Integration of Sustainable Development into Contaminated Sites Management

ARC2010 Oct 27-29, 2010 - Halifax, NS

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Outline of the Presentation

- Sustainable Development (SD) and Engineering Projects
- Site Remediation and SD
- Golder Associates Sustainability Decision Support Tool GoldSET©
- Case Studies (PWGSC/EC Sustainability Decision Support Tool for Site Remediation (« SDST »))
- Conclusion

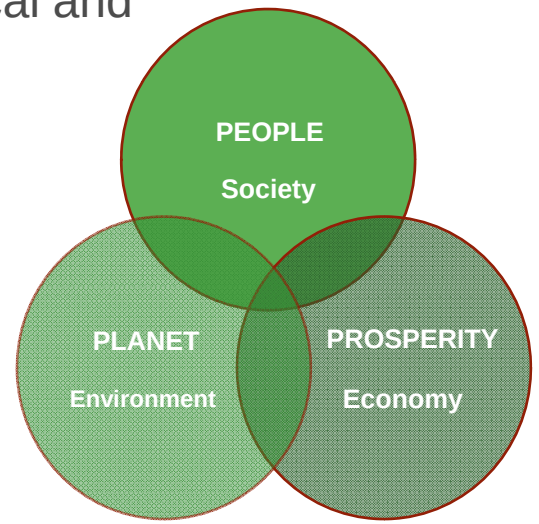
Sustainable Development and Engineering

Sustainable Development (SD):

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
(Our Common Future, WCED, 1987)

SD: the answer to everyone facing the global ecolological and social urgency :

- Climate changes
- Rarefaction of natural resources
- Gap between developed and underdeveloped countries
- Drastic lost of biodiversity
- etc.



It's about maintaining the delicate balance between Profit, People and Planet:
the new corporate Triple Bottom Line

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Sustainability & Remediation

SD principles are increasingly integrated into various types of engineering projects (Green Road, Green Mining, Green Remediation, etc.)

Multiple forums, groups and agencies are working on the application of sustainability principles in remediation :

- Europe
  - CLARINET (« Contaminated Land Rehabilitation Network for Environmental Technologies »)
  - NICOLE (« Network for Contaminated Land in Europe »)
  - EuroDemo (« European Platform for Demonstration of Efficient Soil and Groundwater Remediation »)
  - SURF (« Sustainable Remediation Forum ») – USA & UK
- USA
  - U.S. EPA – Green Remediation
- Canada
  - CIRAIG (Interuniversity Research Centre for the Life Cycle of Products, Processes and Services)

M7

M7 à traduire....

Montreal-Golder, 27/04/2010

GoldSET© (Golder Sustainability Evaluation Tool)

- Created in 2007, GoldSET© was originally designed to integrate and operationalize the SD principles in remediation projects
- GoldSET was designed to bring Sustainable Development at the operational level so that organizations can "**Walk the Talk**"
  - Addresses the evaluation of the "Triple Bottom Line": Economic, Social and Environmental
  - Transparent decision process for stakeholders, investors and regulators alike
  - Provides a quantitative and qualitative evaluation
    - Measures direct and collateral impacts and benefits
    - Efficient and effective decisions
    - Easy to communicate and understand
  - Tailored to the organization undertaking the activities
  - Balanced, impartial and comprehensive, yet simple to use
  - Reduces overall economic impacts through optimization

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GoldSET© : Sustainability Evaluation Tool

Project Description

- Objective(s) Definition
- Site Specific M11
- Conceptualization of Site Conditions
- Stakeholder mapping

Options Description

- Fatal Flaw Analysis:
  - Objectives M12
  - Cost
  - Duration
  - Technical
  - Legal

Indicators M13

Strategic Issues:
- Environmental
- Social
- Economics

Rigorous Selection process:
e.g. GEMI *Metrics Navigator*™

Linking to Stakeholders through:
- International Standards & Best Practices
- Corporate Objectives
- Legal Requirements

Scoring

Quantification of Indicators:
- Specific to Client Requirements

Evaluation of Options based on "Triple Bottom Line":
- Eco-efficiency
- Cost Benefit Analysis
- Stakeholder Concerns

Structured System for Ranking Options:
- Tailored Scoring & Weighting
- Ternary Diagrams

Interpretation & Reporting

OPTION A
OPTION B
OPTION C
OPTION D

Recommendations to support decision making:
- Tangible
- Transparent
- Optimized

Automated Reporting

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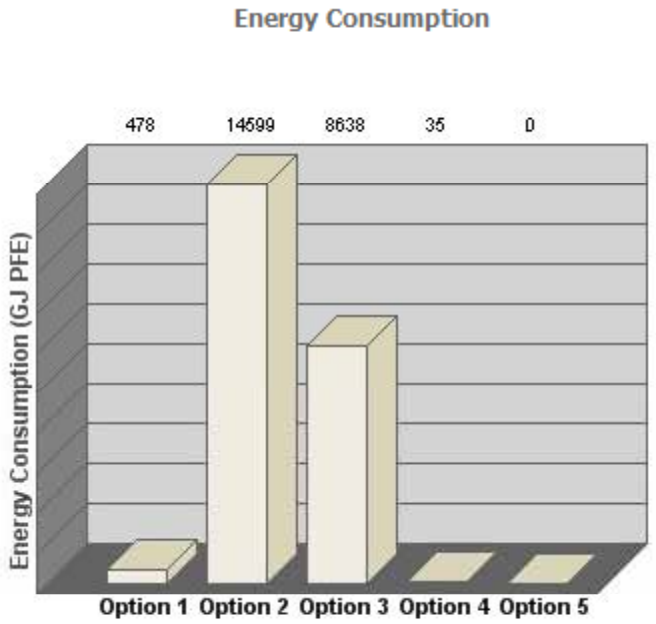
Slide 6

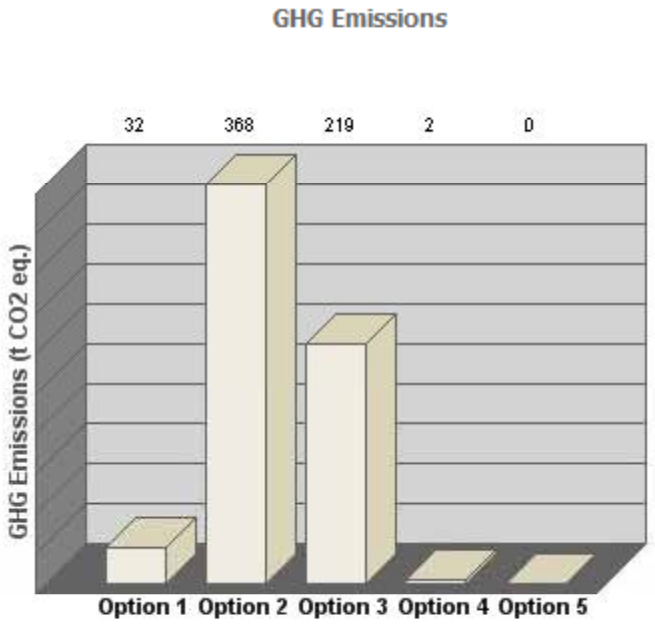
M11 Most important
Montreal-Golder, 30/06/2010

M12 Traditionnal criteria by which we used to evaluate our projects. They are used as a pre-screening.
Montreal-Golder, 30/06/2010

M13 They are your decision criteria that you use to assess the impact of your options
Assessment only as good as the choice of the indicators. The selection process is hence critical for the analysis.
Montreal-Golder, 30/06/2010

GoldSET© : Quantitative Indicators





- Energy & GHG emissions are estimated with the GoldSET© module
- All quantitative indicators ($, t CO2 e, KWh, water usage …) can be compared through normalization
- Can be customized to meet an organization's specific requirements

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Actionable Result Output

- The best approach from a sustainability standpoint is based on:
  - The biggest, most balanced triangle.
  - Highest performance in each dimension
  - Balanced performance between all dimensions
  - Local specificities must be considered in selecting the option

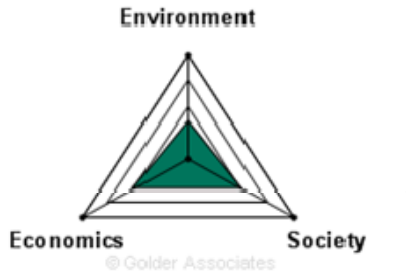
Interceptor Sumps

ENVIRONMENT	27%
SOCIETY	71%
ECONOMICS	34%

Project Cost : $ 488.767.00
Project Duration : 10 years

Interceptor Trench

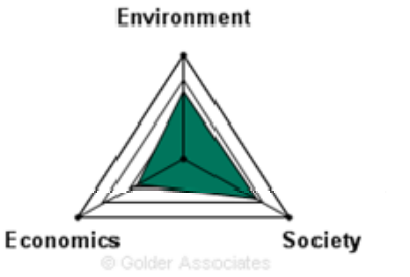
ENVIRONMENT	36%
SOCIETY	50%
ECONOMICS	51%



Project Cost : $ 591.084.00
Project Duration : 15 years

MPE (Multi-Phase Extraction)

ENVIRONMENT	64%
SOCIETY	67%
ECONOMICS	44%



Project Cost : $ 803.263.00
Project Duration : 10 years

GoldSET© - www.gold-set.com

Login page

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Case Study #1: GoldSET Adapted to CN's Needs

Adaptability of GoldSET© to CN requirements for contaminated site planning across North America

- **CN's requirements :**
  - Measuring sustainability of a project
  - Balanced, impartial and comprehensive, yet simple to use
  - Transparent decision tool
  - Tailored to their activities
  - Measure direct and collateral impacts and benefits
  - Reduce overall economic impacts through re-engineering

Case Study #1: GoldSET Adapted to CN's Needs

The GoldSET-CN-SR :

- Decision Support Tool based on MCA (Multi-criteria analysis)
- Semi-quantitative (qualitative & quantitative)
- Several quantitative indicators (GHG, energy, water, waste, etc)

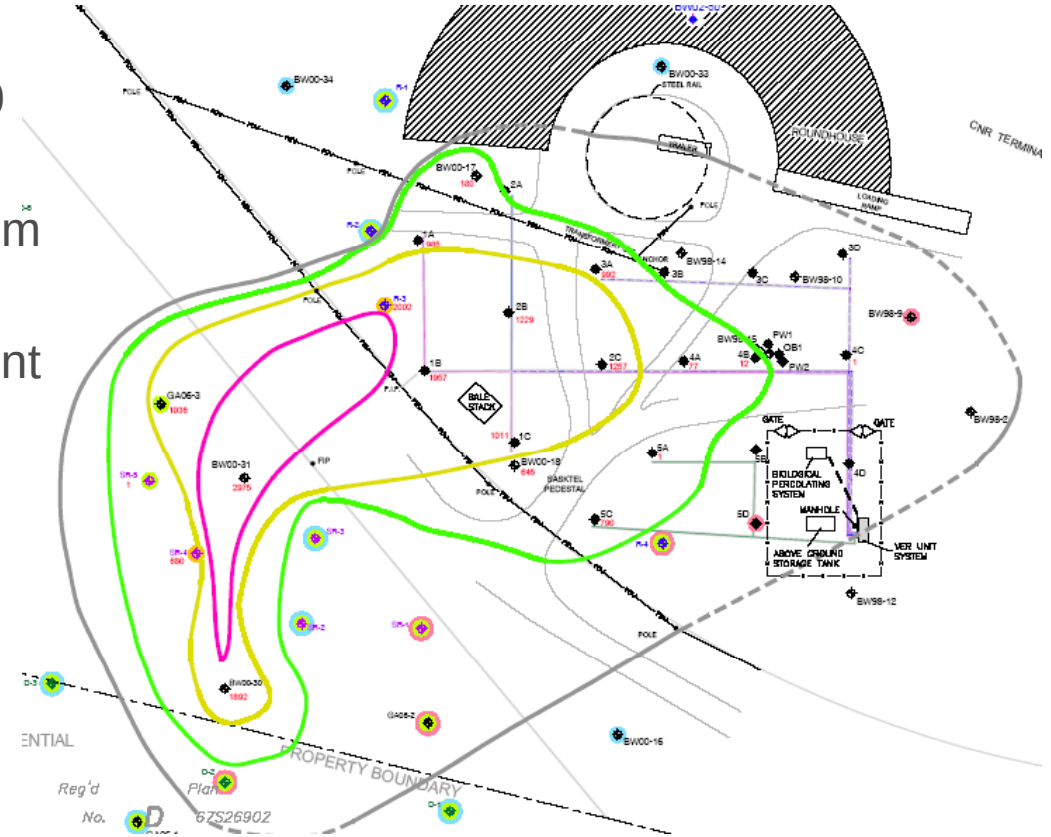
Indicators developed from:

- Global Reporting Initiative (GRI, 2006)
- FIDIC "Project Sustainability Management" guide (PSM, 2004)
- Office for Rail Regulation (ORR) – UK
- Railway Association of Canada (RAC)
- CN documents

Case Study #2: Site in Western Canada

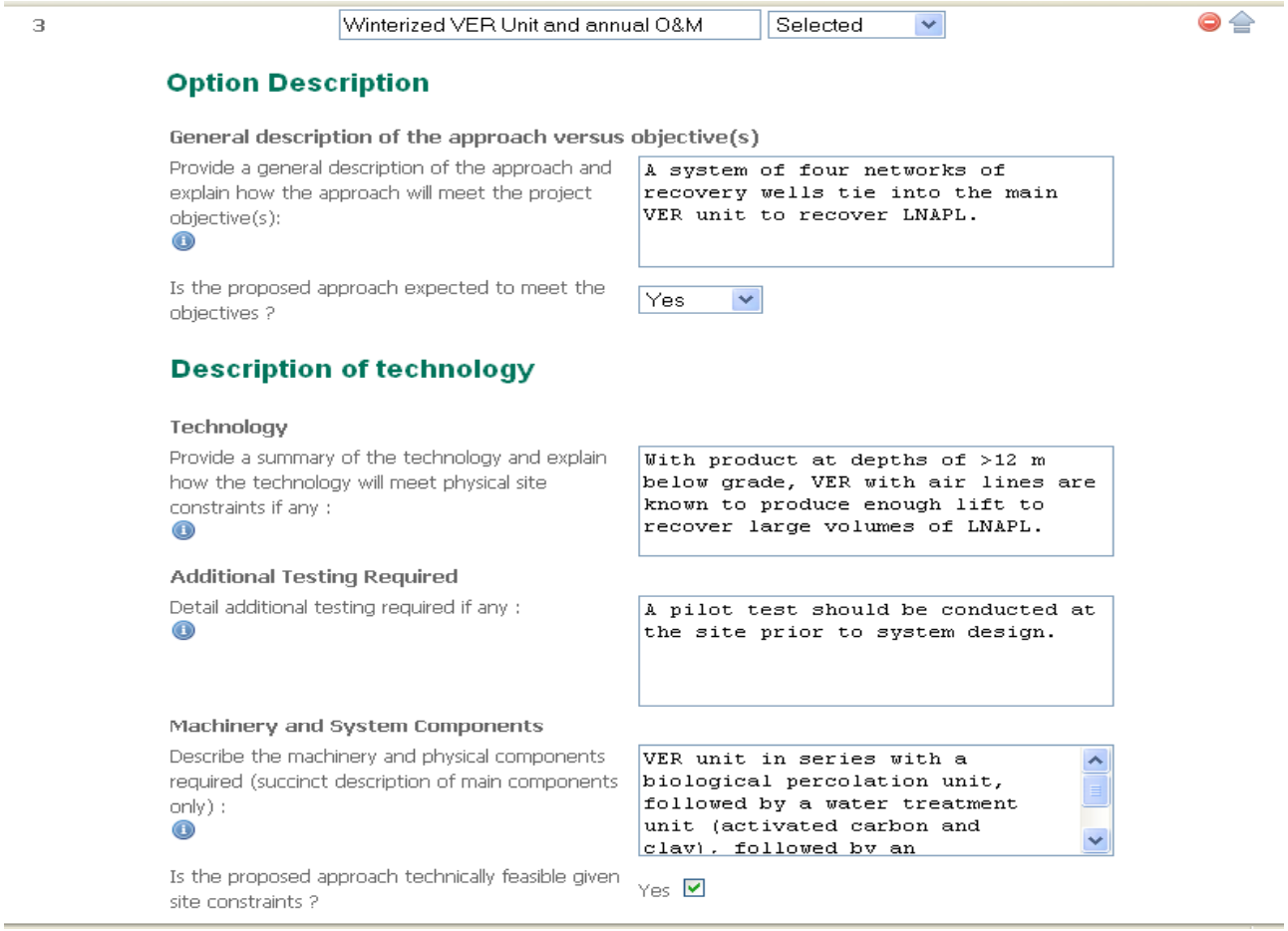
Conceptual model:

- Approx. ½ million litres of weathered diesel in subsurface
- LNAPL thicknesses vary from 0 to 3 m in places
- Depth to product approx.16-18 m below grade
- Dissolved phase impacts present above guideline.
- Silty sand, fine to medium grained
- Plumes appear to be migrating toward site boundary



Case Study #2: Site in Western Canada

Step 2 : Option Definition



Options:

- Recovery trench at property boundary & pump product
- Pump and treat to prevent offsite migration
- Winterized VER unit and annual O&M
- Natural attenuation and monitoring

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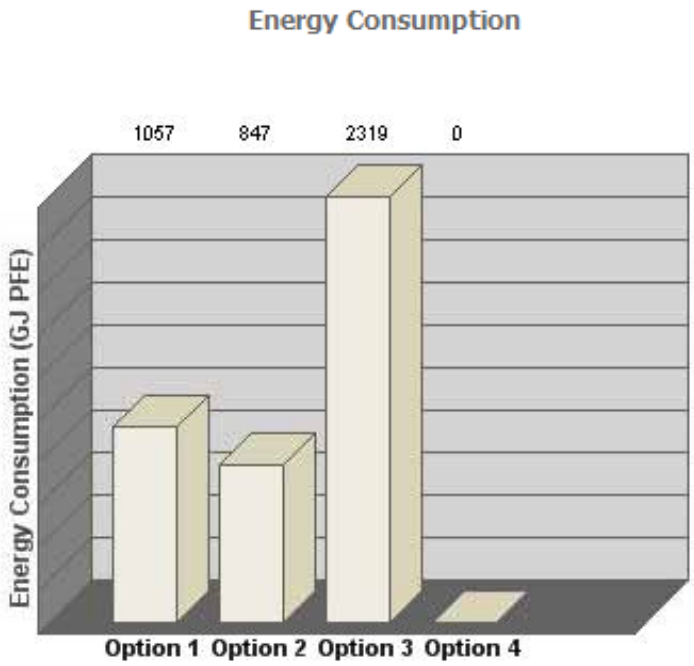
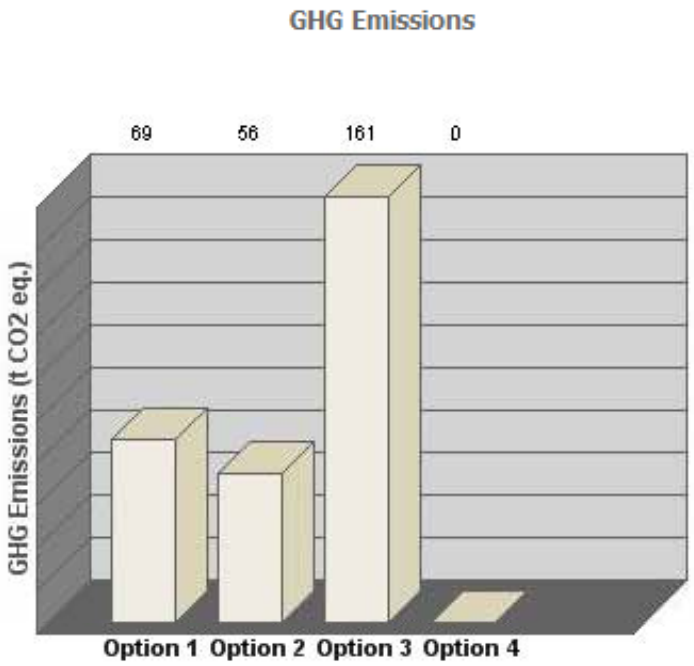
Case Study #2: Site in Western Canada

Step 4 : Scoring – Quantitative (GHG&Energy) - Environmental Aspect





Quantitative Indicator

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Case Study #2: Site in Western Canada

Step 4 : Scoring – Qualitative/Quantitative - Environmental Aspect

Environmental Aspect						
Code	Indicator	Recovery Trench at property boundary&pump product	Pump and Treat prevent offsite migration	Winterized VER Unit and annual O&M	Natural attenuation and monitoring	Weight
ENV-1	Soil Quality	0	50	50	0	1
ENV-2	Groundwater Quality	0	90	100	0	2
ENV-3	Free Product	50	90	100	0	3
ENV-4	Surface Water Quality	0	0	0	0	1
ENV-5	Off-Site Migration	0	50	100	0	3
ENV-6	Greenhouse Gas Emissions	40	48	0	100	1
ENV-7	Energy Consumption	37	47	0	100	1

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Case Study #2: Site in Western Canada

Step 4 : Scoring – Qualitative/ Quantitative – Social Aspect

Code	Indicator	Recovery Trench at property boundary&pump product	Pump and Treat prevent offsite migration	Winterized VER Unit and annual O&M	Do Nothing	Weight
SOC-1	Public Safety	0	50	100	0	2
SOC-2	Worker's Safety	0	50	50		2
SOC-3	Duration of Work	0	0	100	0	1
SOC-4	Quality of Life (During the Project)	100	100	100	0	1
SOC-5	Reuse of the Property by the Corportation	50	50	100	0	1
SOC-6	Use for the Public	50	50	100	0	1
SOC-7	Cultural Heritage	0	0	100	0	1
SOC-8	Local Job Creation and Diversity	0	100	100	0	1
SOC-9	Response to Social Sensitivity	50	50	100	0	1
SOC-10	Standards, Laws and Regulations	50	50	100	0	1
SOC-11	Impact on the Landscape	50	50	50	150	1
SOC-12	Management Practices	50	50	100	0	1
Economic Aspect						

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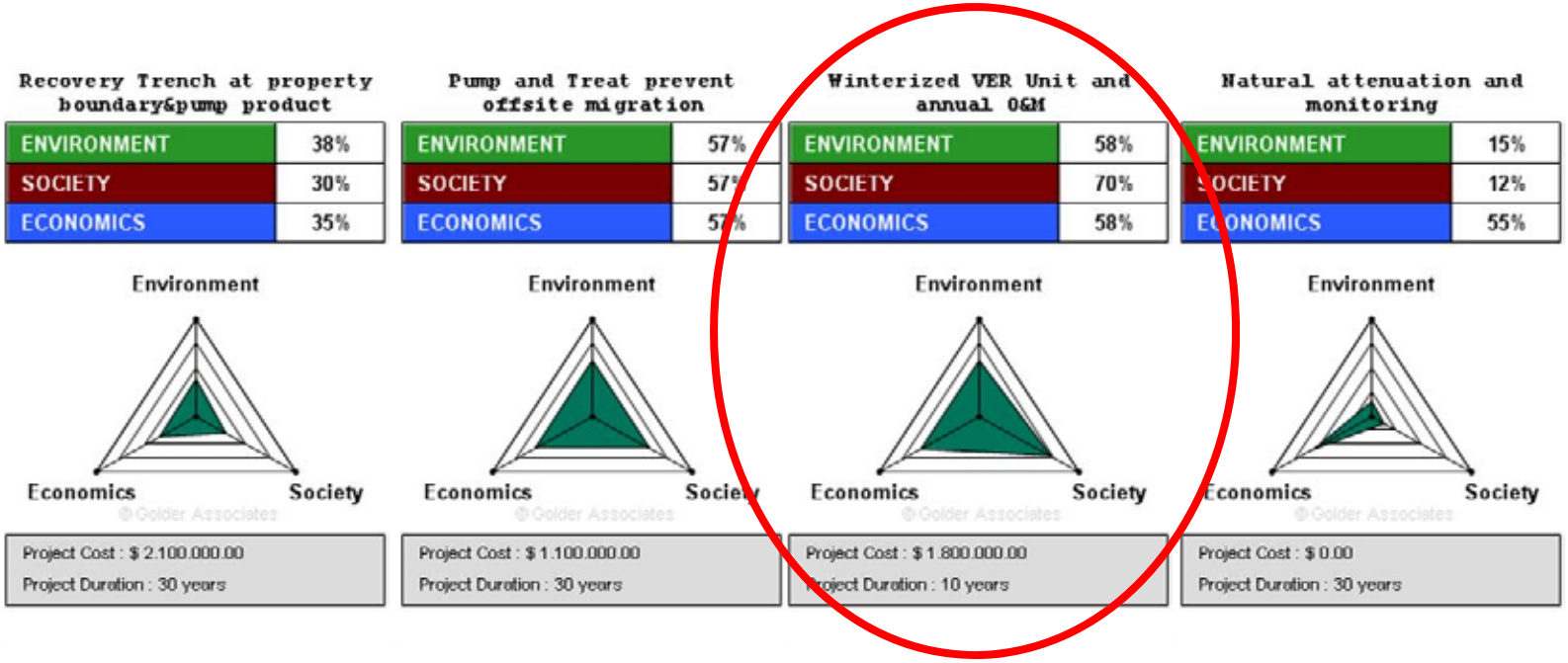
Case Study #2: Site in Western Canada

Results



- VER option optimizes environmental, social and economic aspects
- VER is technically feasible – objectives are met with this option
- Transparent and visual - efficient reporting

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Case Study #3 PWGSC/EC Sustainability Decision Support Tool for Site Remediation – (SDST)

Exploratory project for the management of federal contaminated sites – Golder was mandated by Public Works and Government Services Canada (PWGSC) and Environment Canada (EC), to develop their own sustainability evaluation tool : SDST

- Strategies surrounding the SDST
  - Increase the federal contaminated site manager's awareness on SD issues
  - Increase understanding of SD to help sound decision making
  - Facilitate the communication of issues with the different stakeholder
- Objectives of the SDST
  - Adjust the first generation tool following consultations with TPSGC/EC
  - Be based as much as possible on consulted works from the literature review
  - Be simple and flexible for use by managers of contaminated sites
  - Allow a qualitative technology evaluation founded on generic and semi-generic indicators
  - Include a methodology to allow consideration of indicators systematically during an evaluation

Case Study #3 PWGSC/EC Sustainability Decision Support Tool for Site Remediation – (SDST)

Development Process of the SD Assessment Tool for the Management of Federal Contaminated Sites

GoldSET©

- A decision-making support tool developed by Golder Associates to integrate SD principles into engineering projects by allowing a comparison between different environmental remediation scenarios with regards to the SD aspects:
  - Environmental
  - Social
  - Economic
- Used commercially since 2007 in Canada, the United States, and Australia

Discussions between Golder Associates, PWGSC, and Environment Canada

Federal Government SD Assessment Tool

First Generation

- A literature review supporting the selection of indicators (qualitative and quantitative) and SD aspects
- The adaptation of the GoldSET© remediation module to comply with the Federal Government's requirements
- The development of the tool to compare five technologies:
  - Pump and treat
  - *In situ* bioremediation
  - *In situ* chemical oxidation
  - Excavation and disposal
  - Multiphase extraction
- A simplified Life Cycle Analysis to quantify indicators:
  - Water Consumption
  - GHG Emissions
  - Energy Consumption
  - Solid Waste
  - Traffic

- Validation workshops by PWGSC/EC
- Identification of characteristics for the tool's second generation

Second Generation

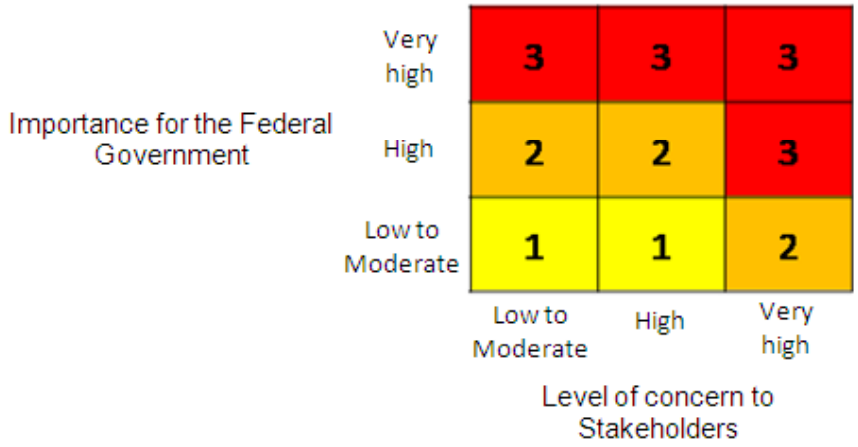
- A revisit of the literature review to support the creation of the indicators' evaluation schemes
- The modification of the tool's 1st generation to improve the comparison method of remediation technologies
- An additional eight technologies are added to the tool:
  - Phytoremediation
  - Excav. and soil washing
  - Excav. and *ex situ* thermal desorption
  - Permeable reactive barrier
  - Excav. and *ex situ* chemical oxidation
  - Natural attenuation
  - Excav. and landfarming
  - Excav. and biopiles
- The analytical process is simplified based on qualitative indicators only (except for costs)
- The creation of a weighing module to help the assessment of technology performances with regards to the perspectives of stakeholders and the federal government

Case Study #3 PWGSC/EC Sustainability Decision Support Tool for Site Remediation – (SDST)

The second generation tool includes different types of indicators:

Type	Evaluation Scheme	Description	# of Indicators
Quantitative	Normalized	When quantitative values are known, they are compared the other options in order to obtain a value between 0 and 100 (100 being the best option).	1
Qualitative	Generic	Generic indicators receive a score of 0, 33, 66, or 100, depending on the technology`s efficiency, but independently of site-specific characteristics. The scores of the generic indicators are found in the *Reference (1)* tab.	18
	Semi-generic	Based on site-specific characteristics specified in the *Site Description* tab, semi-generic indicators receive a score of 0, 50, or 100, depending on the technology's efficiency. The scores of the semi-generic indicators are found in the *Reference (2)* tab.	4
	Custom	The custom scoring scheme is indicator-specific and is used to incorporate some indicators in the assessment. A good understanding of the technology, the project and its context is required to choose the appropriate score.	10

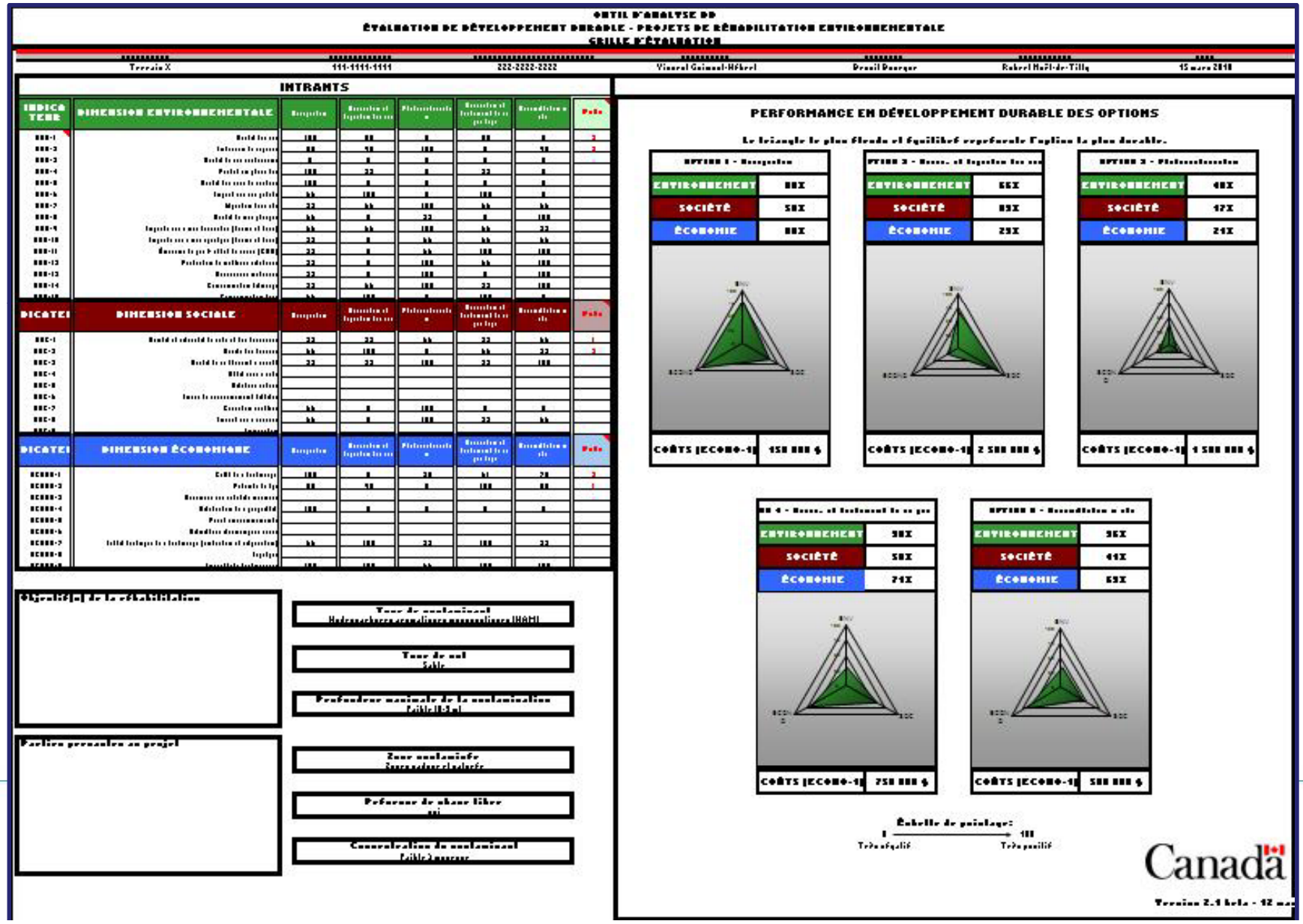
Case Study #3 PWGSC/EC Sustainability Decision Support Tool for Site Remediation – (SDST)



Weighting module

INDICATOR	FEDERAL GOVERNMENT (IMPORTANCE)	STAKEHOLDERS (LEVEL OF CONCERN)	COMMENTS / JUSTIFICATIONS	WEIGHT
ENVIRONMENTAL ASPECT				
Semi-generic	High	Low to Moderate		2
Soil Quality: ENV-1	The indicator is related to an objective of the Federal Government's SD strategy	Stakeholders acknowledge the issues associated with the indicator but do not consider it important in the context of the project		
Applicable				

Case Study #3 PWGSC/EC Sustainability Decision Support Tool for Site Remediation – (SDST)



Case Study # 4 : Study of Alternatives to Off-site Disposal of Contaminated Soils, Pickering Lands Site, ON

- It would have been interesting to compare the results of the Pickering study with the 2nd Generation PWSGC/EC SDST

- However, this was not possible because:
  - This version of the tool is currently in a pilot-testing phase
  - It does not yet allow the evaluation of combined remediation technologies as proposed for the Pickering project. (e.g.: Option 2a – On-site Landfill, Stabilization and Bioremediation or Option 3 – Bioremediation and Disposal)

- This is planned in the next development phase of the tool.

Government of Canada Gouvernement du Canada
Canada
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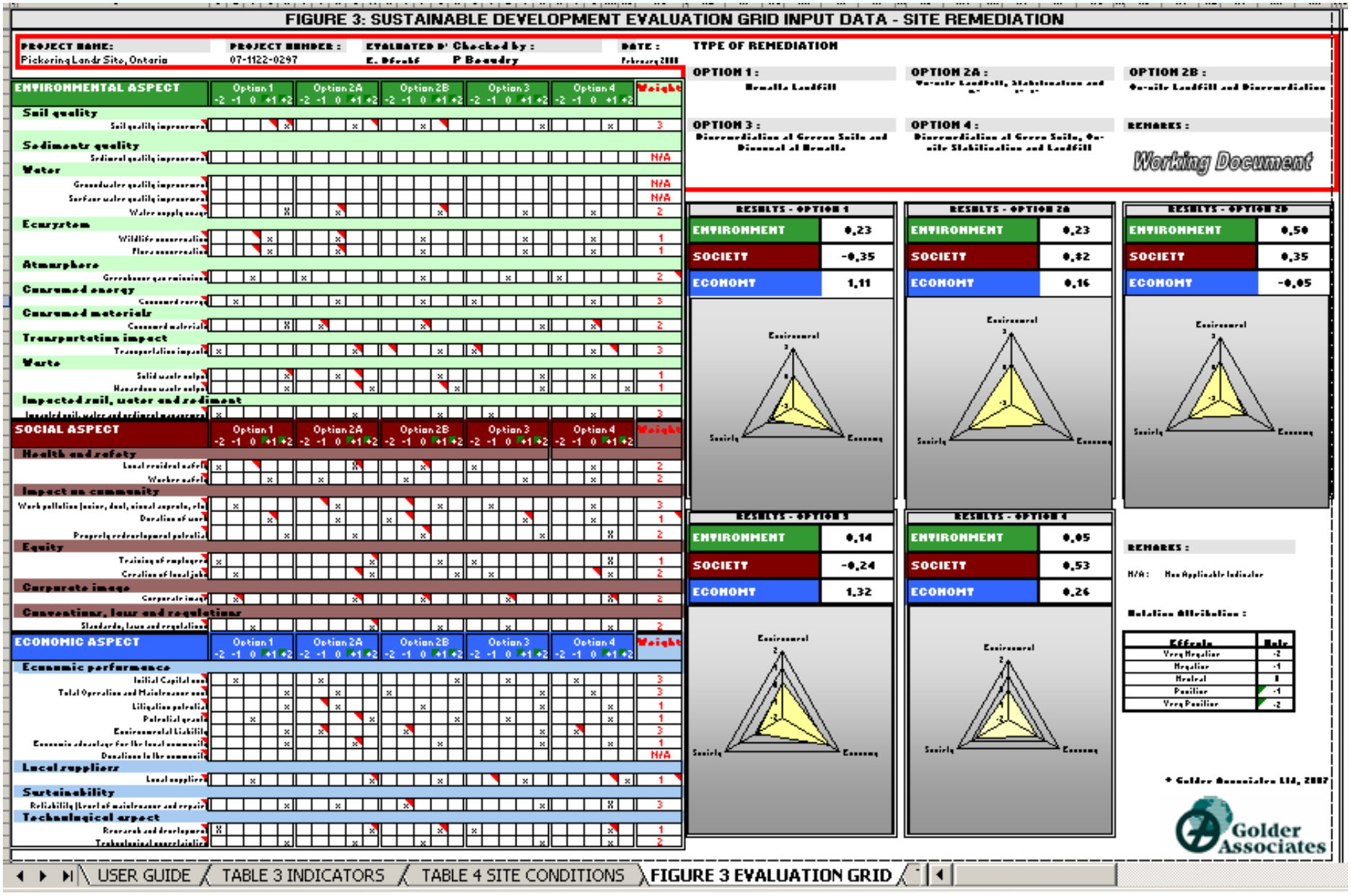
Case Study # 4 : Study of Alternatives to Off-site Disposal of Contaminated Soils, Pickering Lands Site, ON

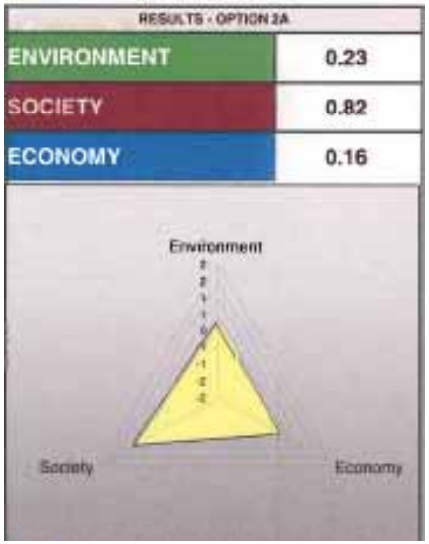
- Mandate PWGSC Environmental Services, on behalf of Transport Canada
  - Approximately 200 properties with environmentally impacted soils:
    - Petroleum hydrocarbons and BTEX (2,000 tonnes);
    - Metals (12,000 tonnes); and,
    - Combined PHC, BTEX and metals (1,500 tonnes)

Remedial Options	Component to Address PHC and BTEX	Component to Address Metals
1	Off-site disposal at landfill	Off-site disposal at landfill
2A	On-site Biopile	Stabilization and on-site Landfill
2B	On-site Biopile	On-site landfill without stabilization
3	Off-site disposal at Bioremediation facility	Off-site disposal at landfill
4	Off-site disposal at Bioremediation facility	Stabilization and on-site landfill

Case Study # 4 : Study of Alternatives to Off-site Disposal of Contaminated Soils, Pickering Lands Site, ON



Case Study # 4 : Study of Alternatives to Off-site Disposal of Contaminated Soils, Pickering Lands Site, ON



Option 2a (On-site Stabilized Landfill) is the Most Sustainable Option:

- Highest scores
- Most well balanced
- Net positive impact on the three dimensions of SD

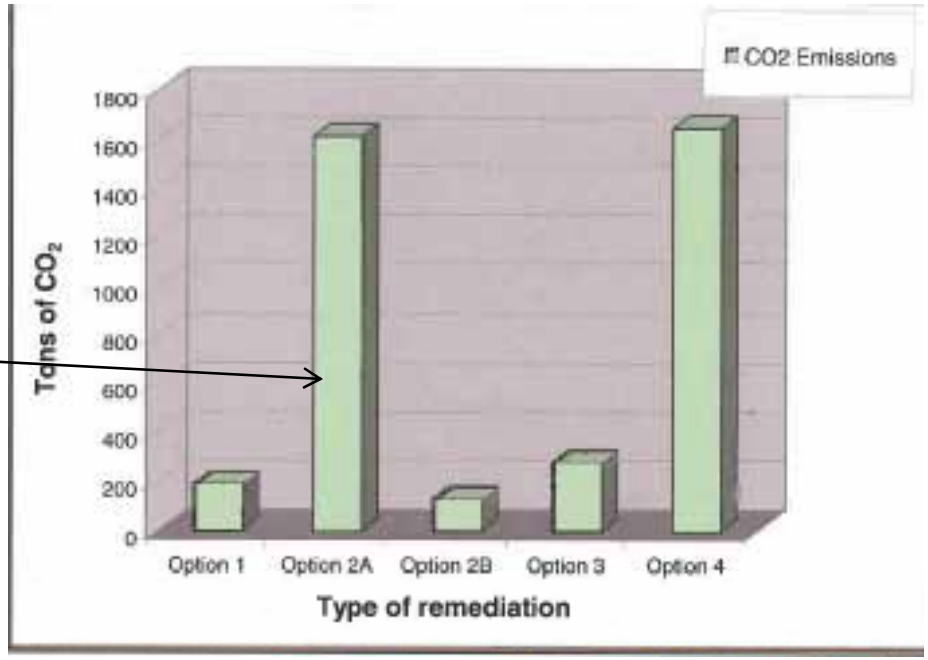
MAIN NEGATIVE EFFECTS	
Greenhouse Gas Emissions	-2
Consumed Material	-1
Worker Safety	-1
Initial Capital Cost	-1
Environmental Liability	-1

MAIN POSITIVE EFFECTS	
Soil Quality Improvement	+1
Transportation Impact	+1
Hazardous Waste Output	+2
Local Resident Safety	+1
Economic Advantage for Local Community	+1
Research and Development	+1

Effects	Note
Very Negative	-2
Negative	-1
Neutral	0
Positive	+1
Very Positive	+2

Case Study # 4 : Study of Alternatives to Off-site Disposal of Contaminated Soils, Pickering Lands Site, ON

Main negative effect of the option is the GHG emissions (1600 tonnes of CO_2 eq.)



- This option would be more sustainable if mitigation measures were introduced (carbon sequestration)
  - Ex: Planting trees over an area in an order of magnitude of 15 hectares (0.2 % of the total area of PLS) could sequester CO_2 emissions from cement over the 15-year lifetime of the stabilized landfill.

Conclusion

- Use of SDT help contaminated site managers introduce Sustainable Development (SD) principles into their activities by assessing the potential environmental, social and economic impacts of different approaches.

- GoldSET© :
  - Structures the decision-making process
  - Provides transparent decision making and simplifies an abstract concept
  - Helps manage business risk (highly adaptable to organizations)
  - Re-engineering & optimization
  - Positive corporate image
  - Good communication tool for impacts & benefits

- The PWSGC/EC SDST is currently in a pilot-testing phase and should be ready very soon for the use of the Federal managers

- The case studies have shown the benefits of integrating SD principles in remediation projects; the use of SDT helps structure the integration of SD principles into remediation projects.

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- Performance and Efficiency
- Responsible Development
- Sustainable Communities

Questions?

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