processing methods for long product stability, pilot scale production, experiments to ensure good storage and transport characteristics of the prototype material, and the development and refinement of analytical methodologies for such analytes.

10/1991 (1) \$55 263 (ER 570) [AMID]

552 Development of Particle Beam Mass Spectrometric Methods for the Determination of Environmental Contaminants

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St. Catharines, Ont. L2S 3A1

This project involves the improvement of the sensitivity and detectability of liquid chromatography (LC)/mass spectrometry (MS) systems for the analysis of environmental contaminants by-the development of an improved particle beam interface to high resolution magnetic analyzer mass spectrometers, and the development of high sensitivity ion sources for use with the particle beam device. Since it is not dependent on volatility and thermal stability, particle beam LC/MS would facilitate access to the many organic compounds not able to be analyzed by gas chromatography/MS techniques, including carbamate pesticides.

6/1991 (2) \$123 300 (ER 571) [AMID]

553 MIFDS: A Microwave Interrupted Flow Digestion System

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McGill University
Montreal, Que H3A 2K6

Further development and evaluation (see ER 453) of two prototypes of microwave interrupted-flow digestion systems for the safe and rapid digestion of environmental samples for instrumental analysis is featured in this project. An interactive investigation of the capabilities of an existing mechanical prototype is accompanied by the development of a series of second generation systems. Particular focus is on the automation of the sample slurry preparation stage, the final step in the complete automation of the entire sample handling process. The development of such rapid automated systems for the preparation of samples would result in reduced sample analysis cost, increased sample throughput, a decrease in laboratory hazards and improved quality of sample preparation.

6/1991 (3) \$124 500 (ER 572) [AMID]

554 Unique Flow Injection Sample introduction for Plasma Spectrometry

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This study continues (see ER 414 and ER 504) and expands on the development of flow-injection/atomic spectrometry interfaces specifically for trace metal analysis in several important areas: real sample analysis, an improved interface and an evaluation of the limits of modern columns. A consideration of electrothermal vaporization instead of direct sample insertion as the means of vaporizing the sample and transporting it to the plasma is included. Based on previous work, this research offers the high probability of improving instrument performance by two orders of magnitude with respect to detection limit, drastically reducing matrix effects and reducing both labour and sample handling requirements.

6/1991 (3) \$145 000 (ER 574) [AMID]

555 Flow Injection Analysis for the Determination of Arsenic, Selenium and Sulfide

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The development of an automated flow analysis method for the determination of arsenic, selenium and sulfide with ppt detection limits will be the focus of this study. A modified gas-chromatographic system with a microwave induced plasma detector incorporating a diode array detector will be utilized. These state-of-the-art tools could be used for more accurate and precise investigations of environmental samples for pollution by trace metals. The proposed technology is also well-suited for automation which would result in significant advances in sample throughput and reduced per-sample cost.

5/1992 (1) \$28 500 (ER 611) [AMID]

556 Supercritical Fluid Extraction Process for Air Pollution Determination

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Analytical supercritical fluid extractions (SFE) significantly lower the cost, shorten the time and improve precision by about an order of magnitude for the analysis of harmful chemicals in air samples. In this project, a novel method based on a short piece of coated capillary will be investigated for the quantitative transfer of extracted material from the extractor onto the front of the gas chromatograph column. This interfacing represents the next logical step in automating analytical methods that employ SFE.

5/1992 (1) \$15 000 (ER 624) [AMID]

557 Bypassing Acid Digestion: instrumentation for Direct Elemental Analyses by inductively Coupled Plasma Spectrometry

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In this project, the development of a sample introduction system that would allow direct (i.e. without acid digestion and with minimum sample pre-treatment) elemental analyses from μ l volumes of liquids and mg quantities of solid samples of environmental concern will be addressed. The proposed system combines concepts from direct sample insertion (DSI) and electrothermal vaporization (ETV) devices and will be developed for ICP-AES spectrometry. A method that could accomplish this direct sample feat with acceptable precision and accuracy would be of tremendous benefit because it would greatly reduce sample preparation time and cost, and the need for strong acids. An improvement in detection limits should also be realized.

5/1992 (1) \$22 000 (ER 625) [AMID]

Previous Projects

558 Provision of PAHs and Aza-PAHs as Environmental Analytical Standards. Dr. V. Snieckus, University of Waterloo. 1982 \$77 900 (ER 75) [AQ]

559 The Chemoreceptive Membrane as an Electrochemical Sensor for Trace Organic Species In the Atmosphere. Dr. U. Krull, University of Toronto. 1983 \$33 000 (ER 76) [AQ]

560 Multi-Element Determination of Metals and Metal Compounds In Air and Related Samples. Dr. J. Van Loon, University of Toronto. 1983 \$39 300 (ER 77) [AMID]

561 Development of a Tunable Diode Laser Based Hydrogen Peroxide Monitor. Dr. H. Schiff, York University. 1983 \$44 500 (ER 79) [AQ]

Development of a Tunable Diode Laser Based Hydrogen Peroxide Monitor. Hastie, D.R. and Schiff, H.I., York University. 1984. (BLO)

562 Synthesis of Polynuclear Aromatic Hydrocarbons of Interest In Environmental Pollution. Dr. E. Lee-Ruff, York University. 1983 \$7 000 (ER 81) [AQ]

563 Laser Induced Emission Spectroscopy of Polycyclic Aromatic Hydrocarbons In Low Temperature Matrices. Dr. Sadowski, York University. 1983 \$33 700 (ER 82) [AQ]

564 Evaluation and Application of Pulsed Nuclear Magnetic Resonance in the Analysis of Environmental Samples. Dr. J. Easton, Ryerson Polytechnical Institute. 1983 \$49 000 (ER 85) [AMID]

565 Studies of Methodology and Instrumental Capabilities for Optimum and Rapid Analysis of PCDD and PCDF Compounds In Water and Related Environmental Samples. Dr. F. Karasek, University of Waterloo. 1983 \$42 750 (ER 102) [AMID]

Studies of Methodology and instrumental Capabilities for Optimum and Rapid Analysis of PCDD and PCDF Compounds in Water. Karasek, F.W. and Charbonneau, G.M., University of Waterloo. 41 Pp. (BLO)

566 Modifications to Chemiluminescent Instruments of NO and NO₂ from an Aircraft and a Mobile Laboratory. Dr. D. Hastie, York University. 1983 \$22 200 (ER 110) [AQ]

Modifications to Chemiluminescent instruments of NO and NO₂ from an Aircraft and a Mobile Laboratory. Kim, S.W., Hastie, D.R. and Schiff, H.I., York University. 1985. 15 Pp. (BLO)

567 Development of a Measurement Method for Nickel Carbonyl. Dr. D. Hastie, York University. 1983 \$21 900 (ER 116) [AC]

Nickel Carbonyl Ambient Monitor. Hastie, D.R. and Schiff, H.I., York University. 1988. 14 Pp. (BLO)

568 Aqueous Phase Liquid Extraction (APLE) System for Extraction and Concentration of Trace Organics. Dr. J. Cobum, Zenon Environmental Inc. 1984 \$14 700 (ER 122) [AMID]

569 Field and Laboratory Validation of a Hi-Vol Denuder for Minimizing PAH-Oxidant Reactions During Sampling. Mr. C. Davis, Concord Scientific Corporation. 1984 \$41 800 (ER 123) [AC]

Field and Laboratory Validation of a Hi-Vol Denuder for Minimizing PAH-Oxidant Reactions During Hivol Sampling. Davis, C.S. *et al*, Concord Scientific Corporation. 1988. 80 Pp. (BLO)

570 Macroreticular Resins as Preconcentrators for Organics, Chlorinated Phenolics and PAHs. Dr. D. Mackay, University of Toronto. 1984 \$15 000 (ER 133) [AMID]

571 Development of Automated Techniques for Reading Gel Plates. Dr. W. Bradbury, University of Toronto. 1984 \$10 000 (ER 134) [AMID]

572 Use of a Special Protein Adsorbent for the Selective Accumulation of Trace Contaminants. Dr. J. Hsia, University of Toronto. 1984 (1) \$32 000 (ER 135) [AMID]

573 A Critical Comparison of ICP-Mass Spectrometry instrumental Neutron Activation Analysis and Flameless AAS for the Analysis of Rain, Snow and Water Samples. Dr. J. Kramer, McMaster University. 1984 \$45 750 (ER 143) [AMID]

574 Synthesis of Chlorinated Anilines. Dr. N. Bunce, University of Guelph. 1984 \$4 100 (ER 146) [AMID]

Synthesis of Chlorinated Azobenzene. Bunce, N.J., University of Guelph. 14 Pp. (BLO)

575 Synthesis of Oxygen and Sulphur PAH's of Interest in Environmental Pollution and Toxicology. Dr. E. Lee-Ruff, York University. 1984 (3) \$33 500 (ER 170) [AC]

576 Microwave Digestion of Environmental Materials Prior to Inorganic Analysis. Dr. J. Mackey, Ryerson Polytechnical Institute. 1984 (1) \$9 400 (ER 175) [AMID]

577 Solid Sample Introduction and Laser Excitation In an inductively Coupled Plasma. Dr. E. Salin, McGill University. 1984 (1) \$27 800 (ER 176) [AMID]

578 A Feasibility Study of the Application of the TAGA 6000E GC/MS System to the Rapid Screening of Municipal Waste incinerator Combustion Products for the Presence of Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans. Mr. B. Suschan, Sciex. 1985 (2) \$141 000 (ER 177) [AC]

579 PAH Analysis of Environmental Samples at Low Temperature Using Fluorescence Detection. Dr. C. Sadowski, York University. 1985 (3) \$58 200 (ER 200) [WQ]

580 Screening Methods for Air and Water Samples: Application of Inductively Coupled Plasma Mass Spectrometry (ICP/MS) to Elemental Analysis. Dr. J. French, University of Toronto. 1985 (3) \$135 000 (ER 207) [AMID]

Electrothermal Vaporization and Gas Chromatography for Sample introduction into a Plasma for Plasma Source Mass Spectrometry. Van Loon J.C. *et al*, University of Toronto. 1988. 28 Pp. (BLO)

581 Provision of PAH's and Aza PAH's as Environmental Standards. Dr. V. Snieckus, University of Waterloo. 1985 (1) \$36 900 (ER 208) [AMID]

Regioselective Synthesis of isomerically Pure Phenanthrene and Phenanthridine PAH. Fu, J.M., Siddiqui, A. and Snieckus, V., University of Waterloo. 17 Pp. (BLO)

582 Development of Effective and Rapid Clean-Up Procedures for the Analysis of Dioxins/ Furans in Fish and Other Biota. Dr. F. Karasek, University of Waterloo. 1985 (1) \$33 000 (ER 210) [AMID]

583 An Unsolicited Proposal to Develop the GC/ Med System as a Non GC/MS Screening Technique for Hazardous Wastes. Dr. R. Jackson, Barringer Magenta Ltd. 1986 (1) \$63 000 (ER 211) [AMID]

Development of the GC/MED System as a Non GC/MS Screening Technique for Hazardous Wastes. Jackson, R., Barringer Magenta Ltd. 1988. 17 Pp. (BLO)

584 Development of Methodology for Complete Organic Compound Analysis of Complex Environmental Samples. Dr. F. Karasek, University of Waterloo. 1985 (1) \$25 000 (ER 216) [AMID]

585 Selenium Analysis Methodology at ng/l Levels for Softwaters. Dr. L Brown, University of Western Ontario. 1985 (1) \$15 000 (ER 222) [AMID]

586 Application of Robotics to the Analysis of Trace Organics In Fish and Other Biological Tissues. Ms. C. Chan, Mann Testing Laboratories Ltd. 1986 (1) \$170 000 (ER 223) [AMID]

587 Sample Preparation for Electron Diffraction. Mr. G. Rees, Ryerson Polytechnical Institute. 1986 (1) \$25 000 (ER 225) [AMID]

The Development of a Sample Preparation Method. Kilner, T., Ryerson Polytechnical Institute. 1987. 51 Pp. (BLO)

588 investigation in Ultrasonic Nebulizations: Development of a Relatively inexpensive, but Reliable System. Dr. J. Van Loon, University of Toronto. 1985 (1) \$31 000 (ER 230) [AMID]

Development of a Relatively inexpensive but Reliable Ultrasonic Nebulizer System for Liquid Sample introduction into ICP's and Flames. Petrucci, J. and Van Loon, J.C., University of Toronto. 44 pp. (BLQ)

589 Direct Solid Sample Analysis with the Direct Sample Insertion Device, Promise and Problems (Laser Excitation). Dr. E. Salin, McGill University. 1986 (1) \$31 000 (ER 247) [AMID]

590 Development and Evaluation of Methods and Instrumentation for the Direct Analysis of Solids by Inductively Coupled Plasma Atomic Emission Spectrometry. Dr. E. Salin, McGill University. 1986 (3) \$125 300 (ER 270) [AMID]

591 Proposal to Demonstrate an Automated Jar Tester. Dr. Tonelli, Zenon Environmental Inc. 1987 (1) \$36 600 (ER 280) [WQ]

592 Development and Critical Evaluation of a Dual Column Gas Chromatography Method for the Determination of Polycyclic Aromatic Compounds In Environmental Samples. Dr. M. Quilliam, McMaster University. 1986 (1) \$70 000 (ER 288) [AMID]

593 A Chromogenic Reagent for the Detection of E. Coli. Dr. S. Wolfe, Queen's University. 1986 (1) \$22 100 (ER 295) [WQ]

Development of a Chromogenic Reagent for the Specific Detection and Enumeration of Escherichia coli in Environmental Samples. A.N. Ley, Queen's University. 1988. 12 Pp. (BLO)

594 An Evaluation of a Sampling Scheme Using Hi-Vol/Sorbent Cartridge for Sampling of Dioxins/ Furans In Ambient Air In Ontario. Dr. A. Szokolcai, Ontario Ministry of the Environment. 1987 \$133 100 (ER 297) [AQ]

595 An Evaluation of a Hi-Vol Sampling Scheme for Measurements of Polynuclear Aromatic Hydrocarbons (PAH's) In Ontario. Dr. A. Szokolcai, Ontario Ministry of the Environment. 1987 (2) \$105 000 (ER 298) [AQ]

596 An intrinsic Chemically Selective Lipid-Based Wave Guide Organic Vapour Sensor. Dr. U. Krull, University of Toronto. 1987 (3) \$34 500 (ER 300) [AQ]

597 Provision of isomerically Pure Nitro PAH Analytical Standards. Dr. V. Snieckus, University of Waterloo. 1987 (1) \$36 900 (ER 304) [AMID]

AZA-Polycyclic Aromatic Hydrocarbons: A Review of the Literature. Cullen, K.T., University of Waterloo. 1988. 139 Pp. (BLO)

598 Development of Liquid Crystal Capillary Columns for Analysis of Polychlorinated Dioxins and Furans by GC/MS. Dr. F. Karasek, University of Waterloo. 1987 (1) \$42 500 (ER 323) [AMID]

599 Procedure for the 2,3,7,8 - Substituted Analysis of PCDD, PCDF and Other Target Compounds In Environmental Samples. Dr. F. Karasek, University of Waterloo. 1987 (1) \$92 000 (ER 324) [AMID]

600 Preparation of Heterocyclic Polynuclear Aromatic Hydrocarbons for Analytical Standards. Dr. E. Lee-Ruff, York University. 1988 (2) \$48 000 (ER 325) [AMID]

601 An Expert System for Quality Control and Quality Assurance In Analytical Chemistry. Dr. M. Stillman, University of Western Ontario. 1987 (1) \$54 100 (ER 326) [AMID]

602 Solid-Supported isolation and Derivation an Approach to Automation of Environmental Organic Analysis. Dr. J. Rosenfeld, McMaster University. 1987 (2) \$73 000 (ER 327) [AMID]

603 Detection and Quantification of Herbicides in Soil, Water and Plant Extracts Using an Enzyme Linked immunosorbent Assay (ELISA). Dr. J. Hall, University of Guelph. 1987 (2) \$66 000 (ER 328) [AMID]

Detection and Quantification of Herbicide Residues in the Environment Using Immunochemical Techniques. Hall, J.C., University of Guelph. 1989. (BLO)

604 Refinement and Testing of a Pre-Concentration Sampler for Dioxins in Water. Dr. B. Hollebone, Carleton University. 1987 (1) \$60 000 (ER 329) [AMID]

Refinement and Testing of a Preconcentration Sampler for Dioxins in Water. Brownlee, L.J. et al, Carleton University. 105 Pp. (LQO)

605 Adaption of Water Analysis: Preconcentration Techniques of Trace Metal Detection. Dr. B. Hollebone, Carleton University. 1987 (2) \$115 000 (ER 359) [AMID]

606 Determination of Group IV Elements from Air Filters. Dr. I. Brindle, Brock University. 1987 (1) \$44 300 (ER 360) [AMID]

607 Solid Phase Extraction of Polynuclear Aromatic Hydrocarbons from Drinking Water. Dr. W. Craig, Paracel Laboratories Ltd. 1987 (1) \$100 000 (ER 376) [AMID]

608 Applications of Gas Phase ion Chemistry to Problems in Chemical ionization Mass Spectrometric Analysis of Trace Organics. Dr. T. McMahon, University of Waterloo. 1987 (1) \$45 000 (ER 377) [AMID]

609 Robustness of the Student's t-test with Censored Environmental Quality Data. Mr. E. Creese, Creese Environmental Consultants. 1987 (1) \$11 480 (ER 378) [AMID]

610 Chlorinated and Non-Chlorinated Qrganics Storage Studies. Mr. W. Neaves, Enviroclean. 1988 (1) \$47 000 (ER 412) [AMID]

Chlorinated and Non-Chlorinated Organics Storage Studies. Neaves, W.M. and Fong, B., Enviroclean. 1989. 33 Pp. (RAC)

611 Solid Phase Extraction of Triazines and Organophosphorus Compounds. Dr. W. Craig, Paracel Laboratories Ltd. 1988 (1) \$52 500 (ER 413) [AMID]

612 Adoptlon of Water Preconcentration Techniques Developed for PCDD Analysis to Other Target Organic Pollutants. Dr. B. Hollebone, Carleton University. 1988 (2) \$186 000 (ER 420) [AMID]

613 Development of a Method for the Analysis of Brominated Dibenzo-p-Dioxins (BDD) and Brominated Dibenzofurans (BDF) In Environmental Samples by GC-MS. Mr. B. Chittim, Wellington Laboratories. 1988 (1) \$23 290 (ER 422) [AMID]

614 Solid Supported Reactions: the Chemical Basis for Development of Automation. Dr. J. Rosenfeld, McMaster University. 1989 (1) \$40 000 (ER 446). [AMID]

BIOTECHNOLOGY

1991/92 Projects

615 Contingency Planning for Accidentally Released Genetically-Engineered Microorganisms in the Environment

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With the possibility that the accidental release of genetically engineered micro-organisms (GEMs) will pose risk to human health and the environment, the development of contingency plans to mitigate these risks is essential. This project commenced with a detailed review of the available knowledge in this area as a prelude to laboratory experiments to monitor the growth and survival of released microorganisms following simulated spills. Physical and chemical methods to destroy accidentally released GEMS will also be tested using laboratory microcosms. Finally, if permitted, small scale field studies will be conducted to test the destruction of naturally occurring (not GEMs), but genetically-marked, strains by physical and chemical methods.

6/1991 (3) \$198 000 (ER 552) [MMCB]

616 Development of DNA Probe(s) for the Detection of *Bifidobacterium* spp. In Water: Phase II

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Bifidobacteria have been widely suggested to be of use as potential indicators of faecal contamination of water. Nucleic acid probe technology could be utilized for rapid, sensitive, accurate and simple detection and enumeration of *Bifidobacterium* spp. directly from environmental samples, without the need of laborious and unreliable bacterial culturing. This would be a major step towards the ability to rapidly and cost-effectively establishing the sources of bacterial pollution. The objective of this phase of the ongoing project was to ascertain the effectiveness (the desired specificity) of the potential probe(s) and determine their sensitivity and specificity for environmental samples.

7/1991 (1) \$49 555 (ER 573) [AMID]

Final Report Received (REV)

Previous Projects

617 Development of Recombinant DNA Probes to Determine the Origin of Fecal Streptococci at the Toronto Area Beaches. Dr. Bradbury, University of Toronto. 1985 \$54 600 (ER 154) [AMID]

618 Biotechnology Policy Development. Mr. D. MacDonald, Canadian Environmental Law Research Foundation. 1986 (1) \$48 000 (ER 265) [MMCB]

Biotechnology Policy Development, Vol. 1. MacDonald, D. Canadian Environmental Law Research Foundation. 1988.40 Pp. (RAC)

Biotechnology Policy Development, Vol. 2. MacDonald, D. Canadian Environmental Law Research Foundation. 1988. 52 Pp. (RAC)

619 Field Trials of Developed DNA Probes for Determining Bacterial Pollution Source Inputs. Dr. Bradbury, University of Toronto. 1986 (1) \$33 600 (ER 287) [AMID]

MISCELLANEOUS

1991/92 Projects

620 Investigation of Vibration isolation Method In a House for Reduction of Train Vibrations

Dr. Hans Rainer

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National Research Council
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The development and application of methodology to determine the characteristics of ground vibrations caused by passenger and freight trains was the objective of this study. Results suggested that site conditions are the most important factor affecting the frequency content and amplitudes of ground vibrations and their attenuation, greatly overshadowing the influence of train type, weight or speed. Subsequently, the methodology was employed to evaluate the effectiveness of placing elastomeric pads between the ground and superstructure of a building in isolating buildings from vibrations.

4/1988 (2) \$73 419 (ER 407) [AQ]

621 An Assessment of Landuse impact on the Microclimate of the Fonthill Kame

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The steep slopes of the Fonthill Kame on the Niagara Escarpment, projecting above the surrounding flat plain, facilitate the drainage of cold air under radiation frost conditions thereby creating a favourable microclimate for small fruit production. This project involves a detailed assessment of the microclimate of the Kame in terms of its spatial variations in temperature noting, in particular, evidence of the depth and rate of cold-air drainage on a variety of slopes under radiation frost conditions. This improved understanding of the effect of variations in topography can be used to evaluate the effect of structural changes to the Kame, such as through aggregate extraction, on its microclimate.

6/1989 (2) \$30 500 (ER 457) [AQ]

Previous Projects

622 Ontario Breeding Bird Atlas. Dr. Francis, University of Waterloo. (ER 51)

The Ontario Atlas of Breeding Birds - A Guide for Participants. Eagles, P., and Sharp, M., University of Waterloo. 1981. 20 Pp. (BLO)

623 The Effects of Forestry Operations Upon the Environment of Ontario. Mr. D. Huff, Federation of Ontario Naturalists. 1987 (1) \$100 000 (ER 315) [ESE]

The Effects of Forestry Operations Upon the Environment of Ontario. Federation of Ontario Naturalists. 1986. 536 Pp. (LQO)

624 A Study to Determine the Feasibility of Modelling Microclimatic Conditions on the Fonthill Kame. Mr. C. Cambay, Regional Municipality of Niagara. 1987 (1) \$9 500 (ER 371) [AQ]

Feasibility Study for Assessing and Modelling Microclimatic Conditions on the Fonthill Kame. Shaw, T.B., Brock University. 1988. 59 Pp. (LQO)

625 Proposal for Partial Support of a Collection of Algal, Microbial, and Plant Cell Cultures. Dr. C. Nalewajko, University of Toronto. 1988 (3) \$36 000 (ER 387) [WQ]

626 Avian Pest Dispersal Mechanisms for Horticultural Crops. Mr. F. Ingratta, Ontario Ministry of Agriculture and Food. 1989 (1) \$14 500 (ER 455) [MMCB]

**ENVIRONMENTAL RESEARCH PROGRAM
CROSS REFERENCE INDEX**

Conventional Environmental Research Program project numbers (ER 999) are referenced to the Report catalogue number. Note that this catalogue number has no relevance beyond this document

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ER 314	423	ER 354	326	ER 394	173	ER 434	536
ER 315	623	ER 355	252	ER 395	256	ER 435	463
ER 316	167	ER 356	054	ER 396	280	ER 436	498
ER 317	244	ER 357	253	ER 397	257	ER 437	338
ER 318	245	ER 358	254	ER 398	276	ER 438	049
ER 319	246	ER 359	605	ER 399	258	ER 439	007
ER 320	175	ER 360	606	ER 400	139	ER 440	050

ER 441	057	ER 481	358	ER 521	186	ER 561	091
ER 442	537	ER 482	359	ER 522	360	ER 562	289
ER 443	330	ER 483	440	ER 523	--	ER 563	290
ER 444	058	ER 484	008	ER 524	443	ER 564	066
ER 445	303	ER 485	052	ER 525	444	ER 565	548
ER 446	614	ER 486	182	ER 526	547	ER 566	187
ER 447	259	ER 487	141	ER 527	466	ER 567	188
ER 448	051	ER 488	061	ER 528	409	ER 568	549
ER 449	059	ER 489	283	ER 529	410	ER 569	550
ER 450	178	ER 490	305	ER 530	361	ER 570	551
ER 451	407	ER 491	101	ER 531	362	ER 571	552
ER 452	329	ER 492	183	ER 532	430	ER 572	553
ER 453	538	ER 493	262	ER 533	411	ER 573	616
ER 454	539	ER 494	184	ER 534	431	ER 574	554
ER 455	626	ER 495	284-	ER 535	----	ER 575	306
ER 456	084	ER 496	086	ER 536	011	ER 576	189
ER 457	621	ER 497	541	ER 537	012	ER 577	103
ER 458	499	ER 498	542	ER 538	143	ER 578	067
ER 459	260	ER 499	543	ER 539	013	ER 579	291
ER 460	179	ER 500	062	ER 540	064	ER 580	190
ER 461	304	ER 501	002	ER 541	088	ER 581	068
ER 462	282	ER 502	003	ER 542	089	ER 582	292
ER 463	261	ER 503	544	ER 543	014	ER 583	104
ER 464	263	ER 504	545	ER 544	144	ER 584	307
ER 465	429	ER 505	009	ER 545	145	ER 585	105
ER 466	060	ER 506	053	ER 546	065	ER 586	191
ER 467	301	ER 507	524	ER 547	287	ER 587	528
ER 468	264	ER 508	004	ER 548	526	ER 588	529
ER 469	180	ER 509	525	ER 549	363	ER 589	530
ER 470	277	ER 510	063	ER 550	527	ER 590	446
ER 471	--	ER 511	185	ER 551	467	ER 591	447
ER 472	181	ER 512	285	ER 552	615	ER 592	331
ER 473	465	ER 513	501	ER 553	502	ER 593	531
ER 474	405	ER 514	546	ER 554	364	ER 594	332
ER 475	428	ER 515	087	ER 555	445	ER 595	333
ER 476	438	ER 516	142	ER 556	090	ER 596	092
ER 477	085	ER 517	010	ER 557	146	ER 597	106
ER 478	439	ER 518	441	ER 558	288	ER 598	334
ER 479	408	ER 519	286	ER 559	102	ER 599	---
ER 480	540	ER 520	442	ER 560	147	ER 600	432

ER 601	335	ER 641	469
ER 602	365	ER 642	509
ER 603	093	ER 643	510
ER 604	412	ER 644	511
ER 605	--	ER 645	512
ER 606	192	ER 646	450
ER 607	308	ER 647	513
ER 608	309	ER 648	514
ER 609	293	ER 649	515
ER 610	294	ER 650	516
ER 611	555	ER 651	----
ER 612	366	ER 652	470
ER 613	----	ER 653	517
ER 614	----	ER 654	518
		ER 655	519
ER 615	336	ER 656	520
ER 616	----		
ER 617	094		
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ER 620	015		
ER 621	448		
ER 622	433		
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ER 630	193		
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EXCELLENCE IN RESEARCH AWARDS

Environment Ontario acknowledges significant achievement in environmental research in three categories through its annual Excellence in Research Awards. Awards are given in principal investigator, student and ministry staff categories, and are presented at the ministry's annual Technology Transfer Conference.

1991 AWARDS

PRINCIPAL INVESTIGATORS

Water Quality Research

Douglas Haffner
University of Windsor

For his project on "The Use of Aquatic Vegetation and Invertebrates to Monitor Chlorinated Hydrocarbons in the Lake Huron - Lake Erie Corridor which has contributed to the understanding of the use of biological monitors of contaminants in aquatic systems.

Analytical Methods Research

Ian Brindle
Brock University

For his projects on "Development of an Automated Batch Hydride Generator for the Determination of Arsenic and Selenium" and "Investigations into the Analysis of Hydride-Forming Elements" which have contributed to improving capabilities for the determination of volatile toxic elements in environmental materials.

Liquid and Solid Waste Research

Raymond McBride
University of Guelph

For his project on "Slow Sand Infiltration Land Treatment and Recirculation of Municipal Solid Waste Landfill Leachate in Ontario" which has contributed to the understanding of how leachate applied on land may affect the environment and vegetation

Air Quality Research

Philip Hopke
Clarkson University

For his project on "Development of Multi-Variate Analysis Procedures for Ontario Air Quality Data" which has contributed to advances in the statistical evaluation of APIOS deposition data.

Winners received a \$1,000 award and a citation, and their organizations received plaques in recognition of their support and encouragement.

STUDENTS

Water Quality Research

Gordon Kirby
University of Guelph

For his studies on "Pathogenesis of Pollution-Associated Neoplasms in Feral Fish from the Great Lakes" which has contributed to the understanding of the various factors advancing the knowledge of cancer susceptibility in fish and provided new insights into the use of wild fish as sentinels of the effects of environmental pollution.

Pesticides Research

Trevor Kraus
University of Guelph

For his study on 'Modulation of Ethylene Synthesis in Wheat and Soybean Seedlings' which has demonstrated that uniconazole protects plants from damage caused by heat and herbicide thereby contributing towards minimizing the use of herbicides.

Liquid and Solid Waste Research

Clayton Barclay
University of Waterloo

For his study on "Bio-degradation of Polynuclear Aromatic Hydrocarbons by *Phanerochaete chrysosporium*' which has contributed to the understanding of the processes involved in bio-remediation of soils contaminated with polynuclear aromatic hydrocarbons (PAHs) leading to complete mineralization of PAHs to carbon dioxide.

Analytical Methods Research

Robert Burk
Carleton University

For his study on 'Supercritical Fluid Extraction of Trace Organics from Solid Matrices' which has resulted in the development of rapid and reliable techniques for the extraction of trace organic compounds from solid samples using supercritical fluids.

Winners received a \$1,000 award and a citation, and their departments received plaques in acknowledgment of their encouragement and support.

MINISTRY STAFF

Water Quality Research

Wolfgang Scheider
Water Resources Branch

For his outstanding work as the longest serving research coordinator in support of the ministry's research programs, and his research efforts which have contributed to the management of internal and external water quality research projects and the development of research needs.

Analytical Methods Research

Paul Yang
Laboratory Services Branch

For his research efforts which have contributed to the "Development of GC/FT-IR Techniques and Technologies for the Determination of Toxic Organics in Air".

Air Quality Research

Robert Bloxam
Air Resources Branch

For his research which has contributed to the "Development and Application of CAP (Reg. 308) Modelling System" and "Development and Application of the Transport and Deposition Model for Mercury"

Multi-Media and Biotechnology Research

Adam Socha
Hazardous Contaminants and Standards Branch

For his research which has contributed to the development of "Hazard Assessment of Environmental Contaminants using the Ministry of the Environment Scoring System"

Recipients received a \$500 cash award and a plaque.

Note: These awards are now entitled "Excellence in Environmental Research and Technology Development".

ENVIRONMENTAL TECHNOLOGIES PROGRAM

The Environmental Technologies Program (ETP) was initiated in 1990 to help develop new technologies to overcome environmentally damaging practices. The program's focus is on the latter stages of the technology innovation process, the development, refinement, and commercialization of the product or process. Particular emphasis is placed on the creation of technologies which can be marketed internationally.

Developmental projects eligible under the ETP fall into seven categories:

- ▶ Waste Management
- ▶ Water and Sewage Treatment
- ▶ 3Rs Technologies
- ▶ Analytical Instrumentation
- ▶ Tire Technologies
- ▶ Air Pollution Control
- ▶ Socio-Economic Analysis

Management of the ETP rests with the Environmental Technologies Advisory Committee (ETAC). Among its responsibilities are the definition of technology priorities and the recommendation of projects for funding.

To be eligible for funding, recipients must operate or reside in Ontario. A wide range of organizations qualify, including Canadian corporations, subsidiaries of foreign owned firms, universities and municipalities.

Typical ventures eligible for funding include:

- ▶ research leading to the development of an innovative process or product
- ▶ 3 equipment prototype development and testing
- ▶ pilot-scale equipment refinement and adaptation
- ▶ field trials and demonstration of innovative technologies to determine system performance, reliability, and cost effectiveness
- ▶ initial demonstration of foreign technologies to determine their suitability to Ontario conditions

Only developmental or demonstration aspects of the technology are eligible for support. Costs associated with full-scale production and marketing are not supported. Generally, funding for a project does not exceed 50 per cent of the total cost to a maximum of \$500,000 per year for up to three years.

Applications for ETP funding are received throughout the year. Submissions must include detailed technical and commercial objectives, a budget, anticipated goals, and a commercialization plan. The contribution of the project to ministry technology and regulatory needs must be clearly defined, as must the potential value to the environment.

At least three reviewers from various provincial ministries including the Ministry of Industry, Trade and Technology, and such agencies as the Ontario Development Corporation give technical and financial evaluations of each proposal. Reviews are based on broad selection criteria including:

- ▶ net contribution to environmental protection
- ▶ effectiveness in addressing ministry technical, policy, and regulatory requirements
- ▶ technical excellence
- ▶ degree of innovation
- ▶ commercialization potential locally and internationally
- ▶ industrial and economic benefits
- ▶ financial and management capability of the applicant

The ETAC meets quarterly to evaluate reviewed proposals using similar criteria. Preference is normally given to technologies that prevent or reduce pollution at the source, rather than at the end of the pipe or stack. Those which assist organizations in meeting such regulatory requirements as the Municipal-Industrial Strategy for Abatement (MISA) are particularly favoured.

With ETAC recommendation for approval, and senior management concurrence, the ministry negotiates a contract with the proponent. This agreement details milestones or goals to be achieved during the developmental phase.

With possible assistance from an external expert or ministry technical committee, a ministry Liaison Officer then becomes responsible for monitoring progress toward technical, financial and commercial goals.

The proponent of each project must submit progress reports, including expenditure details, every six months or upon reaching each major milestone. Although there are provisions for payment of funds prior to project initiation, continued payments are generally made only upon achievement of previously negotiated milestones.

Upon completion of the developmental phase, a report must be submitted which discusses major research and development components, and provides an updated commercialization plan. As well, the net environmental, economic, and industrial benefits that will accrue to the province must be defined. Typically, this would include expected reductions in specified emissions, or anticipated levels of reduction, reuse, and recycling.

After the commercialization phase, which is typically expected to take three to four years after completion of technical development work, a final report must summarize the production levels and sales achieved, as well as the actual net environmental, economic, employment and industrial benefits achieved. The reasons for any discrepancies between forecast and actual levels or benefits must be discussed.

Participation in the ETP can be a winning situation for everyone - the organizations that develop the new products and processes, the government, all those who ultimately benefit from the new technologies and, most of all, the environment.

ENVIRONMENTAL TECHNOLOGIES PROGRAM

Research and Technology Branch
Environment Ontario
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5
Fax: (416) 323-4437

Manager, Environmental Technology Development

Mr. Doug Vallery
(416) 323-4476

Environmental Technology Analyst

Ms. Val Moraglia
(416) 323-4627

Environmental Technology Assistant

Ms. Kirsten Mania
(416) 323-4675

General enquiries requesting program guidelines, application forms and other publications should be addressed to the

Grants Assistant

Ms. Ana Rosati
(416) 323-4649

ENVIRONMENTAL TECHNOLOGIES PROGRAM PROJECT DIRECTORY

The following directory summarizes active projects in the Environmental Technologies Program in the 1991j92 fiscal year. An explanation of each entry follows:

999	Report catalogue number NOTE: THIS NUMBER HAS NO SIGNIFICANCE BEYOND THIS DOCUMENT Project title Company / Project Director Contact details Project summary
5/1990 (2)	Month and year of initiation (duration in years)
\$175 000	Total amount committed
(ET 010)	Environmental Technologies Program project number

For reference purposes, Environmental Technologies Program project numbers are cross-referenced to the Report catalogue number in an index on Page 117.

WASTE MANAGEMENT

627 Demonstration of Vitrokele™ Technology to Recycle Cyanides and Metals at Gold Plants

Jasmetech Metal Technologies Inc.
Dr. Denis Kidby

(519) 836-9494

67 Watson Rd. S.
Guelph, Ont., N1H 6H8

In this project, an economically attractive process based on Vitrokele™ technology for producing environmentally acceptable effluent from gold mills was demonstrated at Bell Creek Mine near Timmins, Ont. Vitrokele™, a family of synthetic adsorbents, capture cyanide as well as significant quantities of such heavy metals as copper from slurries and discharge solutions. The cyanide is recycled back to the primary gold leaching circuit and the metals recovered for other uses. Potentially, this technology could result in a pollution prevention process which recovers all capital expenditure and produces an ongoing operating profit.

11/1990 (1) \$406 000 (ET 010)

Final Technical Report Received

628 Plasma Gasification Feasibility Study of Hospital Solid Waste PSW89-01

Resorption Canada Ltd.
Mr. George Carter

(613) 822-1842

2610 Del Zotto Ave.
R.R. #5, Gloucester, Ont. K1G 3N3

An investigation of the plasma gasification disposal of Hospital Solid Waste in their plasma research facility is the focus of this company's developmental work. The process operates at approximately 1200°C and produces an inert slag which may have commercial uses and a medium value heating value gas which may be burned immediately or stored for later use. The plasma disposal system requires an extremely small space compared to other disposal technologies. Optimal operating parameters for the process will be determined and a full environmental analysis for organics, acid gases and trace metals in the product gas, flue gas and quencher water conducted, plus a full leachate analysis of the slag.

1/1992 (1) \$145 400 (ET 032)

629 Electrolytic Recovery of Zinc from Galvanized Steel Metal Recovery Industries Inc.

Mr. Andrew Kellner

(416) 549-9894

670 Strathearne Ave. N.
Hamilton, Ont. L8H 7N7

An alkaline zinc electrowinning process which can be used in conjunction with an electrochemical degalvanizing process to produce a high quality zinc product is under development in this project. Once operating parameters are optimized, a prototype zinc harvesting and purification system will be designed and constructed. This will allow test marketing of the recovered zinc. Successful development would afford the opportunity to recover much of the 700,000 kg of zinc waste now generated annually in galvanized steel remelting in Canada.

3/1991 (2) \$120 000 (ET 033)

630 Development of Innovative Electrochemical Membrane Technology to Permit Source Recovery and Recycling of Waste Acids and Etchants

Prosep Technologies Inc.
Mr. Michael Sheedy

(416) 831-2474

Unit 7, 817 Brock Rd. S.
Pickering, Ont. L1W 3L9

The objective of this project is the development of an electrochemical membrane process to recover and recycle waste acids, metal salts and etchants from the metal finishing industry. This will help to eliminate the production of hazardous metal hydroxide sludges and salts now produced during the conventional neutralization of such wastes. With the completion of laboratory work, a pilot plant has been constructed and is now operating. This will be followed by a full-scale demonstration at a secondary steel producer.

1/1991 (3) \$732 600 (ET 057)

631 Treatment of Fluids Containing Organic Contaminants

Trojan Technologies Inc.
Dr. William Cairns

(519) 685-6660

845 Consortium Ct.
London, Ont. N6E 2S8

Under consideration in this project is the development of a process and hardware for the treatment of gases and liquids containing organic contaminants. The process could be used in the treatment of off gases, industrial effluents, groundwater recharge, potable water and wastewater. The process and equipment under development build upon Trojan Technologies' experience in UV reactor design for control of microbial contaminants in water and wastewater. The new process and hardware are being engineered to provide high level destruction of chemical contaminants present in the fluids.

1/1991 (3) \$314 450 (ET 076)

632 Development of a Micro-computer Based Expert System for Mine/Mill Effluent Treatment Plant Design (Gold industry Case)

Wastewater Technology Centre
Mr. Abbas Zaidi

(416) 336-4618

867 Lakeshore Rd., P.O. Box 5050
Burlington, Ont. L7R 4A6

A micro-computer based system which can be used to design and tailor the most cost effective effluent treatment system for cyanide/metals/toxicity removal for any given gold mill is being formulated. The expert system, which will be designed specifically for the Ontario gold mining industry with capabilities for expansion into other industrial sectors and the rest of Canada, will be able to generate a comprehensive report containing all relevant information on process design and cost of the selected system.

8/1991 (3) \$284 750 (ET 127)

633 Extension and Finalization of the LANDIS Expert System

Dearborn Chemical Company Ltd.

Mr. David Young

(416) 279-2272_

3451 Erindale Station Rd.
P.O. Box 3060, Station A
Mississauga, Ont. L5T 3T5

This study involves the extension and final development of the LANDIS (LANd DISposal) expert system based software decision tool to a form relevant to Canadian situations and suitable for distribution. LANDIS is a solid waste landfill disposal assessment system. It is designed to guide the user through a solid waste assessment process to determine the suitability of disposing a specific waste in a specific landfill site. Expert system rules control the evaluation process and incorporate the expertise necessary to render final conclusions and recommendations. LANDIS is also a useful tool for conducting "what if" hypothetical scenarios.

6/1991 (3) \$200 000 (ET 130)

634 BEI/GM Research Project to Develop a Commercial Enzymatic Process for the Polishing/ Removal of Contaminants from Wastewater on an industrial Scale

Biotech Environmental Inc.

Mr. Brian Ablett

(416) 543-3097

Suite 115, 2550 Argentia Rd.
Mississauga, Ont. L5N 5R1

An economical and effective wastewater treatment system for the removal of dissolved phenolic compounds from water is being evaluated in this project. The system under consideration is based on the immobilization of peroxidase enzyme on the granular bone product BIOBONE™. The peroxidase enzyme acts by polymerizing phenols to insoluble polyphenols which are trapped on the bone. Two demonstration reactors (intermediate and full-scale) based on this process are being evaluated for their effectiveness in phenol removal from wastewater at the General Motors foundry in St. Catharines Ont.

9/1991 (1) \$313 540 (ET 155A)

635 Field-Based Pilot-Scale Remediation Trials for Industrially-Contaminated Environmentally-Hazardous Soils

Tallon Metal Technologies Inc.
Dr. Bruce Holbein

(519) 766-9160

67 Watson Rd. S.
Guelph, Ont. N1H 6H8

The focus of this project is the design, construction and operation of a field-based pilot scale plant to evaluate a metal extraction and recovery process based on synthetic Vitrokele™ adsorbents for the remediation of contaminated soil. These adsorbents are used in conjunction with standard mineral processing unit processes (soil washing) and proprietary hydrometallurgical processes to produce decontaminated soil for reuse, while recovering metals for use in other applications.

8/1991 (1) \$914 650 (ET 173)

636 Biofiltration of Toxic Metals from Acid Mine Drainage Through Actinorhizal Plant Systems

Mikro-Tek Laboratories
Mr. Mark Kean

(705) 264-2048

36 Emerald St., P.O. Box 2120
Timmins, Ont. P4N 7X8

The effectiveness of alders (*Alnus rugosa*) inoculated with the microsymbionts *Frankia* and mycorrhizal fungi as a biological fitter for the control of acid mine drainage is being evaluated in this undertaking. The metal and water tolerant alder is proposed as an ideal species for the immobilization of toxic metal pollutants from contaminated soil. Following laboratory/greenhouse studies on metal uptake and tolerance, pilot test plots will be established at a selected site. This ecological approach could prove to be a novel strategy to revegetate sterile areas of former mine tailing ponds.

8j1991 (3) \$225 550 (ET 175)

3Rs TECHNOLOGIES

637 Development of a Process which will Reclaim Scrap and Produce New Products for Interior and Exterior Architectural Applications

Plastiglas Industries Ltd.
Mr. Stephen Baker

(416) 428-2002

403 Clements Rd.
Ajax, Ont. L1S 6N3

Fibreglass reinforced products cannot presently be recycled. The objective of this project is the development of a new process for the recovery of fibres from fibreglass-reinforced plastic scrap and their incorporation into such new products as interior and exterior building materials, or furniture. When fully operational, the company would be able to recover much of their scrap and that from other fibreglass manufacturers diverting a significant quantity of material from landfill sites.

2/1991 (1) \$67 100 (ET 029)

638 Development of Mercury Free Reusable Alkaline Manganese Dioxide (RAM) Consumer Batteries

Battery Technologies Inc.
Dr. Klaus Tomantschger

(416) 820-1755

2480 Dunwin Dr.
Mississauga, Ont. L5L 1J9

The development of mercury free RAM battery technology for use in small format consumer battery sizes (AAA, AA, C, D) is being accelerated in this project. The emphasis is on the further development and refinement of the technology to produce a rechargeable alkaline AA battery which is free of mercury, and with performance and cost comparable to existing single use alkaline batteries. Use of such batteries would greatly reduce the estimated 13 tonnes of mercury disposed of annually into the Canadian environment through the disposal of small format batteries into landfill sites and incinerators.

4/1991 (3) \$247 500 (ET 048)

639 RMDC Roofing Shingles Recycling

Roofing Materials Disposal Company Ltd.
Mr. Keith Beare
(416) 336-7575
247 Elmhurst Cres.
Burlington, Ont. L7L 2A5

The objective of this project is the development of a small portable processing plant for the recycling of roofing shingle waste. Based on an auger extruder, the plant will mechanically disintegrate roofing waste and homogenize it into a bituminous raw material. The material formed, asphalt composition mix, could then be marketed as a roading material or formed into such products as paving stones. Successful introduction of this technology could divert as much as 500,000 tonnes of waste from landfills in Canada each year.

11/1990 (1) \$90 000 (ET 052)

640 Deinking of Wastepaper by High Pressure Steam Treatment for Paper Reuse

Stake Technology Ltd.
Dr. Ernest Yu
(416) 455-1990
2838 Highway 7
Norval, Ont. LOP 1K0

The feasibility of continuous steam-explosion treatment in the deinking of selected wastepapers for paper recycling is being assessed in this project. Studies at both the laboratory and pilot scale have suggested numerous technical and economic benefits compared with conventional processes. Using this technology, enhanced ink removal from paper fibres is possible with reduced or even no use of deinking chemicals. This enhanced overall cleanliness of the fibres would also likely reduce the requirement for downstream cleaning after pulping. These benefits have been demonstrated for a wide range of paper types including coated magazines, office waste and old corrugated containers including resin-based wet-strength material.

8/1991 (2) \$192 250 (ET Q68)

641 Proactive Printer's Waste Ink Recycling, Phase II & III

Proactive Recycling Inc.
Mr. Bert Wakeford
(519) 371-6511
235 10th St. W.
Owen Sound, Ont. N4K 2R3

This project is centred on the further development and application of a self-sufficient, mobile ink recycling unit, capable of on-site filtering and processing. The compact prototype could be transported to the site of waste generation and produce economically viable daily quantities of recycled ink. It will be able to produce recycled ink with characteristics approaching those of virgin product and ensure full four colour recycling. This could facilitate up to 95% reduction in the amount of hazardous liquid waste ink requiring disposal.

5/1991 (2) \$257 500 (ET 080)

TIRE TECHNOLOGIES

642 Transportable Tire Shredder

Shred-Tech Ltd.
Mr. John Bell

(519) 621-3560

201 Beverly St., P.O. Box 1508
Cambridge, Ont. N1R 7GB

This venture involves the design, development, testing and demonstration of a transportable tire shredder that could be operated at remote locations and smaller landfill sites where permanent installations are not feasible. This would offer an alternative approach to shipping whole tires to central shredding sites. Capabilities of the shredder will include single person operation, extended knife life, the ability to handle both car and truck tires, and the ability to ensure 2 to 4" shred size if required in order to make fuel chips for export. Following laboratory testing, the machine will be made available to various landfill sites in Ontario for practical demonstration.

2/1992 (1) \$300 000 (ET 179)

643 Preparing of New Thermo Plastic Compounds Containing Ground Rubber Tires

Department of Chemistry
Queen's University
Dr. Warren Baker

(613) 545-2621

Kingston, Ont. K7L 3N6

The preparation of thermoplastic compounds containing maximum amounts of ground rubber tires that could be processed into cost effective finished products is the objective of this study. Initially, characteristics of ground rubber from different sources and processes and how their surface and bulk properties can be modified advantageously are being assessed. Accompanying this is an examination of the compounding of ground rubber with several virgin plastic polyethylene polymers. This project will provide scientific information and technical support to Ontario industries pursuing new market and new product opportunities for scrap tires.

12/1991 (2) \$181 058 (ET 226)

WATER AND SEWAGE TREATMENT

644 Modular Drinking Water Pilot Plant for the 1990's

Department of Civil Engineering
University of Waterloo
Dr. Peter Huck

(403) 492-4738

Waterloo, Ont. N2L 3G1

The focus of this development is the design, construction and testing of modular drinking water pilot plants for use in advanced investigations with different water types. State-of-the-art processes such as ozonation, granular activated carbon and biological treatment are included. Ultimately, a refined modular design will be developed to a state of market readiness for Canadian and offshore sales.

10/1990 (3) \$785 900 (ET 006)

645 Development of Membrane Technology for Drinking Water Production: Treatment of Coloured Waters

Zenon Environmental Inc.
Dr. Pierre Cote

(416) 639-6320

845 Harrington Ct.
Burlington, Ont. L7N 3P3

The potential of nanofiltration membrane technology for the removal from water of a number of soluble organic compounds, many of which cause brown-tinted water, is being evaluated. Apart from aesthetic problems, these organic substances react with chlorine during conventional disinfection processes to form such harmful products as trihalomethanes. Membrane technology would be an effective alternative to conventional treatments that are not completely effective, and are either expensive, lead to undesirable by-products, or require spacious installations.

1/1991 (2) \$160 000 (ET 007)

WATER AND SEWAGE TREATMENT

646 Demonstration of Expert System Software for Pollution Control Planning

Wastewater Technology Centre
Ms. Judy Czajkowski

(416) 336-4599

867 Lakeshore Rd., P.O. Box 5050
Burlington, Ont. L7R 4A6

The formulation of an integrated set of computer-based tools which will allow the systematic planning and evaluation of municipal sewage collection and treatment facilities is the objective of this project. The software will then be demonstrated in a case study at Port Colborne, Ont.

11/1991 (3) \$300 000 (ET 017A)

647 Further Development of the Rayox^(R) Enhanced Oxidation Product

Solarchem Enterprises Inc.
Dr. Stephen Cater

(416) 764-9666

Unit 5, 40 West Wilmot St.
Richmond Hill, Ont. L4B 1H8

Removal of organic pollutants from the aquatic environment using the Rayox (R) enhanced oxidation technology involves using high-powered ultraviolet lamps, with oxidants, which cause the generation of reactor intermediates such as the hydroxyl radical, leading to mineralization to harmless substances. Treatment of a variety of contaminated waters have been examined, including process wastewater and groundwater. Excellent results have been obtained to date even in the most problematic process waters. Such compounds as chlorinated organics, aromatic hydrocarbons, N-Nitrosodimethylamine and pentachloro-phenol can all be readily reduced to or below required discharge levels. Research and development is focussing on physical and chemical process improvements to reduce the overall costs of treating contaminated water.

11/1990 (2) \$688 000 (ET 024)

648 Hard Metal, High Efficiency Sludge Handling Pump

Hayward Gordon Ltd.
Mr. John Hayward

(416) 677-6440

7505 Bath Rd.
Mississauga, Ont. L4T 1L3

This undertaking involves the design, development and field evaluation of eleven models (horizontal, vertical dry pit and immersible configurations) of a hard metal, screw impeller

centrifugal pump to be used for handling both sewage and sludge in municipal and industrial wastewater treatment plants. This may lead to development of a superior system for the transfer of heavier and grittier municipal and industrial waste sludges and contribute to the more efficient and economic operation of wastewater treatment plants.

8/1991 (2) \$134 000 (ET 036A)

649 Catalysed Reductive Degradation of Halogenated Organic Compounds

Waterloo Centre for Groundwater Research
University of Waterloo
Dr. Robert Gillham

(519) 888-4658

Waterloo, Ont. N2L 3G1

Halogenated organic compounds are a major threat to the water environment. A cost-effective method based on reductive dehalogenation with metal surfaces acting as a catalyst for the removal of such halogenated organic compounds from water is being investigated in this project. This could be an alternative to such processes as activated carbon adsorption or aeration. Through laboratory and field testing, a system having application in such areas as remediation of existing zones of groundwater contamination and the removal of trihalomethanes from chlorinated municipal water supplies is being developed and tested.

3/1991 (2) \$227 000 (ET 074)

650 Development of Continuous Preparation of Activated Silica

National Silicates Ltd.
Mr. Stephen Gibson

(416) 255-7771

429 Kipling Ave.
Toronto, Ont. M8V 3S7

Under development in this project is a process for the continuous preparation of activated silica, an effective inorganic coagulant aid. Activated silica is produced through the polymerization of sodium silicate with a variety of activating agents. It *has* been demonstrated as an effective coagulant aid in the reduction of total phosphorus discharges from sewage treatment plants and other industrial institutions. Successful development of an on-site production process that is practical and economical would enable the manufacture of an alternative to organic polyelectrolytes for use in potable, sewage and industrial wastewater treatment.

9/1991 \$194 000 (ET 132)

WATER AND SEWAGE TREATMENT

651 Wastewater Aerator Prototype

Aqua Aeration Systems Inc.
Mr. Andrew Jankowski

(416) 338-9237

3221 Valmarie Ave.
Mississauga, Ont. L5C 2A4

The fabrication and installation at a sewage plant of a full-scale prototype aerator design consisting of a multi-bladed conical configuration enclosed in a similarly conical encasement is the focus of this venture. The aerator functions by drawing in and mixing atmospheric air from above the liquid. Its efficiency is such that it can function effectively without the need for a supplementary supply of air. When installed in existing wastewater treatment facilities, the aerator would have the capability to simultaneously increase capacity and reduce operating costs through reduced energy and maintenance requirements.

3/1991 (1) \$90 000 (ET 135)

652 Technology for Destruction of Organic Pollutants and Detoxification of inorganic Pollutants in Water Streams

Nutech Environmental Inc.
Mr. Brian Butters

(519) 457-2963

511 McCormick Blvd.
London, Ont. N5W 4C8

This project involves the design, construction and testing of a commercially viable TiO_2 photocatalytic technology for the destruction of organic pollutants in water. Such a technology would be superior to such conventional treatment processes as air stripping and activated carbon adsorption because the organic contaminants are destroyed and not merely transferred to another medium such as air or carbon.

10/1991 (2) \$201 040 (ET 139A)

653 Development of Sealable-Joint Sheet Pile Cutoff Walls for Groundwater Remediation

Waterloo Centre for Groundwater Research
University of Waterloo
Dr. John Cherry

(519) 888-4516

Waterloo, Ont. N2L 3G1

The development and production of modified steel sheet pile sections and selection of sealants for use in construction of low permeability walls has been the objective of this project. This new sheet piling differs from conventional sheet piling in that the joints can be sealed after the wall has been driven into the ground. Leakage from contained soil has been shown to be reduced to such a low value that these sheet pile cutoff walls appear suitable for a wide variety of environmental control purposes", including as a relatively low cost containment system in "pump and treat" remediation programs at contaminated sites.

3/1991 (3) \$152 000 (ET 143)

654 Demonstration and Full-Scale Testing of a New Thermal Chemical Reduction Process for Remediation of Hamilton Harbour Sediments

EcoLogic International Inc.
Dr. Douglas Hallet

(519) 856-9591

143 Dennis St.
Rockwood, Ont. NOB 2K0

This developmental work has been an examination at the laboratory- and pilot-scale of the effectiveness of a new thermo-chemical reduction process for the destruction of such contaminants as polyaromatic hydrocarbons, polychlorinated biphenyls and other organic compounds in harbour sediments. The technology has also been assessed at the bench scale for the destruction of such pure compounds as polychlorinated biphenyls and tri- and hexachlorobenzene. Based on such criteria as destruction efficiency, non-formation of dioxins and furans, suitability for aqueous wastes, mobility and cost, this process appears suitable for application in a wide range of organic hazardous waste problems.

4/1991 \$311 800 (ET 153)

Final Technical Report Received

AIR POLLUTION

655 Development of Differential Optical Absorption Spectroscopy System (DOAS) for Air Monitoring and Measurement

Unisearch Associates Inc.
Dr. Gervase Mackay

(416) 669-3547

222 Snidercroft Rd.
Concord, Ont. L4K 1B5

The objective of this project is the development of a commercial, mobile instrument based on differential optical absorption spectroscopy capable of measuring air pollutants automatically, simultaneously and continuously with high sensitivity and selectivity. The instrument could be used either in a remote sensing mode suitable for plume or air quality measurements or in situ for such applications analyzing HCl and CH₄ from stack emissions and landfills. It would also have application in field studies including that of oxidant chemistry to measure key atmospheric species, including a number such as NO₃ which cannot be measured by any other method.

7/1991 (3) \$396 000 (ET 136)

ANALYTICAL INSTRUMENTATION

656, Development of a Nitrogen-Specific GC/ Detector for Measurement of Atmospheric Nitrates

Unisearch Associates Inc.
Dr. John Drummond

(416) 669-3547

222 Snidercroft Rd.
Concord, Ont. L4K 1B5

This project involves the development, construction, testing and evaluation of a market-ready nitrogen specific gas chromatograph/detector designed for the sensitive and selective measurement of organic nitrates and mutagenic nitro-polyaromatic hydrocarbons. Applications for the instrument would include the measurement of a variety of atmospheric pollutants that are linked to oxidant formation in the atmosphere, the analysis of nitrosamines in food and the detection of explosives.

6/1991 \$248 980 (ET 066)

657 Development of Supercritical Fluid Extraction (SFE) with ion Mobility Detector (IMD) for Qualitative Prescreening for Environmental Contaminants

Pylon Electronic Development Co. Ltd.
Dr. Frank Bales

(613) 226-7920

147 Colonnade Rd.
Nepean, Ont. K2E 7L9

The integration, development and testing of the technologies of Ion Mobility Detection and Supercritical Fluid Extraction to construct a self-contained, field portable and cost effective extraction instrument is the focus of this study. This tool could be used to extract, concentrate and qualitatively analyze numerous organic contaminants occurring in most environmentally sensitive effluents and other matrices.

12/1991 (1) \$89 450 (ET 094)

There were no active projects in the Socio-Economic Analysis category in the year.

ENVIRONMENTAL TECHNOLOGIES PROGRAM CROSS REFERENCE INDEX

Conventional Environmental Technologies Program project numbers (ET 999) are referenced to the Report catalogue number. Note that this catalogue number has no relevance beyond this document.

ET 006	644	ET 052	639	ET 135	651
ET 007	645	ET 057	630	ET 136	655
ET 010	627	ET 066	656	ET 139A	652
ET 017A	646	ET 068	640	ET 143	653
ET 024	647	ET 074	649	ET 153	654
ET 029	637	ET 076	631	ET 155A	634
ET 032	628	ET 080	641	ET 173	635
ET 033	629	ET 094	657	ET 175	636
ET 036A	648	ET 127	632	ET 179	642
ET 048	638	ET 130	633	ET 226	643
		ET 132	650		

TECHNOLOGY TRANSFER

A feature of the activities of the Research and Technology Branch is the continuing emphasis given to information and technology transfer initiatives. This reflects the importance to the branch of being actively involved in the dissemination of scientific and technical information to an increasingly diverse audience.

Technology transfer is the process through which the results and implications of research and technological developments are made available to an end user or incorporated into their activities. It may also include the dissemination of this and other information to a more general audience for educational purposes. With the wealth of information generated from projects supported by the Environmental Research, Environmental Technologies and Environmental Education and Awareness Programs, the importance of this role to the mandate of the ministry is immense.

An effective technology transfer program can have many tangible and intangible benefits. It can:

- ▶ assist the development of partnerships between the ministry and other public and private organizations, and of organizations within the non-government sector, in addressing environmental concerns
- ▶ facilitate the rapid incorporation of research results and technology developments into ministry scientific, policy, and regulatory processes
- ▶ stimulate new avenues of research and technology development
- ▶ inform and educate a diverse audience as to the many environmental problems and the means and opportunities for their prevention or amelioration
- ▶ enhance the reputation of the ministry and the branch in the view of technology and research based organizations
- ▶ raise awareness of the various support programs coordinated through the branch and that of its other activities within and beyond its traditional audience
- ▶ provide recognition and new professional opportunities for individual researchers or companies

A major element of such activities during 1991 was the 12th annual Technology Transfer Conference held on November 25 and 26 in Toronto. The conference, centred on the theme "The Multi-Media Approach: Integrated Environmental Protection", was attended by more than 400 delegates from universities, private laboratories and consulting firms, industry and government.

A feature of the technology transfer program during the year was the inaugural publication of *The Proving Ground*, an eight page bulletin currently published four times annually. In profiles and feature articles, *The Proving Ground* reports on significant projects being conducted under the Environmental Research and Environmental Technologies Programs, and on other activities related to the mandate of the Research and Technology Branch.

The Proving Ground and other publications supporting branch programs, including this report, will continue to be produced in 1992/93. For further information on *The Proving Ground* and other publications, contact the Research and Technology Branch or the ministry's Public Information Centre.

Research and Technology Branch
Environment Ontario
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5

Fax: (416) 323-4437

**Coordinator, Environmental Grants and
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(416) 323-5875

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Ms. Oksana Solomon
(416) 323-4440

Program Resources Officer

Dr. Roger Scott *(Publications)*
(416) 323-5879

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Environment Ontario
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5

Telephone: (416) 323-4321

ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAM

The purpose of the Environmental Education and Awareness Program (EEAP) is to provide financial assistance (to a maximum of \$25,000) for environmental education and awareness projects that support the mandate of the Ministry of the Environment.

As EEAP has a very limited budget, only those projects with strong environmental elements and benefit are supported. Funding for multi-year projects is not considered and, except under exceptional circumstances, only one approval per applicant per fiscal year is given.

Proposals for EEAP assistance are received and reviewed quarterly according to the following application deadlines:

- ▶ March 1
- ▶ June 1
- ▶ September 1
- ▶ December 1

Eligible proponents include:

- ▶ non-profit organizations
- ▶ schools, colleges and universities
- ▶ native groups
- ▶ Conservation Authorities
- ▶ municipalities

A broad range of education and awareness projects are eligible including:

- ▶ conferences, seminars, meetings and workshops on environmental issues
- ▶ development of publications such as newsletters, pamphlets, flyers, factsheets and kits
- ▶ environmental fairs or exhibits
- ▶ theatrical or musical presentations

The production of films and videos is now specifically excluded.

Only specific project costs of such endeavours are eligible for assistance, however. This list embraces:

- ▶ preparation (non-salaried), printing and distribution costs of documents (e.g. typesetting, desktop publishing, ink, postage, envelopes and stationery, photocopying)
- ▶ set-up costs for conferences and seminars (e.g. reasonable rental cost of room, audio-visual equipment, etc.)
- ▶ materials and supplies (where details are given which directly relate these to the project)
- ▶ display and communication materials (e.g. displays, pamphlets, brochures and flyers)
- ▶ publicity costs (e.g. reasonable costs for newspaper and radio advertising and promotional material)
- ▶ rental of space for theatrical presentations

Ineligible project expenses include:

- ▶ salaries
- ▶ overhead expenditures (e.g. office rental, operating costs for telephones and fax machines)
- ▶ capital expenditures for equipment and durable goods
- ▶ sustaining grants
- ▶ travel, accommodation and food costs
- ▶ honoraria and expenses for conference, seminar or workshop invitees
- ▶ start-up funding and operating expenses
- ▶ recovery from debt
- ▶ purchase or lease of land

Applications are reviewed by a committee comprised of ministry staff representing the various divisions, branches and regional offices. Preference is given to those projects that:

- ▶ have a clear environmental and educational purpose and fit the priorities and plans of the ministry
- ▶ will advance and promote environmental awareness, education and the transfer of information to a large audience
- ▶ encourage the acceptance and application of pollution prevention as opposed to pollution control (i.e. "picking up garbage", beautification, etc. are NOT preferred)
- ▶ are unique and different from previously funded projects
- ▶ are most likely to succeed
- ▶ are most cost effective
- ▶ indicate support from a broad range of involved agencies, including shared funding arrangements

Grant recipients are generally required to provide a final report to the ministry within three months of project completion. The report must include a detailed summary of the project including its environmental benefits and a detailed budget accounting for all expenses and revenues. Grant recipients are not considered for funding for new projects until all outstanding reports are submitted.

Environmental awareness and literacy are a key step in the resolution or prevention of environmental problems. With the greater understanding of the environment made possible through the many projects of EEAP, the citizens of Ontario can all work together to improve the province for the current and future generations.

ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAM

Research and Technology Branch
Environment Ontario
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5
Fax: (416) 323-4437

Coordinator, Environmental Grants and Technology Transfer

Ms. Sharon Suter
(416) 323-5875

Environmental Grants and Technology Transfer Assistant

Ms. Oksana Solomon
(416) 323-4440

General enquiries requesting program guidelines, application forms and other publications should be addressed to the

Grants Assistant

Ms. Ana Rosati
(416) 323-4649

ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAM PROJECT DIRECTORY

The following directory summarizes active projects in the Environmental Education and Awareness Program in the 1991/92 fiscal year. This edition of the Report also contains details of all other projects previously conducted in this and other similar previous ministry programs. An explanation of each listing follows:

999	Report catalogue number NOTE: THIS NUMBER HAS NO RELEVANCE BEYOND THIS DOCUMENT. Project title Additional key words (previous projects only) Organization / Project Director Contact details (current projects only) Project summary (current projects only)
1990	Year (previous projects only)
\$20 000	Total amount awarded
(EC 9999)	Environmental Education and Awareness Program project number (also PE, CC, OT)

Where this information is omitted, it is unavailable from current or archival sources.

For reference purposes, Environmental Education and Awareness Program project numbers are cross-referenced to the Report catalogue number in an index beginning on Page 148.

A brochure entitled *Our Environment - Our Future (A Guide to Resources on Environmental Issues Made Possible Through the Support of Environment Ontario)* details the availability of specific publications and other resources produced through a number of EEAP projects. The brochure is available through the ministry's Public Information Centre at (416) 323-4321.

CONFERENCES AND SEMINARS

1991/92 Projects

658 Recent Advances in Molecular Microbial Ecology Canadian Society of Microbiology

Dr. Jack Trevors
(519) 824-4120
c/o Department of Environmental Biology
University of Guelph, Guelph, Ont. N1G 2W1

As part of the annual meeting of the society, this symposium examined new technologies and scientific aspects of environmental biotechnology and micro-biology in Canada. Topics included diagnostic tools, molecular microbial ecology and regulatory aspects of environmental microbiology.

\$1 500 (EC 9056)

659 Energy Expo

University Women's Club of Burlington
Ms. Heather Copeland
(416) 637-3612
349 Rankin Dr.
Burlington, Ont. L7N 2B2

Assistance was provided for the costs of promotional flyers and advertising for Energy Expo, a one day seminar on society's growing energy needs and its environmental consequences. The need for individual and collective energy conservation initiatives was emphasized at the forum which also addressed the pros and cons of nuclear and alternative energy sources.

\$355 (EC 9077)

660 Water Pollution Control Federation Conference

Pollution Control Association of Ontario
Mr. Terry Matthews
(416) 502-1440
63 Hollyberry Trail
North York, Ont. M2H 2N9

This annual conference attracts over 13,000 people and represents the largest equipment exposition in North America. Over sixty sessions cover such issues as industrial waste treatment, sewage treatment plant operations and maintenance, and research findings on various water pollution and water quality related topics.

\$4 199 (EC 9078)

661 Green Cities

School of Urban and Regional Planning
University of Waterloo
Ms. Leann Wagner
(519) 885-1211
Waterloo, Ont. N2L 3G1

This annual conference was the twelfth in a series organized by graduate students at the university. The objective was to draw attention to the importance of protecting the natural environment specifically in relationship to urban development. With greater awareness and careful planning, more livable cities for current and future generations could be created.

\$390 (EC 9079)

662 It's Our Environment Workshop

Thousand Islands Area Residents Association
Dr. Harry McAdie
(416) 489-7067
c/o Suite 340, 245 Eglinton Ave. E.
Toronto, Ont. M4P 3B7

This workshop centred on three key areas of concern to the residents in the Thousand Islands area: individual waste reduction; the trade-off between the environment and industrial development along the St. Lawrence; and the control of destructive wildlife in an environmentally responsible manner. Support was provided for publicity costs, speaker expenses and the rental of audio-visual equipment.

\$1 300 (EC 9080)

CONFERENCES AND SEMINARS....

663 Mass Balancing and Virtual Elimination of Toxic Chemicals at Niagara-on-the-Lake

Institute for Environmental Studies
University of Toronto
Dr. Donald Mackay

(416) 978-4019

Toronto, Ont. M5S 1A4

This three day workshop at Niagara-on-the-Lake, Ont. brought together some 20 scientists and managers from Canada and the United States concerned with the fate of toxic substances in the Great Lakes Basin. The purpose was to review, discuss and agree on a common simple mass balance model for assessing the linkage between loadings of chemicals and concentrations in water, sediments, fish and wildlife.

\$6 000 (EC 9082)

664 Decision-Making and the Environment

Foundation for International Training
Ms. Michelle Sweet

(416) 449-8838

Suite 200, 1262 Don Mills Rd.
Don Mills, Ont. M3B 2W7

This public forum addressed the question of how to make the preservation of our planet the basis for development of all economic and social policies. Attended by policy makers from government and industry, discussion included limits to growth, carrying capacity, managing common resources, and the role humans play in enhancing or degrading natural systems.

\$3 000 (EC 9089)

665 Lake Simcoe Conference and Festival

South Lake Simcoe Naturalists' Club
Mr. Paul Harpley

(416) 722-8021

P.Q. Box 1044
Sutton West, Ont. L0E 1R0

This conference, featuring art shows, music and historical walks, examined the deteriorating environmental quality of the Lake Simcoe watershed. The conservation of natural areas within the watershed, watershed management, reducing erosion from agriculture and the reduction of phosphate loading were among the many concerns addressed. Support was provided for advertising and mailing expenses.

\$800 (EC 9091)

666 Global Warming Symposium

Department of Chemistry
Queen's University
Dr. R.J. Brown

(613) 545-2616

Kingston, Ont. K7L 3N6

At this one day symposium, various specialists lectured to students and faculty on the basic science of the atmosphere, climatology and the economic aspects of global warming. The costs of rental of room and equipment, advertising and printing of posters and brochures for the symposium were supported by the grant.

\$1 379 (EC 9093)

667 Education and Communications on Environment and Development

Council of Outdoor Educators of Ontario
Mr. Chuck Hopkins

(416) 393-9678

885 Dundas St. E.
Toronto, Ont. M4M 1R4

This event combines a conference, festival, exposition, an outreach program and pre-conference workshops. The objective is to improve the accuracy, quality and delivery of environmental and development education on a global level by exchanging current knowledge and experience about environmental and development issues among educators, public officials, industrialists and scientists.

\$25 000 (EC 9095)

668 Youth '92 Ontario Workshop

Canadian Youth Foundation
Ms. Bethany Sutton

(613) 761-9206

3rd Floor, 55 Parkdale Ave.
Ottawa, Ont. K1Y 1E5

This four day workshop brought together young people between the ages of 15 and 24 from across the province to discuss environmental issues. The overall objective was to improve participants knowledge and skills concerning environmental and developmental issues and to prepare a select group to participate in the United Nations Conference on Environment and Development. A kit for the conference and an Ontario Youth Working Paper on the Environment and Development, to be presented at the Youth '92 National Conference, were both developed.

\$4 250 (EC 9098)

CONFERENCES AND SEMINARS....

669 Eastern Georgian Bay Association

Georgian Bay Association
Mr. John Birnbaum

(416) 486-8600

19 Edgcombe Ave.
Toronto, Ont. M5N 2X1

This conference focussed on water-related issues affecting the Georgian Bay ecosystem. Areas of concern included crown land management, fisheries management, wildlife and boating uses and their impact on the Bay. As a result, a plan reflecting responsible industrial/tourism strategies and responsible sharing of the Bay's economic future was developed.

\$5 000 (EC 9099)

670 Strengthening the Spirit

Indigenous 500 Committee
Mr: Lawrence Courtoreille

(613) 236-0673

47 Clarence St.
Ottawa, Ont. K1N 9K1

This was the first in a series of international conferences of the Indigenous Nations of the Americas with the objective of establishing relationships of mutual respect and cooperation between governments, institutions, international agencies and other indigenous nations. Concrete strategies and mechanisms aimed at effectively addressing the concerns of indigenous peoples were also addressed at the forum for which assistance was provided for promotion and communication activities.

\$7 000 (EC 9100)

671 World Cities and their Environment

Conference
World Cities and their Environment
Ms. Hazel Farley

(416) 392-1246

City Clerk's Department, City of Toronto
2nd Floor E., 100 Queen St. W.
Toronto, Ont. M5H 2N2

This five day conference provided an opportunity for municipal leaders from around the world to collectively develop a coordinated response and action plan to urban environmental challenges, and prepare for the United Nations Conference on Environment and Development.

\$17 500 (EC 9101)

672 Emerging issues In Aboriginal Peoples' Land Rights and Use

Canadian Environmental Law Association
Ms. Michelle Swenarchuk

(416) 960-2284

Suite 401, 517 College St.
Toronto, Ont. M6G 4A2

This two day conference was on aboriginal land use rights and the implications for Ontario. Conservationists, native people, government and other interest groups came together in the hope that through increased knowledge and dialogue, there would be a greater understanding and awareness of aboriginal issues.

\$10 000 (EC 9102)

673 Seminar for Journalists on Environmental issues in the Great Lakes Basin

The Institute for Research on Public Policy
Mr. David Runnals

(613) 238-2296

5th Floor, 275 Slater St.
Ottawa, Ont. K1P 5H9

The purpose of this conference was to provide journalists with basic information on environmental issues in the Great Lakes area with the objective of increasing the quality of news coverage of such events. A briefing document formed the basis of the seminar which also included presentations by speakers representing alternative view points on various issues.

\$10 000 (EC 9105)

674 Holistic Environmental Education In the Great Lakes

Ms. Julie Rienzo
41 Trotter Lane
Brampton, Ont. L6Y 1B5

This workshop was designed to assist educators in the planning, development and presentation of classroom environmental units to students. This was primarily achieved by familiarizing the teachers with various resource materials and through outdoor field experience.

\$600 (EC 9107)

CONFERENCES AND SEMINARS....

675 The Role of Models In Understanding Atmospheric Chemistry

CIRAC/AWMA-OS International Conference on Atmospheric Chemistry

Ms. Ann McMillan

(416) 739-4867

4905 Dufferin St.
Downsview, Ont. M9H 5T4

This two day event provided a forum for the exchange of information on atmospheric chemistry. In conjunction with the conference, high school students were invited to develop and attend a poster display on environmental issues providing them with the opportunity to discuss environmental issues with scientists and engineers, and explore career opportunities.

\$1 200 (EC 9108)

676 Sixth international Conference on Urban Storm Drainage

Organizing Committee for the 6th International Conference on Urban Storm Drainage

Mr. Jiri Marsalak

(416) 336-4899

National Water Research Institute
867 Lakeshore Rd., P.O. Box 5050
Burlington, Ont. L7R 4A6

The conference provided a forum for the exchange of information among citizens groups, consultants, environmental planners, municipal officials and researchers concerned about the impact of urban drainage on the environment. Primary objectives were to promote advanced approaches to urban drainage contributing to the attainment of sustainable development, improve awareness of drainage impacts on urban ecosystems and means of prevention or mitigation, and to provide direction for future research.

\$20 000 (EC 9114)

677 Project Indigenous Restoration 1992

The Artists/Environmental Forum

Mr. Danny Beaton

(416) 921-0014

235 Borden St.
Toronto, Ont. M5S 2N5

This forum provided an opportunity for natives and non-native people to discuss the state of the environment and work towards joint participation in environmental

protection. Emphasis was placed on the promotion of environmentally friendly habits, environmental leadership among young people and increased understanding of the environmental consequences of native traditions.

\$25 000 (EC 9117)

678 Common Ground: Action for Environmental Land-Use in Ontario

Land-Use Caucus - Ontario Environmental Network

Mr. Clifford Maynes

(705) 745-3521

4 Knox St.
Peterborough, Ontario K9H 2A8

The weekend conference brought together representatives of citizens and environmental groups, and ratepayers and cottagers associations to discuss land-use issues. Current land-use trends, associated environmental problems and strategies for change were examined with topics covered including farmland protection, livable cities, natural areas preservation, landfill siting, aggregate extraction, transportation alternatives, and recreational land-use and water quality.

\$3 400 (EC 9119)

679 Resolving Conflicts and Uncertainty In Water Management Canadian Water Resources Association

Dr. Dan Shrubsole

(519) 679-2111

c/o Department of Geography
University of Western Ontario
London, Ont. N6A 5C2

This two day conference outlined and assessed approaches to resolving conflicts and uncertainty in water management. Themes addressed included water resources and aboriginal people, municipal water issues, economic instruments, watershed planning and impact assessment Support was provided for costs of publicity and publication of conference proceedings.

\$5 000 (EC 9120)

CONFERENCES AND SEMINARS....

680 Development of Curriculum Pertaining to Environmental Legislation and Programs

The Inst. for Environmental Policy and Stewardship
Ms. Jane Dougan
(519) 824-4120

The Arboretum
University of Guelph
Guelph, Ont. N1G 2W1

Targeted at persons within government, industry and business, this course is intended to provide an understanding of the concepts and rationale behind current and proposed environmental legislation. The goal is to enhance the formulation of public policy and programming, and to create informed public comment and understanding of environmental regulations and policies.

\$15 000 (PE 9214)

681 Globe '92 International Trade Fair and Conference

Globe '92
Mr. David Marshall
(604) 666 8020
Suite 601, 535 Thurlow St.
Vancouver, B.C. V6E 3L6

Global Opportunities for Business and the Environment (Globe) is a non-profit international conference on sustainable development. More than 70 countries were represented at the 1992 event with attendance reaching 4,500. The conference focussed on four themes and their application to international, industrial and urban development, namely policy and legislation, economics and finance, research and technology, and communications education and training.

\$15 000 (PE 9237)

682 Air Pollution - The Automobile - Public Health

The Lung Association
Metro Toronto & York Region
Mr. Ian Morton
(416) 864-1112
Suite 201, 573 King St E.
Toronto, Ont. M5A 4L3

Representatives from a wide range of non-profit, government, industry and academic organizations attended this forum which was designed to facilitate the exchange of ideas and information on the automobile, air pollution and public health. Discussions focussed on four key areas; technology and industry, education and advocacy, government policy and legislation, and community and municipal

roles. The goal was to establish a basis for collaborative action on air pollution.

\$1 850 (PE 9280)

Previous Projects

683 The Legal Challenge of Sustainable Development. (Legislation). Canadian Institute for Resources Law, University of Calgary; Ms. C. Hunt. 1989 \$5 000 (EC 9002)

684 A Multi-Disciplinary Approach to Water Management Perspectives from Engineers, Biologists and Planners. (Water, soil and forest conservation and management, and legislation). Canadian Water Resources Association; Ms. J. Harker. 1989 \$2 000 (EC 9010)

685 Advances In Materials Recycling. (Recycling technologies). Department of Mechanical Engineering, Queen's University; Dr. H. Wevers. 1989 \$3 000 (EC 9012)

686 Prevention Congress IV: Health & Supportive Community - From Commitment to Action. (Sustainable development and pollution). Ontario Prevention Clearinghouse; Mr. B. Hayday. 1989 \$3 000 (EC 9014)

687 What on Earth are We Doing? (General environmental issues). Couchiching Institute on Public Affairs; Mr. J. Gibson. 1989 \$10 000 (EC 9015)

688 The Next Decade. (3Rs and composting including research and development), Recycling Council of Ontario; Mr. J. Hanson. 1989 \$5 000 (EC 9017)

689 'Our World'. (General environmental issues and technologies). The Summit on the Environment; Mr. D. Mills. 1989 \$20 000 (EC 9018)

690 Women and the Environment. (Women's perspective on general environmental issues). Ms. M. Wyman. 1989 \$2 000 (EC 9022)

691 Financing the Turnaround Decade. (General environmental issues). Committee on Monetary and Economic Reform, Department of Economics, University of Waterloo; Ms. J. Davis. 1989 \$5 000 (EC 9023)

CONFERENCES AND SEMINARS....

692 C.L.E. Symposium. (*MISA regulations and Regulation 308*). Canadian Institute of Energy; Mr. J. Tracey. 1989 \$2 000 (EC 9025)

693 "No Dig" Conference on Trenchless Technology. Pollution Control Association of Ontario; Mr. R. Pickett. 1989 \$1 600 (EC 9026)

694 Water Quality Issues. (*Environment and health*). Ontario Public Health Association; Mr. P. Elson. 1989 \$1 500 (EC 9027)

695 52nd National Conference. (*General environmental issues*). Canadian University Press; Ms. D. Fisher. 1990 \$3 000 (EC 9028)

696 1990 Conference on Law and Contemporary Affairs. (*Environmental law*). University of Toronto, Faculty of Law; Ms. L. Bauml. 1990 \$2 500 (EC 9029)

697 Ontario Public School Board Association Environmental issues Conference. (*Curriculum development*). Ontario Public School Boards Association; Ms. G. Anderson. 1990 \$5 000 (EC 9030)

698 How Dangerous are PCBs? University of Toronto, Institute for Environmental Studies; Dr. P. Jones. 1989 \$3 000 (EC 9032)

699 The Environmental Challenge: Managing for the Future. University of Western Ontario. (*General environmental issues including sustainable development*). MBA Association, University of Western Ontario; Mr. P. Meneley. 1990 \$10 000 (EC 9037)

700 The Role of No Emission in Designing Effective Ozone Control Strategies. (*Air pollution and nitrogen oxide controls*). Northeast States for Coordinated Air Use Management; Ms. N. Seidman. 1990 \$5 000 (EC 9038)

701 Waste Management and Sustainable Development. Sault College of Applied Arts and Technology; Mr. R. Doyle. 1990 \$10 000 (EC 9039)

702 The Great Lakes, Great Legacy. (*Sustainable development*). University of Western Ontario, Centre for American Studies; Mr. D. Conklin. 1990 \$4 000 (EC 9040)

703 Healthy People-Healthy Places. City of Sudbury Leisure Plan; Mr. P. O'Sullivan. 1990 \$2 000 (EC 9041)

704 Aboriginal Peoples and Sustainable Development in Ontario: Our Environment in the 1990's. (*Native perspectives*). Ontario Metis and Aboriginal Association; Mr. C. Recollet 1990 \$15 000 (EC 9042)

705 Stormwater Management Workshop. (*Stormwater recharge technology*). American Fisheries Society, Southern Ontario Chapter; Mr. L. Stanfield. 1990 \$2 000 (EC 9044)

706 Ontario Summer Seminar. (*General environmental issues*). State University of New York at Plattsburg, Centre for the Study of Canada; Dr. R. Beach. 1990 \$2 000 (EC 9045)

707 Social Aspects Symposium. (*Hazardous waste management facilities and the assessment of social impact*). Atomic Energy of Canada Ltd, Waste Management Division.; Mr. G. Leitch. 1990 \$3 000 (EC 9046)

708 Forum on Global Warming. (*Industrialization in developing countries and the consequences for climate change*). Foundation for International Training; Mr. R. Kumar. 1990 \$4 000 (EC 9047)

709 Ontario Secondary School Teachers Federation Professional. Development Conference. (*Curriculum development*). Ontario Secondary School Teacher's Federation (District 51); Mr. J. Lyons. 1990 \$3 500 (EC 9048)

710 Communities and the Environment. (*Sustainable development*). United Nations Association in Canada; Ms. B. Gibaut. 1990 \$8 500 (EC 9049)

711 Elders Conference on Environment. (*Native perspectives and environmental policies*). Chiefs of Ontario; Mr. Fred Plain. 1990 \$2 500 (EC 9052)

712 Upcoming Provincial Workshop on Water Quality issues. (*Drinking water and groundwater quality*). Ontario Public Health Association; Mr. P. Elson. 1990 \$1 500 (EC 9053)

713 Conference on International Environment. (*Global warming, waste, water conservation and pollution, and deforestation*). Worldwide International Awareness Centre; Ms. S. De Cuyper. 1990 \$4 600 (EC 9054)

CONFERENCES AND SEMINARS....

714 Environmental Sciences Education Curricula. (*Curriculum development, and current and future education training needs for university undergraduates*). University of Guelph, College of Physical and Engineering Sciences; Mr. R. Hallet. 1990 \$14 500 (EC 9055)

715 Winds of Hope. (*Native perspectives on environmental issues*). Chippewas of Nawash First Nation, Cape Croker Band Office; Mr. R. Alkiwenzie. 1990 \$13 400 (EC 9057)

716 6th Canadian Construction Congress "Preview 2000". (*Recycling and other environmental issues*). Canadian Construction Research Board, National Research Council of Canada; Mr. G. Granek. 1991 \$5 000 (EC 9058)

717 Next Step - A Conference on the Environment. (*Waste management, sustainable development and employment issues*). Labour Council of Metro Toronto and York Region; Mr. B. Howes. 1991 \$2 000 (EC 9059)

718 Student Conference on the Environment. (*General environmental issues*). Environmental Club, Parkside High School; Mr. R. Varey. 1990 \$2 500 (EC 9060)

719 The Greater Toronto Area Solid Waste Management Plan. (*Waste management, recycling, composting and energy recovery*). Canadian Institute of Energy; Mr. D. Legge. 1991 \$2 898 (EC 9062)

720 Investing in the Environment. (*Ethical considerations*). Social Investment Organization; Mr. M. de Sousa-Shields. 1991 \$2 000 (EC 9063)

721 Environment and the Law: Rights and Responsibilities. (*Legislation on air and water quality, and energy and waste management*). Toronto Environment Alliance; Ms. V. Alexander. 1991 \$5 200 (EC 9064)

722 Glasnost and the Global Village. (*Global ecology*). York University, McLaughlin College; Mr. M. Lanphier. 1991 \$13 600 (EC 9065)

723 Project Indigenous Restoration. (*Forum on native perspectives on environmental issues*). The Artists'/ Environment Forum; Mr. D. Beaton. 1990 \$20 000 (EC 9066)

724 Signs of Hope. (*Recycling, waste management, native perspectives, wildlife and environmental law in the context of the Muskoka region*). Muskoka Environmental Educators Association; Mr. W. Drew. 1991 \$2 600 (EC 9068)

725 Business and Our Environment. (*Sustainable development, and business and environmental ethics*). University of Western Ontario, School of Business Administration; Mr. D. Konantz. 1991 \$15 000 (EC 9072)

726 Ontario chapter of CEIA. (*Environmental products, services and markets*). Canadian Environmental Industry Association; Mr. J. Wouters. 1991 \$15 000 (EC 9088)

727 Decisions for Lake Ontario. (*Course on water quality and land use*). Great Lakes Tomorrow; Ms. S. Leppard. 1990 \$500 (PE 9049)

728 Environmental Advisory Research Project Office. (*Health and the environment*). Middlesex-London Health Unit; Dr. J. Pudden. 1990 \$20 000 (PE 9060)

729 U.S. Clean Air Act. (*Legislation on acid rain and vehicle emissions*). Canadian Coalition on Acid Rain; Mr. M. Perley. 1990 \$18 400 (PE 9087)

730 University Level Environmental Course: "The 5000 Days. Environmental Perspectives and Human Choices". Institute for Environmental Policy and Stewardship, University of Guelph; Ms. J. Dougan. 1990 \$25 000 (PE 9100)

731 The Environment: Issues and Options for Actions. (*College course*) CJRT-FM Open College; Ms. M. Maskow. 1990 \$20 000 (PE 9108)

732 Ontario Section American Water Works Association. (*Workshop on water treatment plants and drinking water*). American Water Works Association, Ontario Section; Mr. E. Nevala. 1991 \$7 500 (PE 9119)

733 Conference on Waste Reduction and Communication. It's Not Garbage. Toronto Environment Alliance; Mr. G. Coffey. 1991 \$37 000 (PE 9132)

734 Venture Engineering and Science Camps. (*Workshop and camp for elementary schools*). McMaster University, Faculty of Engineering; Dr. G. Purdy. 1991 \$1 000 (PE 9164)

CONFERENCES AND SEMINARS....

735 "Algonquin Park: The Next 100 Years". (*Wildlife, forestry and nature*). Wildlands League; Mr. T. Gray. 1991 \$5 500 (PE 9171)

736 Limnology Lecture. (*Drinking water, limnology, water management and zebra mussels*). Harbourfront; Ms. A. MacFarlane. 1991 \$5 600 (PE 9177)

737 An Environmental Awareness Seminar for Secondary Students. (*General environmental issues*). Earth Think; Ms. J. Thompson. 1991 \$4 000 (PE 9178)

738 Summer institute for Environmental Values Education. (*General environmental issues*). Harmony Foundation; Ms. J. Bean. 1991 \$4 500 (PE 9195)

739 Community Workshops for the Environment: An Organizer's Manual. (*Conference organizing guide*). Harmony Foundation; Ms. J. Bean. 1991 \$10 000 (PE 9199)

PUBLICATIONS AND GENERAL LITERATURE

1991/92 Projects

740 Down to Earth Newsletter

Downtown Kingston Business Improvement Area and Business Association

Ms. Jennifer Saini

(613) 542-8677

200 Princess St.

Kingston, Ont. K7L 1B2

This newsletter, which reaches over 800 businesses, business organizations and local government officials, is part of a collaborative program headed by the Business Improvement Area, the Business Association and the Environmental Resource Centre in Kingston. Its objective is to assist the business community in identifying opportunities to reduce waste quantities, recycle materials and save energy.

\$600 (PE 9206)

741 Environmental information Kits

Pollution Probe

(416) 926-1907

12 Madison Ave.

Toronto, Ont. M5R 2S1

The preparation and distribution of environmental information kits to schools, students and the general public is the focus of this venture. Objectives of the information kits are to improve the level of understanding and public awareness on the environment, enhance the existing services of other institutions such as schools and libraries, and provide a focal point for the public to seek information the environment.

\$23 500 (PE 9225)

742 Handbook on Environmental Reporting for Journalists

Graduate School of Journalism
University of Western Ontario
Mr. Peter Desbarats

(519) 661-3383

London, Ont.
N6A 5B7

This practical guide and source book for Canadian journalists on environmental issues will be distributed to over 1,000 newspaper, magazine, radio and television newsrooms across the country. The overall objective is to increase the standards of environmental reporting and thereby improve the general public's knowledge of environmental issues.

\$15 400 (PE 9236)

743 Momentum

International Council on Monuments Canada
Mr. Francols Leblanc

(613) 749-0479

P.O. Box 737, Station B
Ottawa, Ont. K1P 5R4

Momentum is a forty-eight page publication featuring articles from the natural and the heritage Conservation fields. The issue also served to attract participants to a national congress, the goal of which was to create a partnership between the heritage and the natural environment movements.

\$500 (PE 9242)

744 Citizen's Guide to Environmental Legislation

Toronto Environmental Alliance
Mr. Marcus Ginder

(416) 348-0660

Suite 104, 401 Richmond St. W.
Toronto, Ont M5V 3A8

Written for the general public, this handbook details the scope and implications of environmental law in Ontario. Topics covered include environmental assessment, worker health and safety, environmental law, the proposed Environmental Bill of Rights, the Pesticides Act, pollution control and land use planning.

\$8 000 (PE 9254)

745 Nature's Plea

Project Preservation
Mr. Jason Stewart

(705) 724-5541

R.R. #4
Powassan, Ont. P0H 1Z0

Nature's Plea is a bimonthly newsletter published for members of Project Preservation. The goal of this organization is to increase public awareness of environmental and native issues which have an impact on our lifestyle, cultural diversity, health and peace, and the health and peace of other living creatures.

\$750 (PE 9256)

746 Earthwords: Education for Action

Friends of the Earth
Ms. Mary Granskou

(613) 230-3352

Suite 701, 251 Laurier Ave. W.
Ottawa, Ont. K1P 5J6

Earthwords is a quarterly newsletter which is distributed to the 23,000 members of Friends of the Earth. Its objective is to move Canadians from awareness to action on a range of key national and international environmental issues.

\$10 000 (PE 9284)

747 Environment and Local Government: A Handbook for Action

The Ontario Public Interest Research Group
Peterborough Chapter
Mr. Keith Stewart

(705) 748-1767

Trent University
Peterborough, Ont. K9J 7B8

This concise booklet, designed for use by municipal officials and members of the public, outlines the environmental powers, responsibilities and potential contributions of local democratic institutions. Subjects covered include land-use intensification, mixed-use zoning, public transit, protection of natural areas and wildlife, water quality and waste management.

\$5 000 (PE 9290)

748 Environmental Games and Activities Kit

Public Focus

Ms. Julie Whitfield

(416) 967-5211

Suite 500, 489 College St.

Toronto, Ont. M6G 1A5

These multi-media, interactive kits contain group games, individual activities, articles, stories and resources for educators and young children. The kits are designed to raise awareness of and interest in the environment and to generate actions which will demonstrate to young people their power as individuals.

\$15 000 (PE 9294)

749 Alternatives - The Environment and the Constitution

Alternatives Magazine

Ms. Susanna Reid

(519) 885-1211

Department of Environmental Studies

University of Waterloo

Waterloo, Ont. N2L 3G1

Alternatives is a scholarly journal and news magazine which provides critical and informed analysis of environmental problems, related social issues and technological developments. This particular issue focussed on "The Environment and the Constitution" and provided a forum for government, environmentalists, and experts in the field to present, discuss and debate constitutional proposals with respect to the environment.

\$1 000 (PE 9295)

Previous Projects

750 Citizen's Guide to Waste Management Planning in Ontario. (*Legislation, policies and regulations*). Canadian Environment Law Association; Ms. T. Vigod. 1989 \$50 000 (PE 9003)

751 Nature: Write On!/Ecrire, C'est Naturell (*General environmental issues*). Ottawa Valley Book Festival; Ms. K. Fletcher. 1989 \$400 (PE 9004)

752 Key to Compliance. (*Environmental management systems, environmental audits and legislation targeted at small businesses*). Canadian Institute for Environmental Law and Policy; Ms. B. Heidenreich. 1989 \$10 000 (PE 9006)

753 Recycling and Sound Environmental Practices within the University of Toronto Community. (*Pamphlet on the 3Rs*). Environmentalist Coalition; Mr. C. Prophet. 1990 \$1 500 (PE 9054)

754 Phase I of ECOSCOPE. (*Student guide on wetlands*). The Common Heritage Programme; Mr. G. Harrison. 1990 \$8 000 (PE 9058)

755 Alternatives - Asking Hard Questions About Sustainable Development. (*Magazine articles on sustainable development, water resource management and conservation*). University of Waterloo, Faculty of Environmental Studies; Ms. M. Pickering. 1990 \$9 208 (PE 9063)

756 Management Waste: A Guide to Citizens involvement. (*Composting, diapers, plastic bags, household products, packaging and the 3Rs*). Ms. B. Wallace. 1990 \$12 000 (PE 9068)

757 Information on Global Environmental Issues. UNEP - Canada; Mr. R. Smith. 1990 \$25 000 (PE 9079)

758 "Chemical Literacy" Series. (*Educational kits*). Pollution Control Association of Ontario; Mr. R. Pickett. 1990 \$10 000 (PE 9081)

759 Environment is Everybody's Business. (*Energy conservation, 3Rs, waste management and reduction in the workplace*). Harmony Foundation; Mr. M. Bloomfield.. 1991 \$25 000 (PE 9093)

760 A Citizen's Handbook to Forest Management Planning in Ontario. (*Legislation*). Canadian Parks and Wilderness Society; Ms. C. Broughton. 1990 \$2 500 (PE 9101)

761 Waste Less Times. (*Newsletter covering the 3Rs, waste management and reduction, household hazardous waste and composting*). Citizen's Clearinghouse on Waste Management; Ms. B. Wallace. 1990 \$9 600 (PE 9125)

762 CELA Library. Canadian Environmental Law Association; Ms. T. Vigod. 1990 \$40 655 (PE 9127)

763 "An Ecotour of Toronto". (*Booklet*). Toronto Environmental Alliance; Ms. V. Alexander. 1990 \$7 000 (PE 9129)

764 Alternatives Magazine. University of Waterloo, Faculty of Environmental Studies; Ms. M. Pickering. 1991 \$10 268 (PE 9150)

REPORTS AND BOOKS

765 Evaluation Book for Sustainable Development Community Education Model. (*Workbook and action plans*). Trinity Theatre, Ms. S. Crockard-Villa. 1991 \$5 000 (PE 9153)

766 Earthroots Tabloid Newspaper. (*Newsletter on the Hudson/James Bay hydroelectric development*). Earthroots Coalition; Ms. S. Hilton. 1990 \$9 000 (PE 9154)

767 Environmental Home Audit Handbook. (*Waste reduction, energy and water conservation, and hazardous household products*). Earth Day Ontario; Mr. M. Mason. 1991 \$26 000 (PE 9160)

768 Community Publication Series. (*Composting, waste management, waste reduction and recycling*). Citizen's Clearinghouse on Waste Management; Ms. B. Wallace. 1991 \$25 000 (PE 9189)

769 Educational Poster and Activity Booklet. (*Acid rain and ozone*). Harmony Foundation; Ms. J. Bean. 1991 \$8 633 (PE 9196)

770 Growing Up Green. (*General environmental issues*). Harmony Foundation; Ms. J. Bean. 1991 \$15 000 (PE 9197)

REPORTS AND BOOKS

1991/92 Projects

771 Environmental Bill of Rights

Pollution Probe
Ms. Patricia Chilton

(416) 926-1907

12 Madison Ave.
Toronto, Ont. M5R 2S1

Support was provided to facilitate participation in the consultative process and the production of a report on the Environmental Bill of Rights, and to assist in the explanation of the legislation to environmental and other interested groups.

\$15 000 (PE 9231)

772 Environmental Bill of Rights

Canadian Environmental Law Association (CELA)
Mr. Richard Lindgren

(416) 960-2284

Suite 401, 517 College St.
Toronto, Ont. M6G 4A2

CELA is a non-profit, public interest organization which works within existing laws to protect the environment and advocate environmental law reform. In this undertaking, CELA participated in the Environmental Bill of Rights Task Force through involvement in the consultative process, the development of the Task Force Report and draft legislation, and the explaining of the proposed legislation to interested parties.

\$15 000 (PE 9238)

773 MOE-OWMA-Pollution Probe Solid Waste Management industry

Pollution Probe
Ms. Ellen Schwartzel

(416) 962-1907

12 Madison Ave.
Toronto, Ont. M5R 2S1

Participation in a Task Force preparing a discussion paper identifying impediments to the efficient functioning of the waste approvals process in Ontario is the purpose of this project. The Task Force, composed of representatives of the ministry, industry and the environmental sector, will develop a strategy

REPORTS AND BOOKS

for improving communication amongst the three parties involved in the approval process, and advance recommendations for changes in either the standards or the process of waste approvals.

\$2 100 (PE 9275)

774 AirWatch Report

Canadian Acid Precipitation Foundation
Mr. David Love

(416) 968-2135

Suite 401, 112 St. Clair Ave. W.
Toronto, Ont. M4V 2Y3

Airwatch is a quarterly report on progress made in implementing Canadian and U.S. acid rain control legislation. A section on the U.S. covers the implementation of the Clean Air Act, while the Canadian segment reviews developments in the implementation of acid rain control programs in the seven eastern provinces, and of motor vehicle emission standards at the federal level. Other types of air pollution including urban smog and toxic air pollutants are also addressed.

\$25 000 (PE 9299)

Previous Projects

775 Research Report on Reducing the Application of CFCs for Medical Purposes. Friends of the Earth; Ms. J. Langer. 1989 \$13 798 (PE 9001)

776 A Study of Intervenor Funding In Ontario. (*Environmental assessment process*). Canadian Environmental Defence Fund; Mr. D. Donnelly. 1989 \$50 000 (PE 9011)

777 Environment on Trial: A Handbook of Ontario Environmental Law. Canadian Institute for Environmental Law and Policy; Ms. Barbara Heindenreich. 1989 \$25 000 (PE 9032)

778 Great Lakes State of the Environment Report. (*Sustainable development*). The Institute for Research on Public Policy; Mr. D. Runnalls. 1990 \$25 000 (PE 9039)

779 Water Rates Study. Ontario Sewer and Watermain Contractors Association; Mr. G. Hopcroft. 1990 \$15 000 (PE 9064)

780 State of the Environment Report. (*Environmental issues and trends, planning and development in the Waterloo region*). Regional Municipality of Waterloo; Mr. W. Lambert. 1990 \$7 500 (PE 9075)

781 U.S. Clean Air Act Review. (*Acid rain*). Canadian Coalition of Acid Rain; Mr. M. Perley. 1990 \$25 000 (PE 9086)

782 The Intervenor Guide and Environmental Assessment Process improvements. Credit Valley Preservationists; Mr. P. Oraphanos. 1990 \$23 500 (PE 9094)

783 Report on Household Waste Audits. Citizens' Clearinghouse on Waste Management; Ms. B. Wallace. 1990 \$49 000 (PE 9118)

RESOURCE LISTINGS AND SERVICES

1991/92 Projects

784 Environmental Publications
Ontario Environmental Network
Mr. Torn Klein Beemik

(519) 837-2565

Suite 201C, 2 Quebec St.
Guelph, Ont N1H 2T3

The promotion of two publications 'The Environmental Resource Book' and 'Sustainability: as if we meant it' was the basis of this project. The Environmental Book lists available environmental resource materials and provides a directory of environmental organizations. 'Sustainability', which could serve as a senior high school text, details actions which can be undertaken to promote a sustainable economy.

\$2 848 (PE 9282)

785 Public Education Services on Current Waste Management Issues

Citizens' Clearinghouse on Waste Management
Ms. Barbara Wallace

(705) 887-1553

R.R. #2
Cameron, Ont. K0M 1G0

Assistance was provided for the revision of a computer database listing of over 3,000 items of waste management educational material, and its publication in the form of the second edition of the Inventory of Waste Management Information Materials.

\$9970 (PE 9291)

Previous Projects

786 The Niagara Falls Environmental Inventory, 1989. (*Natural resources, water pollution, contaminated soil, air pollution and geophysical features*). The City of Niagara Falls; Mr. W. Smeaton. 1989 \$14 500 (PE 9007)

787 inventory of Waste Management Materials. (*Waste management, regulations, pollution, 3Rs, ozone, forestry, energy, land use and human health*). Citizen's Network on Waste Management; Mr. J. Jackson. 1989 \$35 000 (PE 9030)

788 Environmental Resource Book. (*Environmental organizations*). Ontario Environment Network; Mrs. K. Cooper. 1989 \$25 000 (PE 9043)

789 Information Services Program. (*General environmental issues*). Pollution Probe Foundation; Ms. M. Ise. 1990 \$25 000 (PE 9070)

790 Environmental Inventory Project. (*Niagara Falls and Niagara River*). City of Niagara Falls; Mr. W. Smeaton. 1990 \$12 000 (PE 9083)

791 Task Force on Sustainable Development. Peterborough Committee on Sustainable Development; Mr. R. Paechlke. 1990 \$5 000 (PE 9104)

792 Natural Area Inventory of the Hamilton-Wentworth Region. Hamilton Naturalists; Mr. B. McHattie. 1990 \$8 210 (PE 9124)

793 Wastewise. (*3Rs*). Wastewise Resource Centre; Ms. D. van de Valk. 1991 \$16 100 (PE 9187)

PUBLIC CAMPAIGNS AND OUTREACH PROGRAMS.

1991/92 Projects

794 Ethnic Communities Waste Reduction Outreach Project

It's Not Garbage
Mr. Gerard Coffey

(416) 348-9696

Suite 104, 401 Richmond St. W.
Toronto, Ont. M5V 3A8

Through workshops and newsletters, the goal of this project is the diffusion of information on waste management to existing grassroots organizations and four ethnic communities in Metropolitan Toronto. The final phase of the project is a two day conference which brings together individuals from existing waste management networks and the new ethnic organizations to consolidate their position in the waste management process.

\$8 750 (EC 9118)

795 Hazardous Waste - The Alternatives Workshop

Clean North
Mr. Al. Tithecott

(705) 949-0971

95 Mark St.
Sault Ste Marie, Ont. P6A 3M1

The objective of this workshop was to increase public awareness of the environmental effects of improper disposal of household hazardous wastes into water treatment plants and landfill sites. The workshop also provided a forum for a demonstration of the preparation and use of more environmentally friendly alternatives.

\$2 290 (EC 9123)

796 Chemical Spills and the Walpole First Nation

Walpole Island Heritage Centre
Mr. Dean Jacobs

(519) 627-1475

R.R. #3
Wallaceburg, Ont. NSA 4K9

This one day workshop is designed to increase the awareness of the Walpole Island community of spills on the St. Clair River and their effects on the residents. A report will summarize the findings of the workshop, elaborate on spills prevention and provide information to the community on the health effects of spills and their potential impacts on resources.

\$5 000 (EC 9144)

797 Greening the School Yards

The Ottawa Board of Education
Mr. Robert Gillet

(613) 239-2211

30 Gilmour Ave.
Ottawa, Ont. K2P 0P9

The initiation of a pilot project on "Greening of the School Yards" is the objective here. Through involving students in improving their environment, the goal is to raise their awareness of the environment and to stress the importance of positive coexistence between nature and the urban environment. Ecology centres, indigenous plantings, wildflower gardens, rockeries and butterfly gardens are a few examples of activities which could be conducted under such a program.

\$5 000 (PE 9210)

798 Global Action Plan

Global Action Plan for the Earth
R.R. #4, 6080 Durham 23
Uxbridge, Ont. LOC 1K0

Global Action Plan is an innovative environmental project that enables the citizens of Ontario to actively participate in achieving the 15 goals set out in the Agenda for the Green Decade. The plan promotes the development of "Ecoteams", neighbourhood support teams which, with the assistance of a workbook, engage in a six-month program designed to bring ones household into environmental balance. Assistance was provided for publicity, printing and distribution costs for the campaign.

\$25 000 (PE 9212)

799 Whitewash Campaign

The Women and Environment Education and
Development Foundation
Ms. Miriam Wyman

(416) 516-2379

736 Bathurst St.
Toronto, Ont. M5S 2R4

Whitewash is a public education campaign which has the objective of inducing industry to abandon the use of chlorine and chlorine dioxide bleaching processes in the manufacture of paper and sanitary products. Particular emphasis is on educating women about the possible harmful effects of chlorine-bleached products on their bodies and the environment. The goal is to encourage them to exert their consumer power thereby persuading industry to eliminate chlorine bleaching and provide alternative products.

\$25 000 (PE 9217)

800 Green Streets Program

Outaouais Popular Theatre
Mr. Paul Hannon

(613) 722-4000

55 Stevenson Ave.
Ottawa, Ont. K1Z 6M9

Green Streets is a community environmental action program which encourages participation in the achievement of specific environmental objectives as determined by the block, workplace or community group. As part of the program, assistance was provided for the printing of operating kits. These kits consisted of an introductory sheet and ten fact sheets detailing environmental concerns and corresponding local actions.

\$2 000 (PE 9218)

801 Environ-Van

Citizens for a Safe Environment
Mr. Brooke Bell

(416) 462-3860

765 Queen St. E.
Toronto, Ont. M4M 1H3

The Environ-van is an outreach project for residents, schools, stores and community centres in the South Riverdale area of Toronto. The van travels through the

community with the objective of encouraging waste reduction and composting activities through audio-visual displays, theatre pieces, hands-on workshops and other activities. Support was provided for promotional poster and workshop costs.

\$7 340 (PE 9228)

802 Ganaraska River and Watershed

Save the Ganaraska Again
Ms. Niva Rowan
R.R. #1
Newtonville, Ont. L0A 1J0

The mandate of this citizens group is to protect the ecological integrity of the global area of the headwaters of the Ganaraska River, the Ganaraska Forest and that portion of the Oak Ridges Moraine that is in the northeastern part of the Town of Newcastle. Through public meetings, and production of research material and a newsletter, the latter supported by this grant, the group is striving to raise awareness of the value of the Ganaraska River and watershed.

\$1 200 (PE 9239)

803 EARTHHEALERS

Trees for Today and Tomorrow
Mr. Andrew Hazen

(416) 920-8733

Institute of Marine and Terrestrial Ecology
Suite 202, 1320 Yonge St.
Toronto, Ont. M4T 1X2

This educational program, which includes a teachers guide and student manual, is designed to redirect the focus of curriculum from simple problem analysis, to initiation of actions to improve the situation. A combined process of workshops, field testing, and teacher and student evaluations are used to create the publications.

\$15 920 (PE 9243)

804 Air Quality Issues

The Lung Association
Metropolitan Toronto and York Region
Mr. Ian Morton

(416) 864-1112

Suite 201, 573 King St. E.
Toronto, Ont. M5A 4L3

This campaign was designed to assist educators, community, business and government leaders in increasing the awareness of children and their families of the effects of air pollution on their health, and what they can do to contribute to a healthier environment. The program included the production of resource material, seminars and community activities on air quality issues.

\$12 000 (PE 9244)

805 Paper, Glass, Bottles, Batteries - Separating Them Is Easy

Ralph Thornton Centre
Mr. Jim Houston

(416) 392-6810

765 Queen St. E.
Toronto, Ont. M4M 1H3

The project entailed the upgrading of the recycling program at the Ralph Thornton Centre. Through three workshops and a poster display, the goal was to inform the 15,000 members of the need to separate material for recycling. The program plans to divert ten tonnes of material from landfill sites and achieve self-sufficiency through the sale of materials. Assistance was provided for the costs of composters, display materials, audio-visual equipment rental and the printing of a technical report

\$1 525 (PE 9249)

806 Scientists In Schools

Scientists in Schools
Ms. Kathy Moore

(416) 287-7420

1014 Dunbarton Rd.
Pickering, Ont. L1V 1G8

Scientists in Schools is a program run in elementary schools in the Durham Region. Its objective is to encourage children to investigate, think and communicate in a scientific way, and to help teachers to expand classroom scientific activities. Production and distribution costs of promotional booklets and science box kits, and the conduct of workshops for local teachers were supported.

\$4 600 (PE 9253)

807 Waste Less Now

Pollution Probe
Ms. Patricia Chilton

(416) 926-1907

12 Madison Ave.
Toronto, Ont. M5R 2S1

A van equipped with public education displays is visiting festival and fairs in forty to fifty Ontario communities during the summer and fall of 1992. The displays will emphasize the need for waste reduction, energy conservation and water conservation, and will encourage viewers to adopt specific conserver lifestyles. Local environmental and municipal groups will also be encouraged to participate at the events.

\$15 000 (PE 9270)

808 Body Shop Awareness Program

Bradford District High School Environmental Club
Ms. Patricia McLennan

(416) 775-2262

Bradford District High School
Bradford, Ont. L3Z 2A3

This project involved the development of a kit detailing the types of hazardous chemicals used by the automobile body shop industry. The goal of the kit, which was distributed to body shops in the Bradford district, was to promote the use of alternative products which are less harmful to the environment.

\$470 (PE 9276)

809 GreenUp

Peterborough GreenUp
106 Murray St.
Peterborough, Ont. K9H 2S5

The goal of this program is to generate community spirit and foster the implementation of significant lifestyle changes in area residents in order to promote a sustainable local environment. GreenUp Action Challenge Booklets, which include action items and pledge sheets, encourage residents to commit themselves to undertake various actions in four target areas; energy conservation, waste reduction, water conservation and greenspace management. Their success and that of the community is monitored by the GreenUp office.

\$950 (PE 9277)

810 Earth Day Ontario Communication and Education

Earth Day Ontario
Ms. Sandra Beattie

(613) 544-8149

6 Rideau St.
Kingston, Ont. K7K 2Z6.

Earth Day Ontario seeks to foster environmental awareness, education and responsibility using the celebration of Earth Day as its focus. The goal of the project is to increase the effectiveness of the dissemination of information on environmental issues and to increase the number of Ontario communities with Earth Day committees. Coordinator kits, newsletters, regional conferences and workshops and education kits were all included in the campaign.

\$25 000 (PE 9287)

811 Earth Day/Everyday Home Audit: Phase II

Earth Day Canada
Mr. Maury Mason

(416) 962-1991

Suite M108, 150 Bloor St. W.
Toronto, Ont. M5S 2X9

This project was the second stage of a four part audit program designed to assist Canadians in reducing their personal impact on the environment. This phase utilizes results from surveys of household activities and habits previously undertaken to produce individualized action plans for the participants. In addition to providing participants with alternatives and an incremental timeline for environmental action, information on the types of lifestyle changes individuals are likely to adopt and those they will resist will result.

\$12 800 (PE 9288)

812 McMaster Venture Engineering and Science Camp

Faculty of Engineering
McMaster University
Dr. Gary Purdy

(416) 525-9140

Hamilton, Ont. L8S 4L7

This camp was created by engineering students and staff at McMaster University to inspire elementary school student's interest in and dispel the seeming complexity of science and engineering. The program consists of eight, week long camp

sessions and presentations with the emphasis being placed on science demonstrations, student participation and hands-on activities. Printing and postage expenses were supported.

\$750 (PE 9293)

Previous Projects

813 Solar Cup Race. Canadian Solar Cup; Ms. L. Hebert. 1990 \$2 000 (EC 9031)

814 Global Learning Project. (*Educational material*). York University, Faculty of Environmental Sciences; Ms. C. Easton. 1989 \$3 500 (PE 9018)

815 Visions 2020 Program. (*Sustainable development*). Mr. C. Dickman. 1989 \$39 800 (PE 9023)

816 Travelling Exhibition on the Tropical Rainforest. Urban Naturalists, World Wildlife Foundation; Dr. J. Harrison. 1989 \$10 000 (PE 9026)

817 Mazinaw Project 2000. (*Questionnaire on water quality, waste management, sewage systems and wildlife in the Mazinaw Lake region*). Mazinaw Property Owners Association Project; Mr. H. Cross. 1990 \$410 (PE 9052)

818 Earth Day. (*General environmental issues and sustainable development, and tree planting*). Earth Day 1990 Canada; Ms. Joyce Mackenzie. 1990 \$15 000 (PE 9055)

819 Environmental Health Program. (*Environmental health issues including lead and odour pollution*). South Riverdale Community Health Centre; Ms. M. Harding. 1990 \$7 500 (PE 9062)

820 Bringing Environmental Concerns and Solutions into the Homes of Ontario. (*General environmental issues*). Environment Probe; Ms. A. Turner. 1990 \$20 000 (PE 9067)

821 EARTH DAY Activities. (*Ottawa-Carleton region*). Cultural Survival: Earth Day 90 Ottawa Region; Ms. H. Hamilton. 1990 \$5 000 (PE 9077)

822 Trees and Global Warming. (*Tree planting*). Friends of the Earth; Ms. J. Langer. 1990 \$20 000 (PE 9078)

823 Expansion of Public Education and Outreach Program. (*General environmental issues*). Pollution Probe Foundation; Ms. M. Ise. 1990 \$13 950 (PE 9080)

PUBLIC CAMPAIGNS AND OUTREACH PROGRAMS

824 A Human Race Towards a Healthy Planet. (*Trans-Canada bicycle expedition*). Council of Outdoor Educators of Ontario; Mr. D. Stephens. 1990 \$4 000 (PE 9088)

826 Campaign for a Sustainable Future based on the "Guideposts for a Sustainable Future". (*Sustainable development*). Bakavi School of Permaculture; Mr. M. Nickerson. 1991 \$8 400 (PE 9089)

826 Canadian Solar Cup '91. Ms. L. Herbert. 1990 \$2 000 (PE 9090)

827 Save the Oak Ridges Moraine. S.T.O.R.M.; Mr. T. Meininger. 1990 \$4 000 (PE 9095)

828 Fighting for a Cleaner Future. (*Workshops on environmental issues in the Windsor and Essex regions*). Windsor and District Clean Water Alliance; Mr. R. Marentett. 1990 \$7 500 (PE 9103)

829 National Visions 2020 Program. (*Sustainable development*). Public Focus; Mr. S. Smith. 1990 \$15 000 (PE 9109)

830 Environmental and Social Equity Project. Ontario Environmental Network; Ms. V. Alexander. 1990 \$25 000 (PE 9131)

831 Recycling Week Poster. Recycling Council of Ontario; Mr. J. Hanson. 1991 \$39 852 (PE 9139)

832 Environment Home. (*Water and energy conservation, waste management and hazardous household products*). Environmental Corporate Services; Mr. W. Peden. 1991 \$50 000 (PE 9140)

833 Cities for a Cooler World. (*Global warming and greenhouse gases*). Friends of the Earth; Ms. J. Langer. 1990 \$15 000 (PE 9146)

834 Environmental Art Exhibit. (*Energy conservation*). Solar Energy Society of Canada Inc.; Ms. C. Le. 1991 \$5 000 (PE 9148)

835 Tree Day. (*Tree planting*). The Evergreen Foundation; Mr. G. Cape. 1991 \$18 000 (PE 9162)

836 Clean Up Your Act Publication Education Campaign. (*Waste management*). Forevergreen Television and Film Productions. Inc.; Mr. A. Aylward. 1991 \$25 000 (PE 9170)

837 Downspout Disconnection Program. (*Avoidance of sewage treatment plant overflow caused by stormwater*). City of St. Catharines; Ms. Cindy Toth. 1991 \$10 000 (PE 9176)

838 Children's Environmental Outreach Program, 1991-1992. Public Focus; Mr. S. Smith. 1991 \$10 000 (PE 9193)

839 Pitch-In Week Campaign. (*Clean up parks and wilderness areas*). Ontario Federation of Anglers and Hunters; Dr. C. Davison Ankney. 1991 \$75 000 (PE 9260)

840 Junction Creek Park Project. (*Shoreline development and tree planting*). Ukrainian Seniors' Centre; Ms. M. Stefura. 1991 \$15 000 (CC 001)

841 Pitch In 1990. (*Cleanup campaign*). Ontario Federation of Anglers and Hunters; Mr C. Alexander. 1990 \$25 000 (OT 9008)

MONITORING PROGRAMS

1991/92 Projects

842 Grand River Water Quality Monitoring Program

Department of Environmental and Resource Studies
University of Waterloo
Mr. James Robinson
(519) 885-1211
Waterloo, Ont. N2L 3G1

This monitoring program involves grade eleven and twelve students in a water quality study of the Grand River Watershed. The goal of the project is to encourage students to develop an awareness of the importance of water quality in their community and to motivate them to become more environmentally responsible citizens.

\$2 860 (PE 9226)

Previous Projects

843 BARK 90': (Backyard Acid Rain Kit). (*Acid rain monitoring by students in Canada and the U.S.A.*). Public Focus; Mr. S. Smith. 1990 \$10 000 (PE 9065)

844 Vehicular Emission Demonstration. City of Toronto; Mr. T. O'Donohue. 1990 \$23 000 (PE 9082)

845 Program to Monitor implementation of the U.S. Clean Air Act and Canadian Acid Rain Legislation. The Canadian Acid Precipitation Foundation; Mr. D. Love. 1990 \$48,000 (PE 9138)

846 Global Laboratory Environmental Monitoring Project. (*Climate change*). Gananoque Secondary School; Mr. J. MacLeod. 1991 \$1 200 (PE 9183)

847 Back Yard Acid Rain (BARK) Kit - 1991. (*Acid rain monitoring by school students in Canada and U.S.A.*) Public Focus; Mr. S. Smith. 1991 \$10 000 (PE 9191)

FESTIVALS AND FAIRS

1991/92 Projects

848 Ecological Market

Citizens for a Safe Environment
Ms. Gillian Kranias
(416) 462-3860
765 Queen St. E.
Toronto, Ont. M4M 1H3

About 3000 people attended this third annual ecological market at Harbourfront in Toronto for which support was provided for advertising and displays. The event provided support to small businesses and environmental groups by affording an opportunity for the public to learn about and purchase ecologically sound products.

\$12 150 (EC 9073)

849 Changing Our World

Trillium Events Inc.
Mr. Robert Singleton
(416) 475-3324
178 Main St.
Unionville, Ont. L3R 2G9

At this event, seminars, exhibits and entertainment were used to demonstrate how everybody can contribute to improving the state of the environment. Discerning product selection and constructively altered lifestyles were promoted in a weeklong celebration of evolving environmental consciousness.

\$5 000 (EC 9090)

850 Environmental Fair

Grassroots Woodstock
Mr. Stewart Shouldice
(519) 539-2648
632 Springbank Ave.
Woodstock, Ont. N4T 1E8

The theme for this second annual fair was source separation and the diversion of waste from landfill sites and incinerators. The general public, business, government, environmental groups, scientists and political leaders shared their ideas on how to resolve the waste management issue. Various options including composting and conservation were addressed as were concerns regarding water quality and environmental health. Support was

FESTIVALS AND FAIRS

granted towards production and distribution of advertising literature.

\$1 000 (EC 9103)

851 Changing Our World

Trillium Events Inc.
Mr. Robert Singleton

(416) 475-3324

178 Main St.
Unionville, Ont. L3R 2G9

Taking place during National Environment Week, the purpose of this fair was to demonstrate how the public can contribute positively to the state of the environment. An environmental village, educational packages, teachers kits and concerts were included in the fair which provided public exposure to environmentally friendly companies, products and technologies as well as to government departments and environmental associations.

\$5 000 (EC 9106)

852 Arts In the Square 1992

Mississauga Arts Council
Ms. Andrejka Paznar

(416) 276-2787

Suite 1055, 300 City Centre Dr.
Mississauga, Ont. L5B 3C9

Raising awareness of the environment through a combination of music, theatre and visual arts is the focus of this fair. Issues covered include the depletion of the rain forests, and environmentally friendly techniques and materials for artists.

\$6 000 (EC 9116)

Previous Projects

853 Environmental Fair during Environment Week. (*General environmental issues*). Mrs. H. Copeland. 1989 \$400 (EC 9016)

854 Ecological Market. (*Household products*). Citizens for a Safe Environment; Ms. R. Singh Waraich. 1989 \$1 000 (EC 9024)

855 What Can I Do? - Environmental Fair. (*General environmental issues*). St. David's United Church; Ms. Trish Shouldice. 1990 \$1 000 (EC 9061)

856 Children's Environmental Festival. (*General environmental issues*). Public Focus on the Great Lakes; Mr. C. Dickman. 1989 \$25 000 (PE 9002)

857 1990 Children's Environmental Festival. (*General environmental issues*). Public Focus; Mr. S. Smith. 1990 \$25 000 (PE 9076)

858 The Rainbow Connection. (*Employment opportunities*). Ms. E. Brady. 1990 \$1 100 (PE 9120)

859 Artists and the Environment. (*General environmental issues*). Artists' Alliance for the Environment; Ms. E. Rousseau. 1990 \$5 000 (PE 9126)

860 Children's Environmental Festival, November, 1991. (*General environmental issues*). Public Focus; Mr. S. Smith. 1991 \$25 000 (PE 9192)

THEATRICAL PRODUCTIONS

1991/92 Projects

861 Environmental Action Alleyway
Caravan Stage Company
Ms. Sara Diederichs

(613) 385-2935

P.O. Box 106
Wolfe Island, Ont. K0H 2Y0

Environmental Action Alleyway is a component of the play *The Coming*. *The Coming* provides an environmental experience by taking the audience through 150 acres of land with the aim of helping them gain a true understanding of the depth of the damage to the planet. A tour of the Alleyway, a trailer with environmental information and action proposals designed to empower the audience with suggestions for personal and community action, is the final act of the performance. Assistance was provided towards costs of writers fees, flyers, posters, billboards, street banners and newspaper advertising.

\$5117 (PE 9213)

862 Head for the Hills

Mr. Rob Ritchie

(416) 536-5301

Apartment 3, 408 Manning Ave.
Toronto, Ont. M6G 2V7

Head for the Hills is a musical comedy play of approximately sixty minutes in duration which deals with an individual's response to the problems of environmental negligence. Advertising costs for the play were supported which is targeted at secondary schools, senior elementary schools and special interest groups throughout Ontario.

\$1 030 (PE 9241)

863 A Mountain of Garbage

Grassroots Humewood
Ms. Jenny Koniuk

(416) 656-2212

170 Humewood Dr.
City of York, Ont. M6C 2W8

Performed as part of the Humewood Community Fair, the 45 minute musical play "A Mountain of Garbage" depicts the importance of individual and collective action in

resolving local and global environmental problems. The importance of the 3Rs in waste management and the relationship between humanity and nature are stressed.

\$725 (PE 9301)

Previous Projects

864 Message In a Bottle. (*Great Lakes*). Great Lakes United; Ms. S. Miller. 1989 \$600 (EC 9011)

865 Environmental Play. (*Earth Week*). Toronto Studio Players Theatre School; Mr. H. Jacob. 1990 \$18 700 (PE 9084)

866 Environmental Play. (*Earth Week*). St. Lawrence Centre for the Arts; Mr. M. Noon. 1990

\$3 000 (PE 9084A)

867 The Coming. (*General environmental issues*). Caravan Stage Company; Ms. C. Sauter. 1990 \$2 000 (PE 9102)

868 Come Save Today. (*Waste reduction, environmentally friendly products, toxic chemicals, global warming and deforestation*). Children's Educational Theatre Productions; Ms. L. Barnett 1990 \$25 000 (PE 9156)

869 Brazil Nut. (*Rainforests*). Carousel Players; Ms. E. Palmieri. 1991 \$20 000 (PE 9174)

870 Law Day Activities, April 17, 1991. (*Mock trial and essay contest*). Canadian Bar Association, Ontario Section; Ms. L Adlam Manning. 1991 \$15 500 (PE 9175)

871 The Future Is Rs. Inner Stage Theatre; Ms. E. Szathmary. 1991 \$11 000 (PE 9180)

872 Drink the Mercury. (*Industrial waste*). Sault Youth Theatre; Mr. Steve Ballantine. 1991 \$11 775 (PE 9182)

AUDIO-VISUAL MATERIAL

1991/92 Projects

873 Waste Not

TVOntario

Ms. Louise Charbonneau

(416) 484-2895

P.O. Box 200, Station Q

Toronto, Ont. M4T 2T1

Waste Not is an educational series on waste reduction first broadcast between January and March, 1992. It consists of 13 thirty minute segments with the overall objective of reporting on and stimulating waste reduction activities by individuals, businesses and communities in the home and workplace. The series will also be available on video tape.

\$150 000 (PE 9266 PE 9267 PE 9268)

Previous Projects

874 The Environment - Our Common Future. (Video on environmental issues particularly sustainable development, engineering, and science and technology). INCO Limited; Mr. R. Aitken. 1990 \$3 400 (EC 9043/9043A)

875 Green Waves Environment Network. (Radio tapes on environmental issues). Green Waves Environment Network; Mr. J. Culbert. 1990 \$1 120 (PE 9056)

876 Operation Skywatch. (Film). Pixie Bigelow Productions Inc.; Ms. P. Bigelow. 1990 \$7 500 (PE 9073)

877 A Cry for the Common Loon. (Documentary film on the effect of acid rain and the common loon in the Sudbury region). Front Porch Film and Video; Mr. S. Rose. 1990 \$5 000 (PE 9096)

878 "The Green Household": An Environmental Self-Help Film. (Film covering energy conservation, waste management, and energy reduction and conservation). Caber Film and Video Company; Mr. C. Scott. 1991 \$25 000 (PE 9113)

879 Yes Environmental Success. (Video on environmental issues, particularly focussing on the Monteverde conservation project in Costa Rica). T.C. Video Productions; Mr. A. Sumpter. 1990 \$6 000 (PE 9130)

880 A Cry for the Common Loon. (Film on the effect of acid rain and the common loon in the Sudbury region). Front Porch Film and Video; Mr. S. Rose. 1991 \$10 000 (PE 9144)

881 Video on Great Lakes Basin. (Focussed on the Bay of Quinte). Quinte Environmental Resources Alliance; Ms. J. Ralph. 1991 \$16 000 (PE 9151)

882 Teacher's Guide for Educational Video "The Adventures of Ricky Raindrop". (Acid rain, water cycle, groundwater, water pollution and aquatic ecosystems). Arthur Holbrook Productions and KLA Visual Productions. 1991 \$25 000 (PE 9166)

883 Environment In the 1990's - An Educational Series. (Video on environmental issues). Paradigm Communications; Mr. J. Jurkovic. 1991 \$25 000 (PE 9167)

884 3Rs Photographic Slide Collection. Mr. P. Fry. 1991 \$23 500 (PE 9172)

MISCELLANEOUS

1991/92 Projects

885 Develop a Sunset Chemical Protocol for the Great Lakes Basin

Pollution Probe

Ms. Patricia Chilton

(416) 926-1907

12 Madison Ave.

Toronto, Ont. M5R 2S1

The focus of this project is the development of a process within which to implement zero discharge of the most dangerous and hazardous pollutants affecting the Great Lakes. Identification of candidate chemicals, a review of existing legislative, economic and policy frameworks, and development of an outreach program are all included in the protocol.

\$50 000 (PE 9223)

886 Smithville PCB Site - Remediation Options/ Impact Report: Phase IV, Part II

Chemical Waste Management Liaison Committee

Mr. Neil Switzer

R.R. #1

Smithville, Ont. L0R 2A0

Assistance was provided to offset general expenses of the Chemical Waste Management Liaison Committee's review of the Remediation Options/Impact Report on the Smithville PCB Incinerator site.

\$10 700 (PE 9303)

Previous Projects

887 Coordinate the Educational, Research, and Technical Efforts of the PCAO. (*Water pollution control*). Pollution Control Association of Ontario; Mr. S. Davey. 1989 \$7 500 (PE 8901)

888 Model for Community Organization Around Environmental issues. Ontario Association for Continuing Education, Dr. J. Dobell. 1989 \$10 000 (PE 9009)

889 Research on Waste Management Issues. Pollution Probe Foundation; Ms. Miekko Ise. 1990 \$25 000 (PE 9070B)

890 PCB Facility Hearing. Halton Conservation Authority, Chemical Waste Management Liaison Committee; Mr. N. Switzer. 1990 \$3 905 (PE 9110)

891 Shoreline Management Study of Brady Lake. (*Carrying capacity and land use management*). Ryerson School of Urban and Regional Planning; Dr. R. Pushchak. 1991 \$6 000 (CC 002)

ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAM CROSS REFERENCE INDEX

Conventional Environmental Education and Awareness program project numbers (EC 9999) are referenced to the Report catalogue number. Note that this number has no relevance beyond this document.

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**Report on Environmental Research,
Technology Development and Awareness
Activities, 1991/92**

Editor: Dr. Roger Scott

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Project summaries in the three program sections are based on proposals or reports supplied to Environment Ontario. Many research and technology development projects are complex and often multi-year undertakings. Caution should be exercised in extrapolating objectives, results or conclusions out of their original context. Any views, ideas or conclusions do not necessarily reflect the views and policies of Environment Ontario, nor does mention of trade names, commercial products or processes constitute endorsement or recommendation for use.