



Soil and Groundwater Remediation delivered through the Program of Energy Research and Development at Environment Canada



Environment
Canada

Environnement
Canada

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Canada's Energy Policy has Three Overarching Goals:

- 1) Promoting long-term development and stewardship
- 2) Ensure that the environmental impacts of energy development, transport, and use are addressed
- 3) Current and future generations have secure access to adequate supplies energy



Environment Canada's Niche in the Energy Sector

- Research and Development
- Technology
 - Assessment
 - Development and demonstration
 - Transfer
- Defining sustainability and tracking performance for the sector
 - Environment impacts and benefits of technologies
 - Defining sustainability in terms of Canadian environmental quality objectives



Environment Canada's Niche in the Energy Sector

■ Mandate

- Enhance quality of natural environment
- **Program of Energy Research & Development (PERD)**
 - Sustainable energy solutions (including metrics)
 - Environmental stewardship


Program of Energy Research & Development (PERD)

12 Federal organizations:

Environment Canada, Natural Resources Canada, Agriculture and Agri-Food Canada, Canada Mortgage and Housing Corporation, Department of National Defense, Fisheries and Oceans Canada, Health Canada, Industry Canada, Indian and Northern Affairs, National Research Council, Public Works, Transport Canada

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Project Themes					
Oil and Gas	Transportation	Buildings and Communities	Industry	Electricity	Climate Change
EC , FO, INA, NRC, TC, NRCan	DND, EC , HC, NRC, TC, NRCan	CMHC, EC , HC, NRC, PWC, NRCan	AAFC, EC , FO, IC, NRC, NRCan	EC , FO, NRCan	AAFC, EC , FO, NRCan



Soil & Groundwater Remediation Program (SGRP)

- National in scope
- 11 project teams
 - Government, academia, and industry
 - Advancement and sharing of knowledge



SGRP - Program Goals

- Knowledge generation
- Impact reduction through R&D
- Technology transfer
- Ensure sustainable development of 'sensitive' regions



SGRP - Benefits

- Necessity of R&D efforts
 - Dependency of populated areas on GW for drinking water and agricultural uses
 - Regulatory and industrial need for relevant remediation techniques, technologies, and guidelines

- Program supports
 - Decision-making, policy development, and regulatory activities
 - Development of national standards and guidelines
 - Public safety and environmental needs



SGRP - Policy Drivers

- Environment Canada's Mandate
 - Enhance quality of natural environment, ensure sustainability for future generations
- Federal Budget
- Federal Government's mandate to develop S&T
- CCME requirements and needs
- Industrial partners needs
 - PTAC, CAPP, and others

SGRP - Program Funding

Within PERD, the Oil and Gas Strategic Intent represents 44% of the total PERD funding coming into Environment Canada

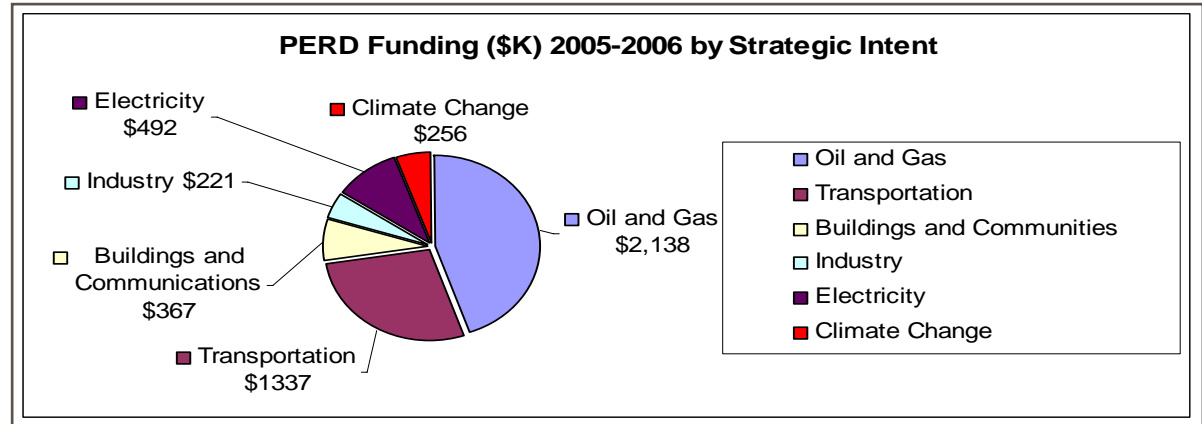


Figure 1. PERD Funding 2005-2006 by Strategic Intent

Of the total PERD funds allotted to the Oil and Gas Strategic Intent, POL 1.3.3(SGRP) receives the largest portion of the funds (35%)

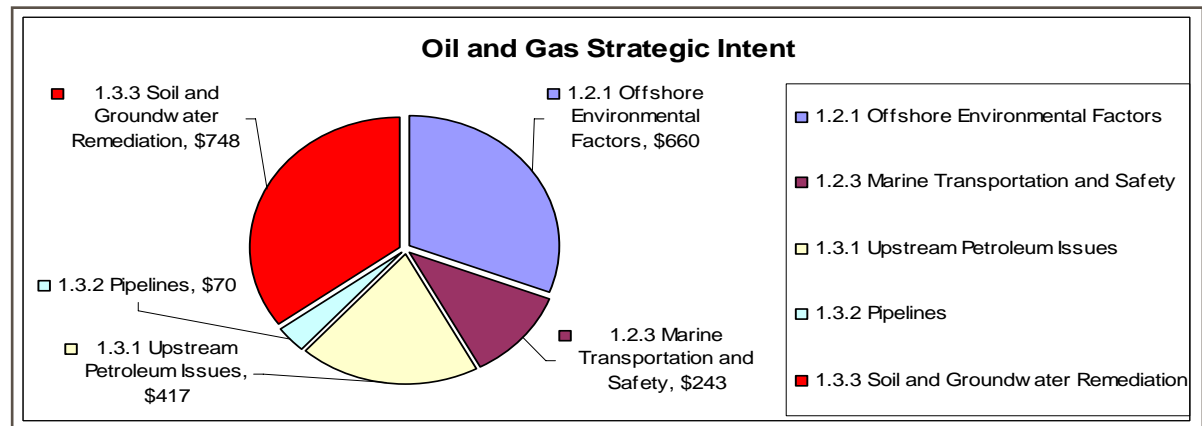


Figure 2. Breakdown of funding for Oil & Gas Strategic Intent

SGRP - Program Partnerships

- Federal laboratories, private industry, NSERC, universities, provincial and municipal government and research organizations, and international organizations
- Enables project teams to work towards common goals while making efficient use of available resources
- Strong partnerships enhance predictability in output and outcome delivery for both industry and government



SGRP - Program Partnerships (cont'd)

- Industrial associations:
 - Canadian Association of Petroleum Producers (CAPP)
 - Representative of major oil & gas producing companies
 - Petroleum Technology Alliance of Canada (PTAC)
 - Coordinates research funding for upstream oil & gas industry

- Participation of project team members in PTAC committees
 - Soil and Groundwater Research Committee
 - Environmentally Acceptable Endpoints Technical Steering Committee

SGRP - Program Organization

Office of Energy Research and Development
 Toxicity, Bioavailability, Relevant Ecological Endpoints
 PERD Panel

Fate, Transport, Biodegradation, Natural Attenuation
 EC PERD Secretariat

PERD EC Leader

Program Committee

Remediation Under Challenging Conditions
 NRC Advisor

Activity Area 1

Activity Area 2

Activity Area 3

Standard Development

EAE

Wetlands

Naphthenic Acids

Northern Fate

Geophysical Assessment

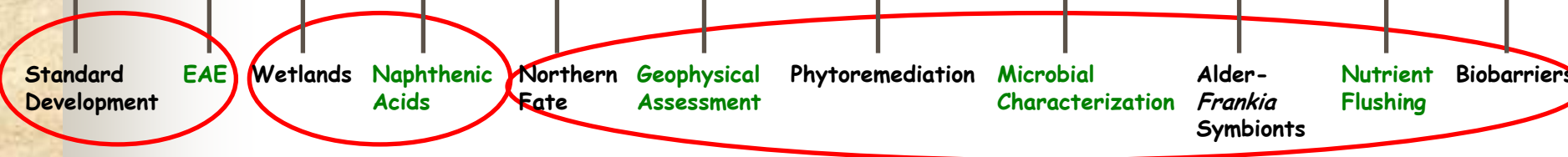
Phytoremediation

Microbial Characterization

Alder-Frankia Symbionts

Nutrient Flushing

Biobarriers



Soil and Groundwater Model

Standard Development EAE Wetlands Naphthenic Acids Northern Fate Geophysical Assessment Phytoremediation Microbial Characterization Alder-Frankia Symbionts Nutrient Flushing Biobarriers

Outputs

Publications; Knowledge transfer
Data for models; potential New Technologies;
Assessment of Technology requirements in Challenging Environments

Intermediate Outcomes

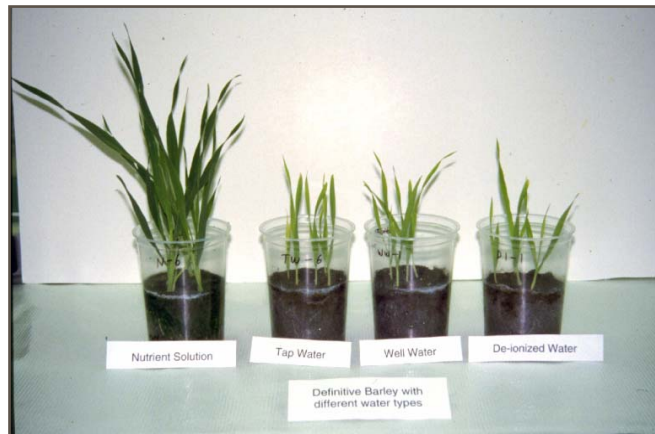
Dvpt of Guidelines; increased awareness of Industry and regulators of ecologically relevant methods;
a better understanding of MNA; **tech transfer from lab to field;** Knowledge transfer
increased awareness and model dvpt for extreme conditions

Final Outcomes

Standardized Test Methods; Knowledge transfer; Guidelines
MNA Effectiveness; Potential New Technologies; Improved Assessments
Improved Remediation Plans; Improved Technical Infrastructure; **Practical Methods for Remediation**

Development of Standardized Toxicity Test Methodologies and Guidance Documents

- R. Scroggins (EC)
- Assessment of the impact of hydrocarbon contamination in agricultural and non-agricultural habitats
- Incorporate organisms of ecological relevance to Canadian soil systems



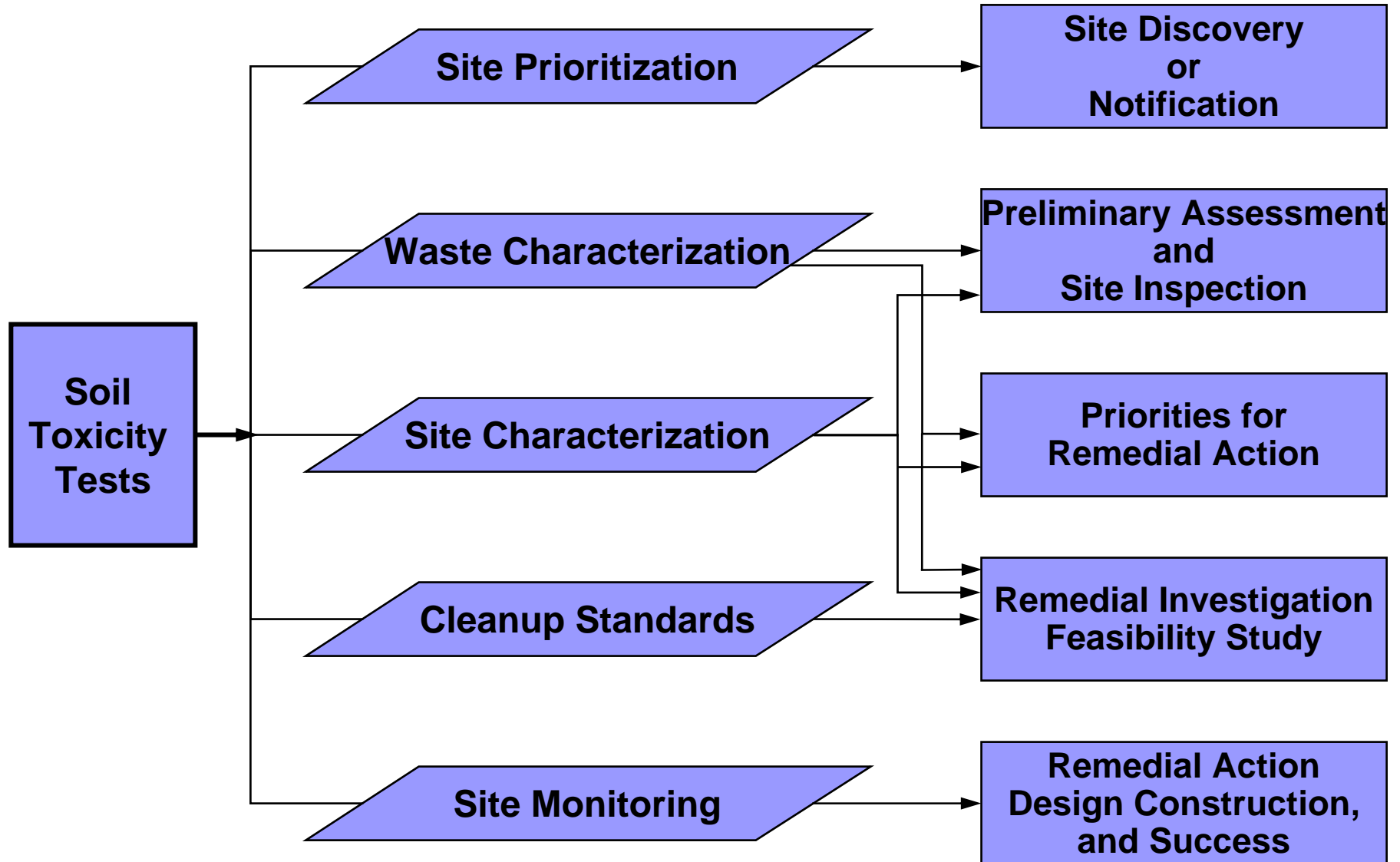


Benefits of Soil Toxicity Testing

- Generate soil toxicity data to derive environmental quality criteria for substances of unknown toxicity
- Estimate toxicity of mixtures of chemicals in contaminated soil
- Alleviates problems of incomplete chemical profiles at contaminated sites
- Provides estimate of bioavailability of chemicals in soil relevant to site-specific locations

Role of Toxicity Tests in the Assessment of Contaminated Soils

(Adapted from Greene et al. 1989)



Wetlands - Containment, Transformation and Remediation

- J. Headley (EC)
- Organic contaminants from natural gas condensates and process chemicals
 - Determine effectiveness of natural wetlands for attenuation
 - Effects of hydrocarbons on wetland ecosystems
 - Model development



Remediation and Revegetation

- C. Greer (NRC)
- Use of alder-*Frankia* symbionts for remediation and revegetation of composite tailings soils containing naphthenic acids and High Salt





Remediation and Revegetation

■ Project Outputs

- Production of alder-*Frankia* symbionts for use on composite tailings soils
- Phytoremediation potential of alder-*Frankia* symbionts on contaminated, high salt soils

■ Project Outcomes

- A practical method for the remediation and revegetation of composite tailings soils

Greenhouse Production of alder- *Frankia* symbionts



Nutrient Amendment and Natural Biodegradation

- M. Brown (Komex), P. Bacchus (EC)
- Development of an innovative system to mitigate environmental impacts related to hydrocarbon contamination
- Evaluate passive gas diffusion samplers as effective monitored natural attenuation measurement tool





Nutrient Amendment and Natural Biodegradation

■ Project Outputs

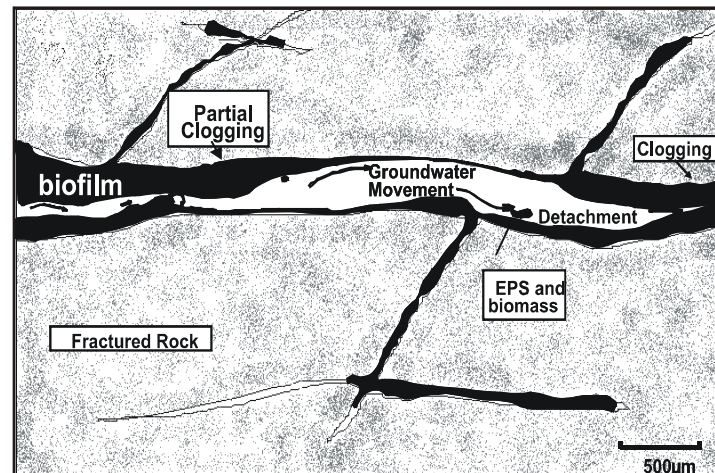
- Method to effectively monitor the progress of plume biodegradation
- Suitability of nutrient enhanced in-situ biodegradation in a fractured bedrock aquifer under complex field conditions

■ Project Outcomes

- Method to amend a hydrocarbon impacted aquifer with suitable nutrient solutions to enhance biodegradation in-situ
- Potential semi-passive technique to remediate difficult contaminated sites

Biobarriers in Fractured Bedrock

- N. Ross (UofO), K. Volchek (EC)
 - A novel approach to the remediation of contaminants in fractured bedrock
 - Reduces the effect hydraulic conductivity of the media, reducing contaminant transport



Schematic - Bioclogging in fractured rock



Biobarriers in Fractured Bedrock

■ Project Outputs

- Knowledge on the fate, transport, and biodegradation in fractured rock
- Assessment of applicability of remediation technology
- Development of models to predict efficacy of technology

■ Project Outcomes

- Pilot-scale demonstration of a bioremediation technique
- Predictive tools

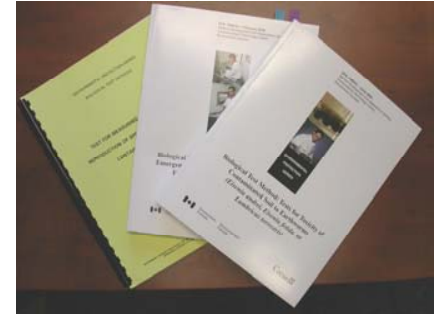


SGRP - Other Projects

- Activity 1
 - Environmentally Acceptable Endpoints of CCME CWS PHC F3 for Weathered PHC in Soil (R. Scroggins, EC)
- Activity 2
 - Remediation of Naphthenic Acids in Subsurface Soils and GW at Oil Extraction Plants (J. Headley, EC)
- Activity 3
 - Microbial Community Characterization and Profiling in Northern Sites (C. Greer, NRC)
 - Phytoremediation of Salt-Affected Sites (J. Headley, EC)
 - Fate of Petroleum Spills and Contaminants in Sumps in Northern Environments (D. Van Stempvoort, EC)
 - Integrated Geophysical assessment of Salt and PHC Contaminated Sites (J. Headley, EC)

Program Highlights

- Toxicity, bioavailability and relevant ecological endpoints
 - Development of standardized test methods and guidance documents for Canadian ecosystems
 - 3 national soil toxicity test methods
 - Development of environmentally acceptable endpoints and relevant soil quality guidelines
 - Addressed data gaps required for the derivation of national soil quality guidelines for total PHCs in soil



Program Highlights

- Fate, transport, biodegradation and natural attenuation
 - Direct impact on industrial processes
 - Refined gas-plant site-management strategies
 - Industry is no longer excavating natural wetlands
 - Influenced development of CCME guidelines on Sulfolane and DIPA
 - Acquire a better understanding of natural processes affecting transport, biodegradation and natural attenuation

Program Highlights

- Remediation under challenging conditions
 - Development of effective remedial techniques
 - Development of biobarriers in fractured bedrock as a potential viable remediation approach
 - Nutrient Flushing and Passive Samplers
 - Contribution to draft guidelines for the use of MNA by upstream oil & gas industry



Path Forward

- Continue 3 existing research areas
- Pursue additional research avenues
 - Future development in the North
 - Coalbed methane (i.e., produced water)
 - Acid deposition from oilsands development
 - Salt contamination
- Address broader soil and groundwater related impacts of oil and gas activities
 - Pipeline scaling
 - Leakage of oil and gas condensates
 - Drilling waste management



And the moral of the story is...

- PERD is an enabling tool
 - Soil & Groundwater Program supports needed R&D
 - Technology transfer
 - Sustainable development of 'sensitive' regions
 - Enhances knowledge base and promotes education via:
 - Publications
 - Forums and workshops
 - Representatives on committees
 - Maintains strong partnerships between government, academia and industry



Acknowledgements

Program Researchers

- Rick Scroggins (EC)
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Program Contributors

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- Academia
- Government

Thank you!