Management of Soil Sterilant Impacted Sites

SMART Remediation

Bonnie Drozdowski

March 11, 2020

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About InnoTech Alberta

InnoTech Alberta is a leading Research and Technology Organization (RTO) established by the Government of Alberta to serve the needs of industry, innovation ecosystem & academia

ALBERTA RESEARCH COUNCIL

Alberta Innovates Technology Futures

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1921

Government Lab

Natural Resource Development Focus

Strategic Research, Technical Services & Technology Development

2010

Government Lab

Industry Sector and SME Support Focus

Basic Research, Applied Research & Commercialization (Funder & Execution)

2016

Research & Technology Organization

Stakeholder & Industry Sector Focus

Industrial Technology Research, Development & Deployment

InnoTech Alberta's Mandate

- Demonstrate **Value to our Clients** and **Industries** by contributing to research, technology development, and innovation for market sustainment, growth, and new disruptive offerings
- Demonstrate **Return on Investment** to the citizens of Alberta as an integral contributor to our stakeholder Alberta Innovates across the Path of Innovation
- Uniquely positioned to provide services where others lack our:
  - **Capability and Capacity** – expertise, facilities, scale
  - **Risk Tolerance** – high risk industrial R&I initiatives
  - **Neutrality** – impartial, independent, global recognition

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What are Soil Sterilants?

- **Non-selective, persistent, residual herbicides that render treated soil unfit for plant growth**
  - Selective vs non-selective
    - Selective herbicides control specific types of vegetation
    - Non-selective herbicides used for total vegetation control
  - Residual vs Non-Residual – can be selective or non-selective
    - Residual herbicides control vegetation long term
    - Non-residual herbicides generally only last one growing season
  - Persistent
    - Continued or prolonged existence of herbicide
    - Related to half life which depends on:
      - Application rate, soil moisture, pH, temperature, OM content, microbial content, etc.
      - Chemical and physical properties, composition, etc.

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Sterilants – What is the Problem?

- Non-selective, persistent, and residual
- Typically applied at high application rates over several years
- Generally older sites - farms, transmission lines, oil and gas distribution and industrial facilities, pipelines and electric metering stations, railways
- Often become contamination source through leaching, runoff or wind dispersion
- Best estimate - >60,000 sites in Alberta

Sterilants – What is the Problem?

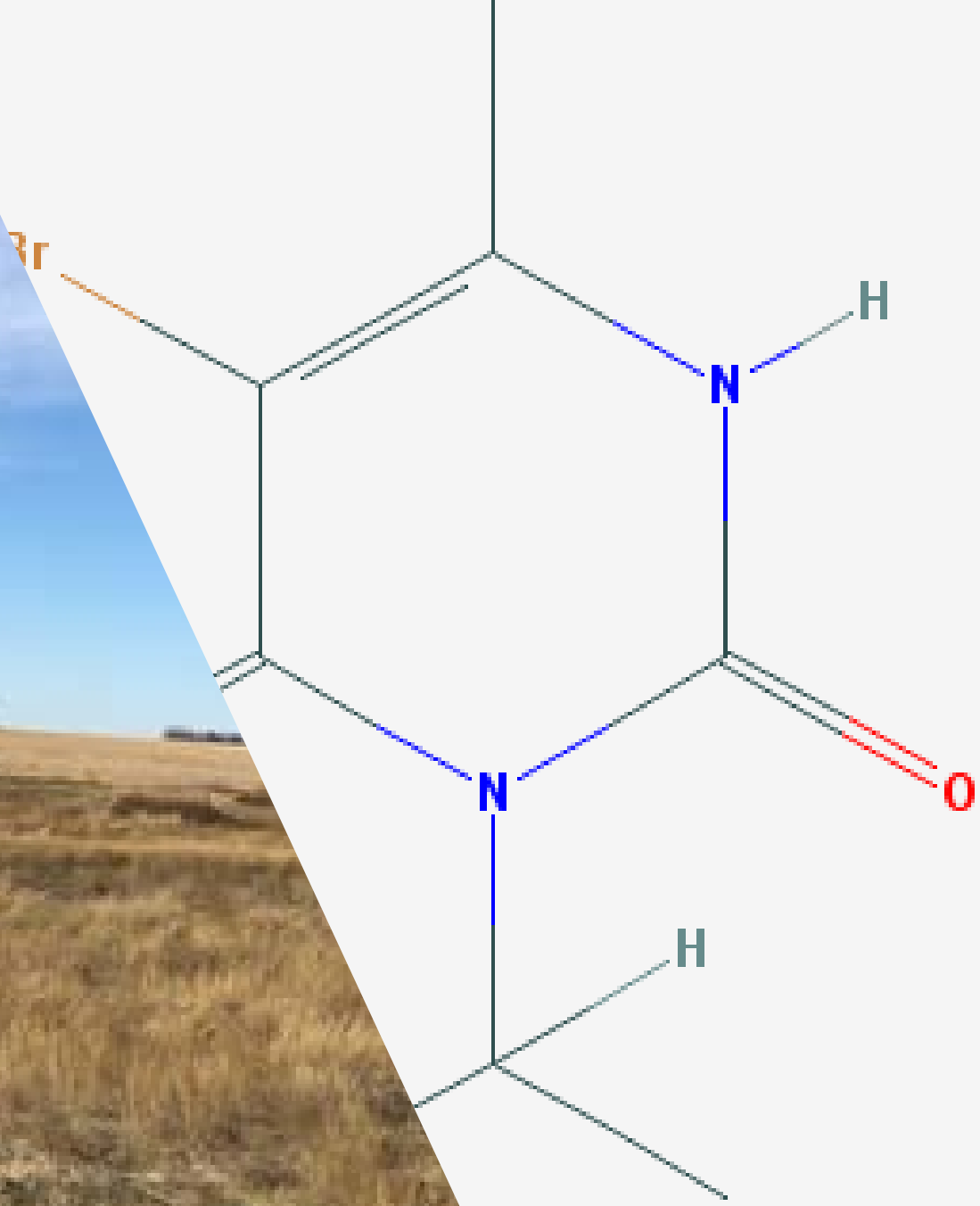
- Remediation stalled due to challenging nature of contaminants and cost associated with conventional remediation approaches
  - Difficult to treat to guideline level
  - Widespread given length of migration time
  - No single, standardized solution due to differences in chemical structure and environmental behavior of products
  - Often confounding contaminant issues

Considerable effort over past 20 years, however knowledge gaps remain

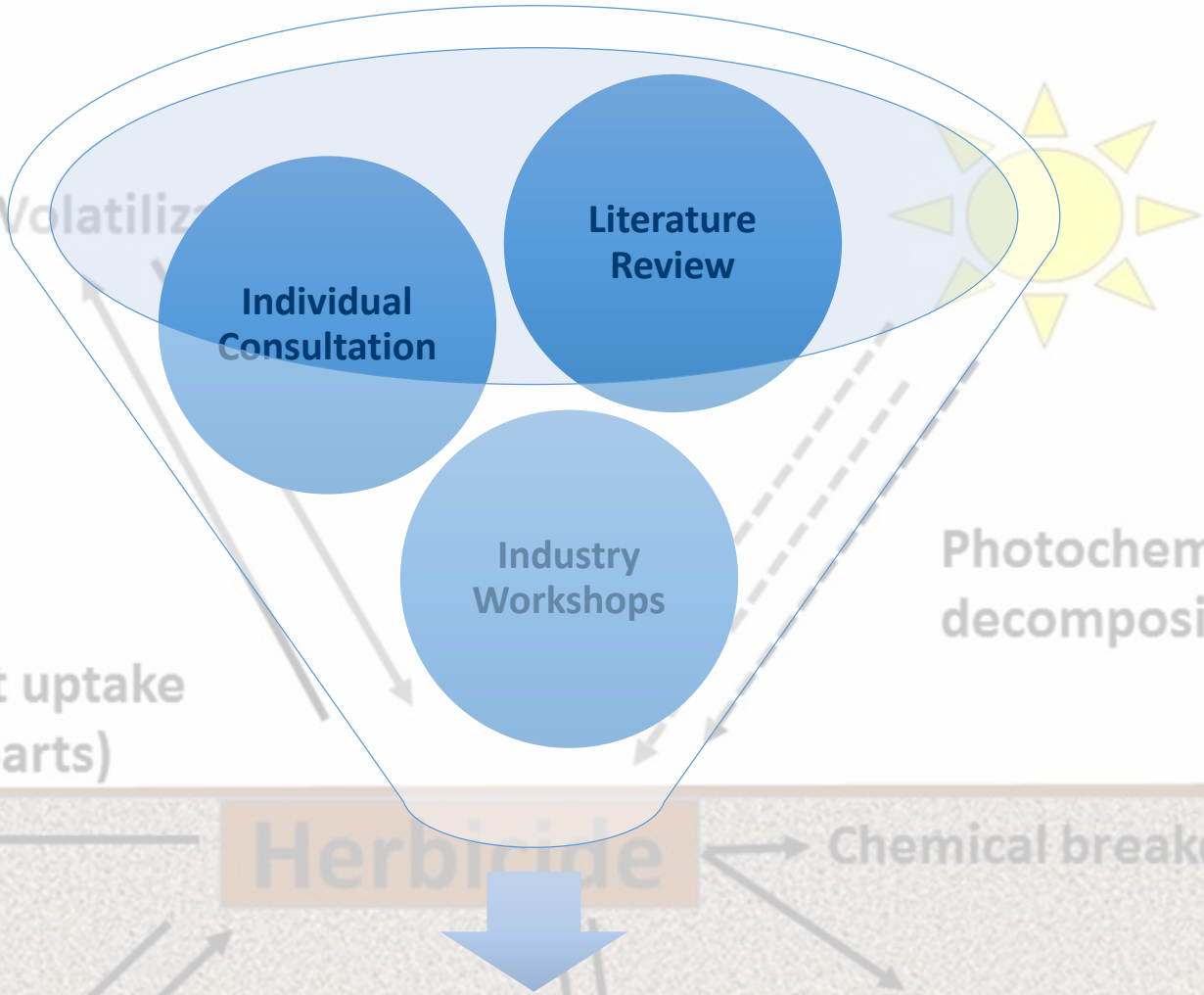
Where did we start?

Initial Objective:

To develop a collective understanding of the scope of sites impacted by soil sterilants and the specific challenges associated with their remediation and management.



Where did we start?



Outcome Orientated Conceptual Program Model

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Sterilants – Opportunity?

Increased emphasis on reducing liabilities

+

Ageing sites nearing their end of life

=

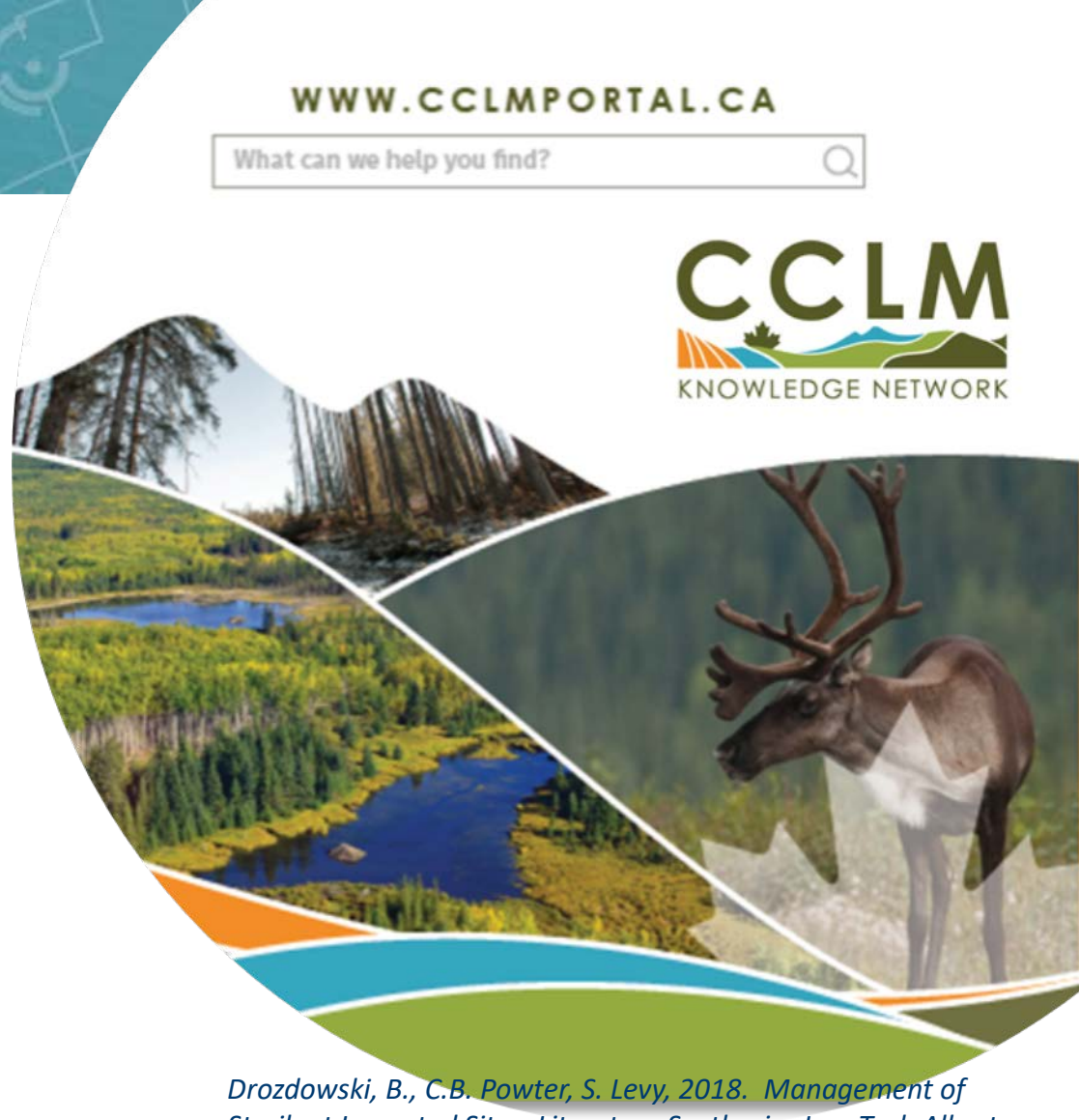
Opportunity to:

- **Synthesize past learnings, and**
- **Partner to develop strategies and methods to effectively manage sterilant impacted sites**

Synthesize Learnings

- Literature review and workshop summary provide an overview of:
  - physical and chemical properties,
  - persistence and fate in the environment,
  - ecotoxicological information,
  - regulatory guidelines,
  - applicable remediation technologies, and
  - operational challenges

associated with the 6 sterilants commonly screened for in Alberta



Drozdowski, B., C.B. Powter, S. Levy, 2018. Management of Sterilant Impacted Sites: Literature Synthesis. InnoTech Alberta, Edmonton, Alberta. 49 pp.

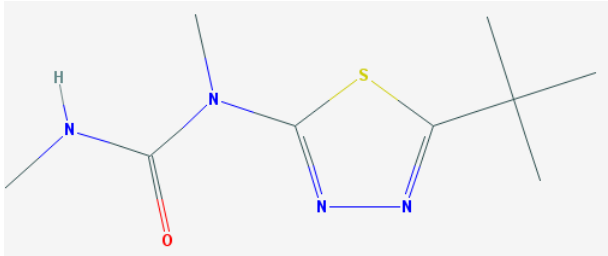
Drozdowski, B., S. Levy and C.B. Powter, 2018. Remediating Soil Sterilant-Affected Lands: Summary of Stakeholder Discussions. InnoTech Alberta, Edmonton, Alberta. 42 pp.

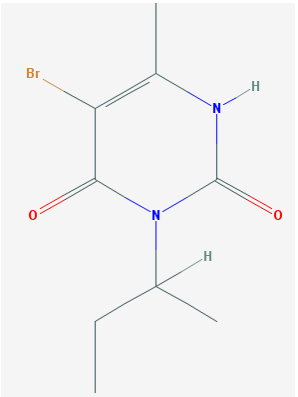
What did we learn?

- Majority of sterilant impacts in Alberta are associated with bromacil and tebuthiuron
- Sites are primarily located in central and southern Alberta
- Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AEP 2016) are conservative and based on data generated outside Alberta
- Lack of available information for use in risk assessment models.
- Remediation technologies have been successfully utilized to reduce or eliminate sterilant impacts – more research required for Alberta conditions and at larger scale

Sterilant	Lab 1±			Lab 2‡		
	Detection Limit (mg/kg)±	# Samples Analyzed in 2017	# of Exceedances in 2017	Detection Limit (mg/kg)	# Samples Analyzed in 2017	# of Exceedances in 2017
Bromacil	0.008	552	102	0.009	508	119
Tebuthiuron	0.005	400	38	0.001	508	9
Atrazine	0.005	400	2	0.009*	506*	17*
Simazine	0.02	400	0	0.01	508	1
Diuron	0.02	400	2	0.01	508	0

± HPLC/MS
‡ GC/MS or HPLC
*Atrazine + Desethyl-atrazine





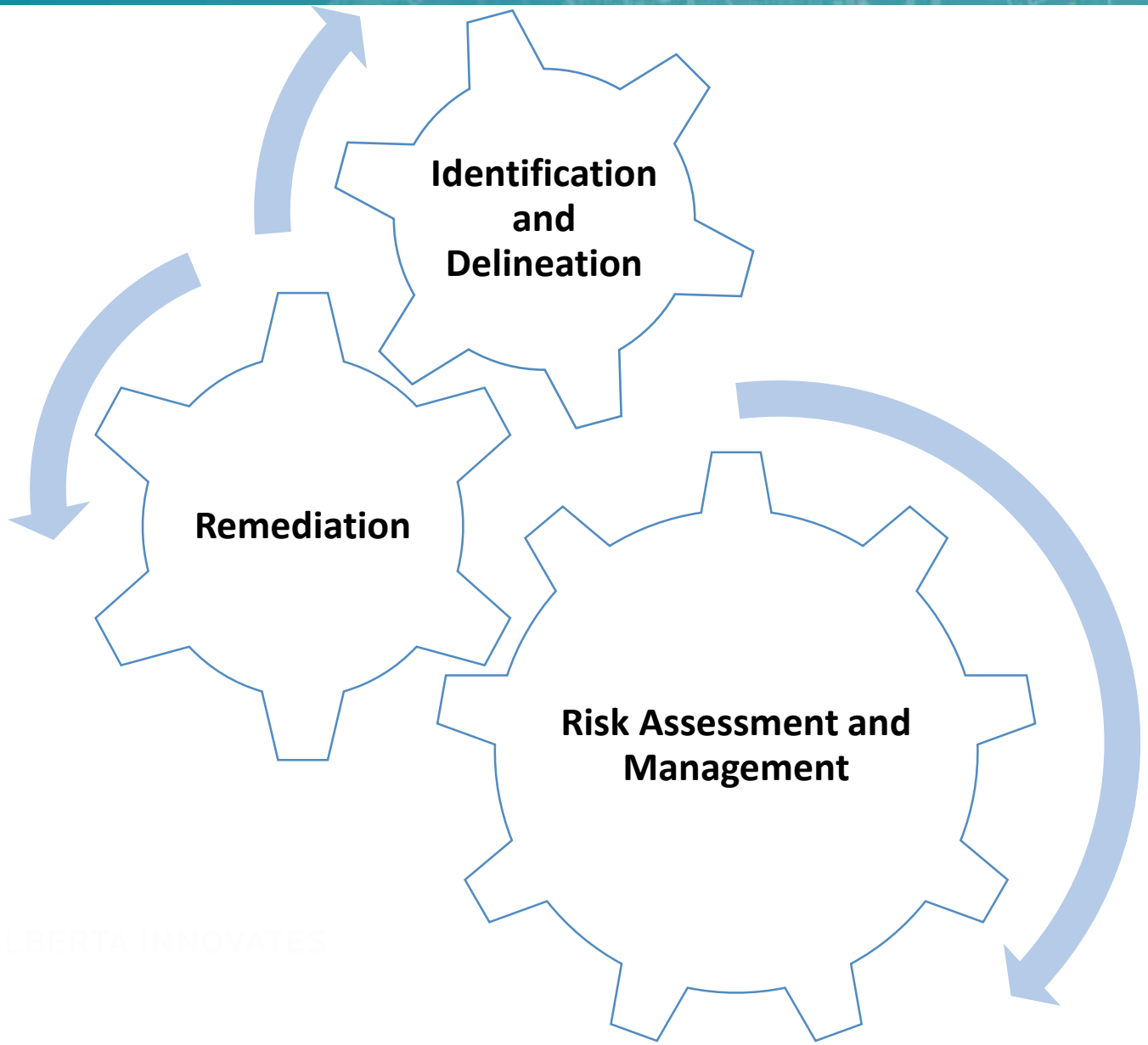
Sterilants – What is the Solution?

Sterilants Program

OBJECTIVE:

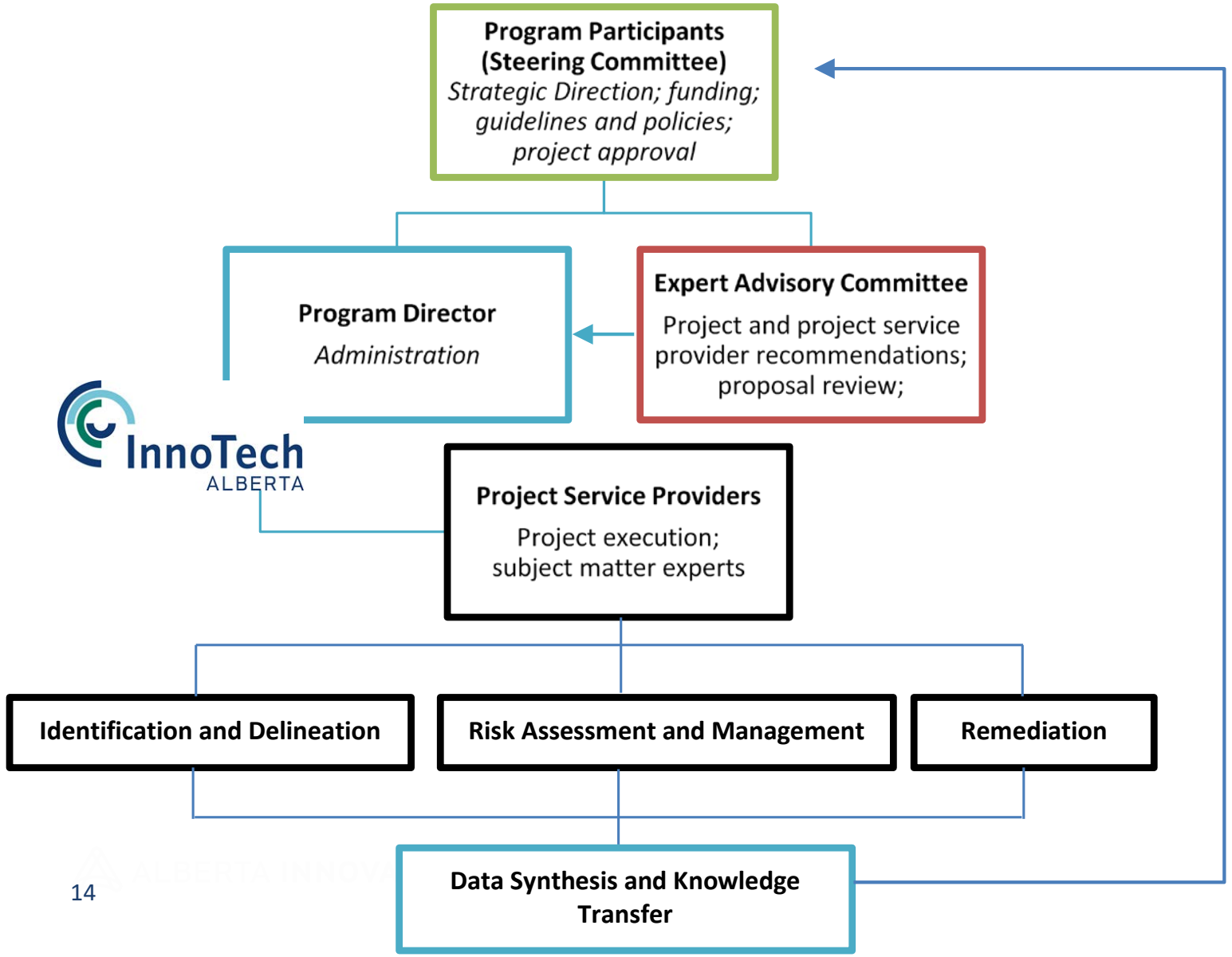
To establish proven, technical, and cost-effective strategies and best management practices for effective management of sites impacted by residual soil sterilants, with the goal of achieving regulatory site closure.

Sterilants – What is the Solution?



The KNOWLE DGE GAP

Sterilants Program



- 5 year Program
  - Initiated in 2019
- Scope
  - Address challenges specific to AB
  - Bromacil and tebuthiuron
- Structure
  - Program management and delivery agent – InnoTech
  - Steering Committee
  - Expert Advisory Committee
- Budget
  - $1.4M

Intended Outcomes

Program Area	Intended Outcome of the Program
Identification and Delineation	• The uncertainty associated with the methods used to identify when/where sterilant impacts occur is reduced.
Risk Assessment and Management	• Reduction of risk associated with empirical data inputs to risk assessment models for protection of ecological pathways. • Reduction of risk associated with sterilant re-activation after the use of immobilization technologies by demonstrating and quantifying their effectiveness with empirical data.
Remediation	• Optimal, state-of-the-art technologies and/or processes are demonstrated under Alberta conditions.
Knowledge Transfer	• Development and retention of a community of practice • Annual workshops and technical information dissemination

Series of Projects

Program Component	Project # and Title	
Identification and Delineation	1.	Decision Support Tool
	2.	Sampling Best Management Practices
	3.	Laboratory Method Investigation
	4.	Detection of Bioavailable Sterilants
	5.	Field Screening Technologies
Risk Assessment and Management	6.	Sterilant-Specific Model Input Data
	7.	Risk Assessment for Protection of Irrigation Water and Freshwater Aquatic Life
	8.	Investigating Sterilant Mobility in Alberta
	9.	Native Species Toxicity Evaluation
Remediation	10.	Investigation of Long-term Effects of Activated Carbon
	11.	Alternative Technical Approaches for Sterilant Immobilization
	12.	Remediation Demonstration(s)

Risk Assessment and Management Projects

Program Component	Project #	Project Initiation	Project Service Provider	Principle Investigator/Team
Risk Assessment and Management	6./8.	October 2019	Advisian Worley Group; Bureau Veritas; University of Guelph	Aaron Tangedal Adele Houston Barry Loescher Ryan Prosser
	7.	October 2019	Millennium EMS Solutions Ltd.	Cory Kartz Ian Mitchell
	9.	October 2019	InnoTech Alberta, A Subsidiary of Alberta Innovates	Sarah Thacker Bonnie Drozdowski

Identification and Delineation Projects

Program Component	Project #	Project Initiation	Project Service Provider	Principle Investigator/Team
Identification and Delineation	1.	March 2022	TBD	TBD
	2.	July 2020	TBD	TBD
	3.	March 2020	InnoTech ALBERTA A SUBSIDIARY OF ALBERTA INNOVATES	Alberto Pereira Julius Pretorius
	4.	April 1, 2020	UNIVERSITY OF ALBERTA	Jackie Maxwell, M.Sc. Candidate Sylvie Quideau
	5.	TBD (Soon)	VERTEX Environmental Inc. Specialized Contractors	Kevin French

Remediation Projects

Program Component	Project #	Project Initiation	Project Service Provider	Principle Investigator/Team
Remediation	10.	April 2020	UNIVERSITY OF ALBERTA; InnoTech ALBERTA A SUBSIDIARY OF ALBERTA INNOVATES	Jackie Maxwell, M.Sc. Candidate Sylvie Quideau Sarah Thacker
	11.	Q2 2020/21	TBD	TBD
	12.	Q1 2021/22	TBD	TBD

Projects #6/8 Sterilant-Specific Model Input and Mobility in AB

Progress to Date:

- Sensitivity analysis of Tier 1 and 2 Models to focus laboratory experiments
- Literature review of metabolites/breakdown products
- Experimental design under review

Laboratory Experiments using Alberta Soils:

- Estimate half-life
- Identify metabolites
- Estimate K_{oc} (water-organic carbon partition coefficient)

Sterilant Fate and Mobility:

- Historical data from sterilant contaminated sites supplemented by additional data collection
- 51 contaminated sites with available data identified – targeted sampling and soil collection at 3 sites in 2020

Advisian
Worley Group

BUREAU VERITAS

UNIVERSITY of GUELPH

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Project #7 Risk Assessment for IW and FAL

Four Tasks:

1. Tier 1 model evaluation – on-going
2. Alternative model evaluation – on-going
3. Risk Matrix development
4. IW and FAL guideline development

General findings to-date:

- More recent aquatic toxicity data has limited application to Alberta conditions
- Potential opportunities for adjusting “chemical-specific” parameters used in guideline derivation based on available literature – ensure Alberta relevance

MILLENNIUM
EMS Solutions Ltd.

Project #9 – Phytotoxicity Evaluation

- Data from acute testing will be used to inform sterilant concentrations for definitive tests (Env. Canada Protocols)
- Measurements included shoot height for each living plant
  - Bromacil completed early – March
  - Tebuthiuron will wrap up mid – March
- Preliminary results
  - Germination not greatly impacted by ↑ concentrations
  - Toxicity ↑ over time
  - Various concentrations that were not lethal after 3 weeks, were found to be lethal after 6 weeks

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What's Next?

- Initiation of remaining projects
- Annual workshop (beginning in March 2021)
- Knowledge synthesis and dissemination (www.cclmportal.ca)

Photo Credit:
Nichols Environmental

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Thank you.

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