GoldSET©-CN-SR: An Innovative Sustainable Development Decision Support Tool Adapted to CN's Needs

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Overview

- What is GoldSET-CN-SR?
- Case Studies
  1. Site in Western Canada, migration of free-phase diesel towards site boundary
  2. Impacted yard with potential for off-site impacts from diesel in fractured bedrock
- Conclusions

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GoldSET : Integrate SD at the Project Level

GoldSET

A Sustainability Support Decision Tool developed by Golder Associates to help project managers and engineers:

1. **Embed the Triple Bottom Line principles at the project planning level (bottom-up approach)**

2. **Manage conflicting pressures from various stakeholders**

1. **Make transparent and impartial decisions**

2. **Reduce the overall economic impacts through optimization**

GoldSET-CN-SR

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

WORDS OF PRAISE FROM CN

"In addition to structuring our decision process, GoldSET-CN-SR provides a transparent communication tool that we believe will demonstrate our commitment to engage with our stakeholders when planning a remediation activity. And most importantly, the tool is designed to help us optimize our decision process and lead to better design and cost reductions."

https://cn.gold-set.com

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GoldSET-CN-SR

- GoldSET-CN-SR has been used in Canada and the United States in different sector of activities - used on multiple sites across North America for remediation projects

- The GoldSET-CN-SR is accessible by all CN's consultants working on their sites

- CN's Terms and Conditions for site remediation now require the use of GoldSET©-CN-SR

- A new "Footprinter" has been incorporated in the GoldSET tool in August 2011.

- A GoldSET©-CN-WT (Wastewater Treatment) is in development - Partnership between CN/Golder/ Concordia University

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GoldSET-CN-SR

MCA THAT MEASURES THE IMPACTS WITH INDICATORS

- Multi-Criteria Analysis Tool (MCA) :
  - Structured system for ranking alternatives
  - Score from 0 to 100 and weight from 1 to 3
  - Results are given by triangular representations

  - Indicators related to three dimensions:
  - Environmental
  - Social
  - Economical

- Indicators developed from:
  - Global Reporting Initiative (GRI, 2006)
  - FIDIC “Project Sustainability Management” guide (PSM, 2004)
  - CN Environmental Policy documents

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GoldSET-CN-SR - List of indicators in the tool

ENVIRONMENTAL ASPECT

- Soil Quality
- Sediment Quality
- Groundwater Quality
- Surface Water Quality
- Water Usage
- Soil Vapour Intrusion
- Free Product
- Drinking Water Supply
- Off-Site Migration
- Short and Long Term Impacts on Biodiversity and Species Status
- Short and Long Term Impacts on Habitat and/or Land Use
- Greenhouse Gas Emissions
- Energy Consumption
- Wastes
- Hazardous Wastes

SOCIAL ASPECT

- Public Safety
- Worker's Safety
- Duration of Work
- Quality of life (During the Project)
- Reuse of the Property by the CN
- Use for the Public
- Cultural Heritage
- Local Job Creation & Diversity
- Response to Social Sensitivity
- Standards, Laws & Regulations

ECONOMIC ASPECT

- Net Present Value of Options' Costs
- Potential Litigation
- Financial Recoveries
- Environmental Reserve
- Train Service Reliability & Performance
- Economic Advantages for the Local Community
- Reliability (Maintenance and Repair)
- Technological Uncertainty

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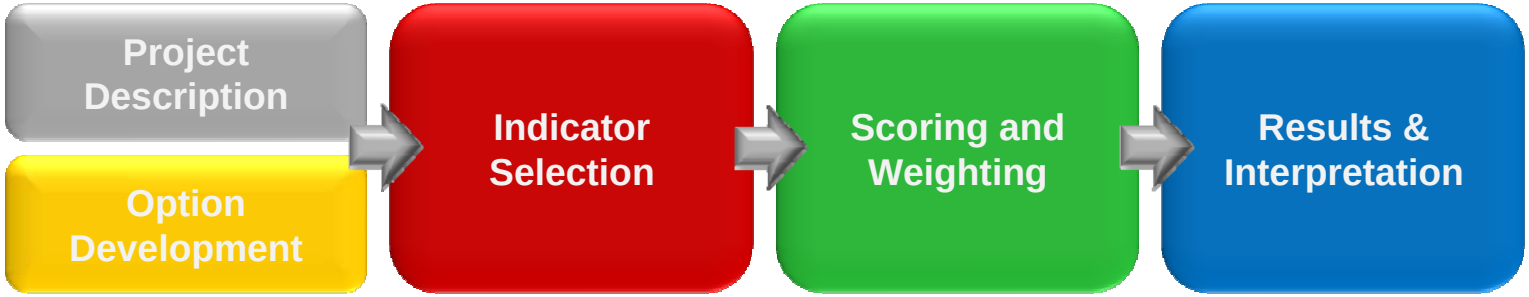
GoldSET-CN-SR : A Tool to Systemize the Approach



Leading to a synthetic graphical result

Interceptor Sumps		Interceptor Trench		MPE (Multi-Phase Extraction)		Well Based Hydraulic Barrier		In-Situ Treatment by Oxygenation Barrier	
ENVIRONMENT	24%	ENVIRONMENT	45%	ENVIRONMENT	77%	ENVIRONMENT	55%	ENVIRONMENT	58%
SOCIETY	81%	SOCIETY	58%	SOCIETY	77%	SOCIETY	71%	SOCIETY	81%
ECONOMICS	29%	ECONOMICS	31%	ECONOMICS	59%	ECONOMICS	57%	ECONOMICS	61%

Project Cost : $ 400.000.00 Project Duration : 20 years	Project Cost : $ 500.000.00 Project Duration : 20 years	Project Cost : $ 550.000.00 Project Duration : 5 years	Project Cost : $ 400.000.00 Project Duration : 15 years	Project Cost : $ 450.000.00 Project Duration : 20 years

Case Study #1: Site in Western Canada

Site Conceptual Model:

•Approx. half a million litres of weathered diesel estimated to be in subsurface from leaks and spills from former ASTs and locomotive fuelling area

•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.

•Hydraulic gradient estimated to be 0.02 to 0.04 m/m

•Silty SAND, fine to medium grained

•Plumes appear to be migrating toward site boundary

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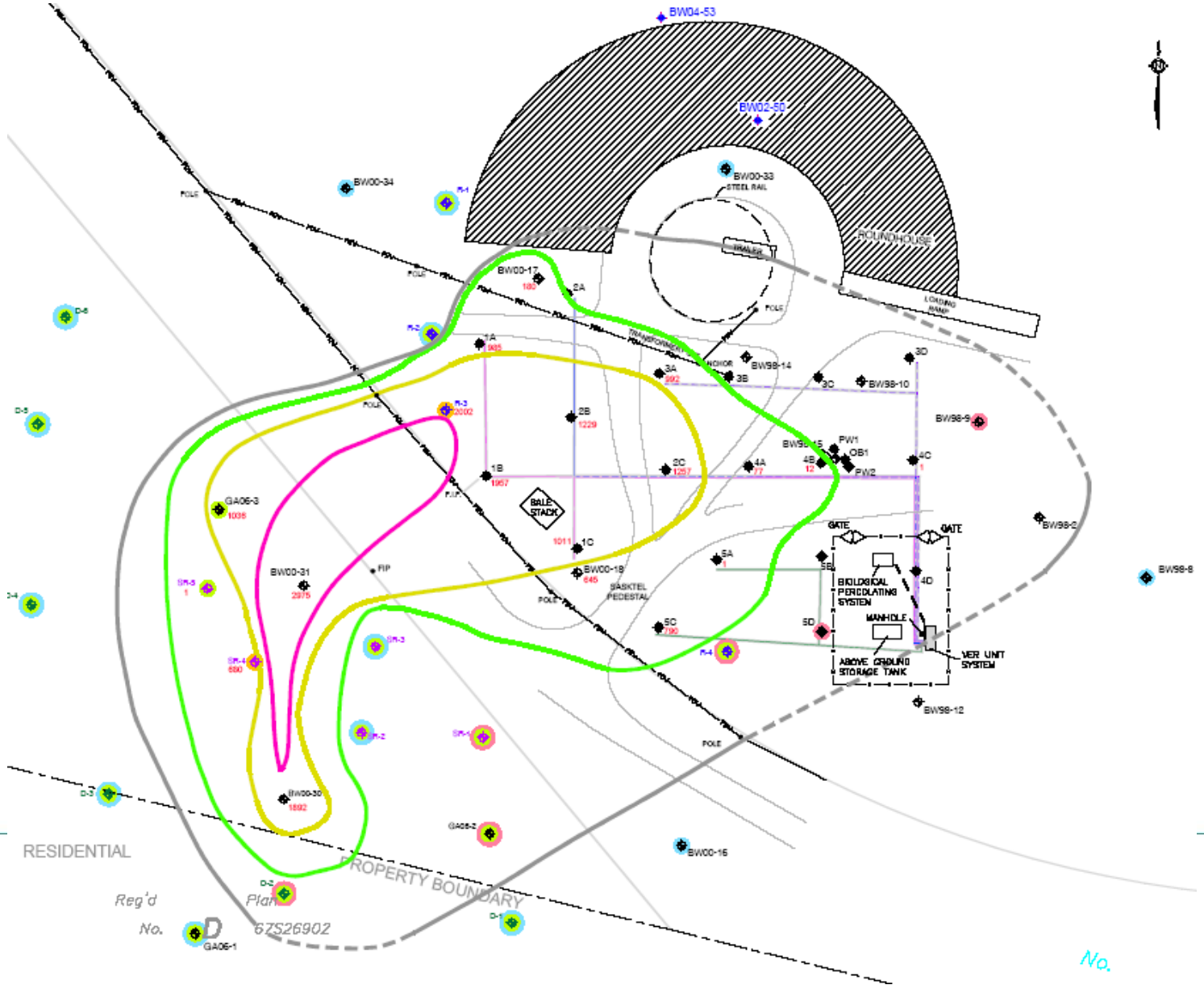
Case Study #1: Site in Western Canada



Case Study #1: Site in Western Canada

Project Description

Step 2 - Site Description : Conceptualization of the site conditions

Project Objective and Constraints

General Description

Zoning & Surroundings

Describe the zoning and the surroundings of the contaminated areas :

The surrounding land use is generally commercial with some light industrial and agricultural. The nearest residendial property is approximately 300 m from the Site boundary.

Above Ground Infrastructure

Detail the above the ground infrastructure on and around the contaminated areas :

There is no above ground infrastructure on the contaminated area. There is one power line adjacent to the gravel road located north of the contaminated area running parallel to the road.

Underground Infrastructure

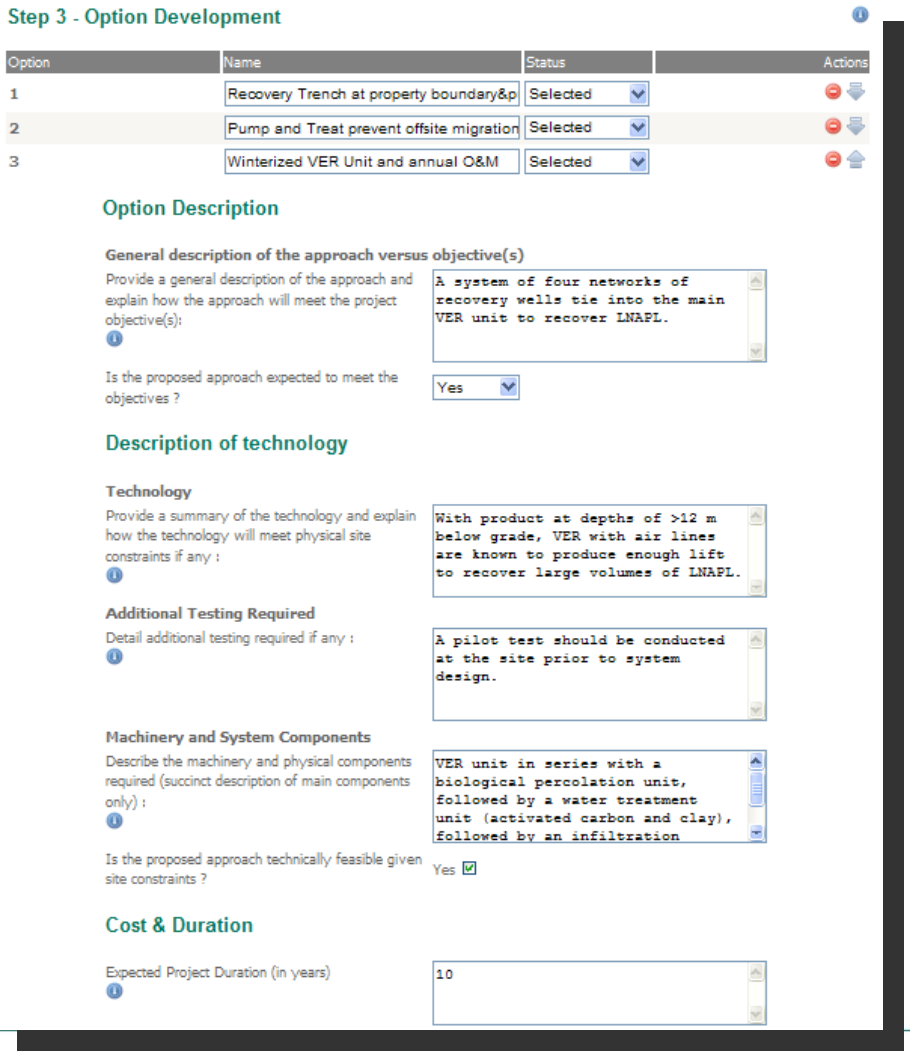
Detail the underground infrastructure on and around the contaminated areas :

There are no undergroud infrastructures on and around the contaminated areas however, the ground surface is rough and undulating which has been a tripping hazard in the past.

Case Study #1: Site in Western Canada

Option Development

Contains a fatal flaw analysis:



Step 3 - Option Development

Option	Name	Status	Actions
1	Recovery Trench at property boundary&p	Selected	
2	Pump and Treat prevent offsite migration	Selected	
3	Winterized VER Unit and annual O&M	Selected	

Option Description

General description of the approach versus objective(s)

Provide a general description of the approach and explain how the approach will meet the project objective(s):

A system of four networks of recovery wells tie into the main VER unit to recover LNAPL.

Is the proposed approach expected to meet the objectives ?

Yes

Description of technology

Technology

Provide a summary of the technology and explain how the technology will meet physical site constraints if any :

With product at depths of >12 m below grade, VER with air lines are known to produce enough lift to recover large volumes of LNAPL.

Additional Testing Required

Detail additional testing required if any :

A pilot test should be conducted at the site prior to system design.

Machinery and System Components

Describe the machinery and physical components required (succinct description of main components only) :

VER unit in series with a biological percolation unit, followed by a water treatment unit (activated carbon and clay), followed by an infiltration

Is the proposed approach technically feasible given site constraints ?

Yes ☑

Cost & Duration

Expected Project Duration (in years)

10

Project Description

Option Development

Indicator Selection → **Scoring and Weighting** → **Results & Interpretation**

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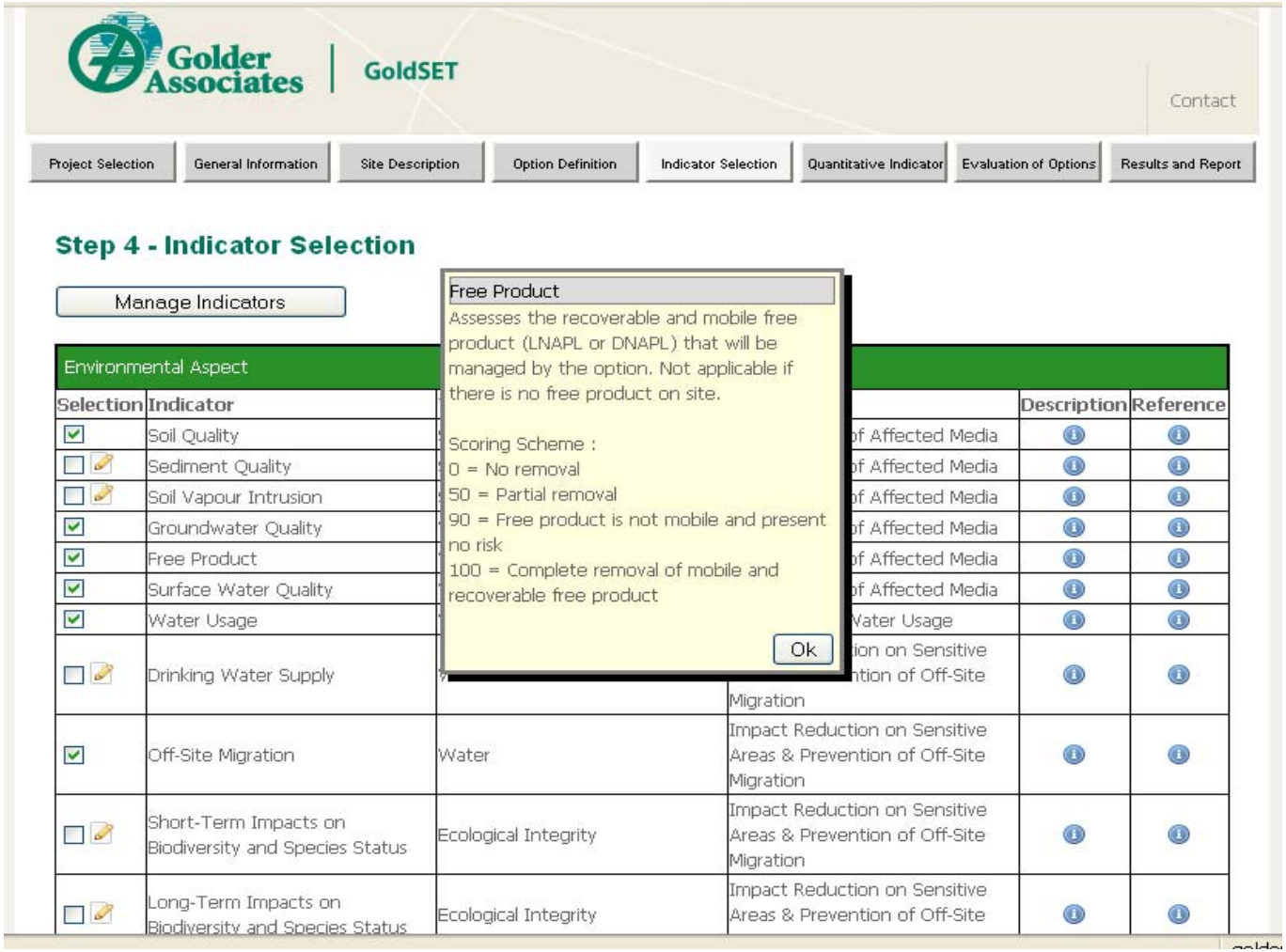
Case Study #1: Site in Western Canada

Indicator Selection

Exemple of a Qualitative indicators:



Project Description
Option Development
Indicator Selection
Scoring and Weighting
Results & Interpretation

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Case Study #1: Site in Western Canada

Scoring and Weighting

Quantitative indicators

Step 5 - Quantitative Indicators

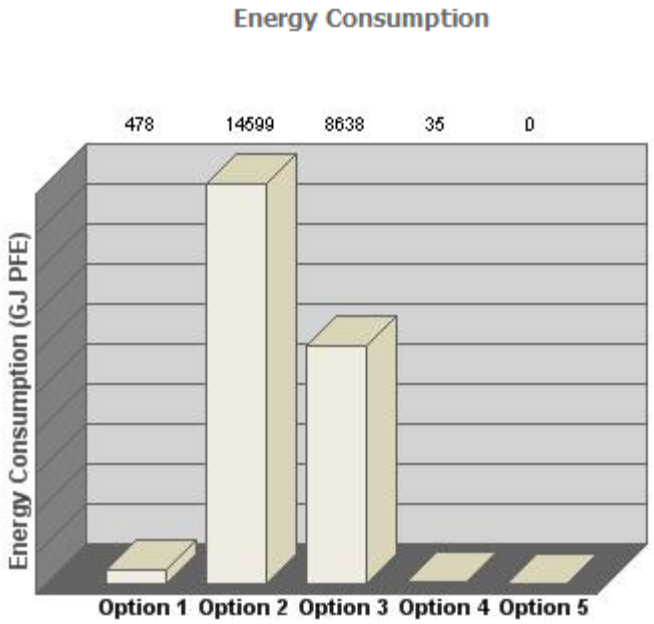
Environmental Aspect						
Code	Indicator	Units	Recovery Trench at property boundary&pump product	Pump and Treat prevent offsite migration	Winterized VER Unit and annual O&M	Natural attenuation and monitoring
ENV-6	Greenhouse Gas Emissions	Tonnes CO2 e	69.16	56.01	161.26	0
ENV-7	Energy Consumption	GJ PFE	1056.99	846.66	2319.28	0

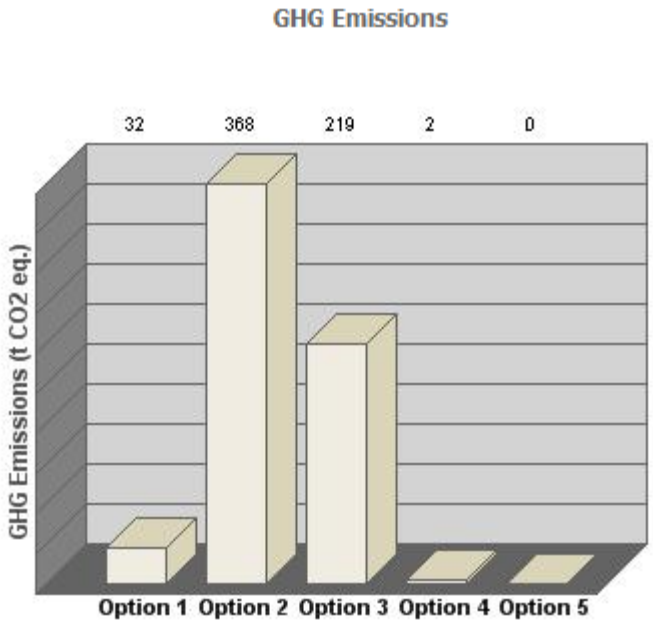
Social Aspect						
Code	Indicator	Units	Recovery Trench at property boundary&pump product	Pump and Treat prevent offsite migration	Winterized VER Unit and annual O&M	Natural attenuation and monitoring
SOC-3	Duration of Work	Years	30	30	10	30

Economic Aspect						
Code	Indicator	Units	Recovery Trench at property boundary&pump product	Pump and Treat prevent offsite migration	Winterized VER Unit and annual O&M	Natural attenuation and monitoring
ECONO-1	Net Present Value of Options' Costs	$	2100000	1100000	1800000	0

Case Study #1: Site in Western Canada

Scoring and Weighting





- Energy & GHG emissions are estimated with 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

Case Study #1: Site in Western Canada

Scoring and Weighting

Step 6 - Evaluation of Options

Environmental 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
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	Water Usage					1
ENV-6	Off-Site Migration	0	50	100	0	1
ENV-7	Greenhouse Gas Emissions	100	100	0	100	1
ENV-8	Energy Consumption	100	100	0	100	1

Case Study #1: Site in Western Canada

Results & Interpretation

OPTION A
OPTION B
OPTION C
OPTION D

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

Automated Reporting

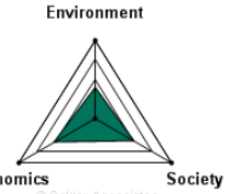
Recovery Trench at property boundary&pump product

ENVIRONMENT	40%
SOCIETY	29%
ECONOMICS	35%

Project Cost : $ 2.100.000.00
Project Duration : 30 years

Pump and Treat prevent offsite migration

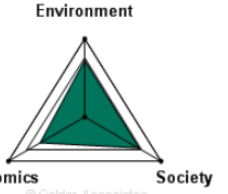
ENVIRONMENT	40%
SOCIETY	50%
ECONOMICS	53%



Project Cost : $ 1.100.000.00
Project Duration : 30 years

Winterized VER Unit and annual O&M

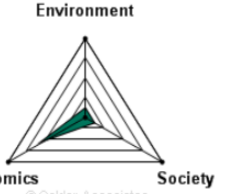
ENVIRONMENT	72%
SOCIETY	71%
ECONOMICS	58%



Project Cost : $ 1.800.000.00
Project Duration : 10 years

Do Nothing

ENVIRONMENT	12%
SOCIETY	12%
ECONOMICS	54%



Project Cost : $ 0.00
Project Duration : 30 years

- 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

Project Description
Option Development
→ Indicator Selection → Scoring and Weighting → Results & Interpretation

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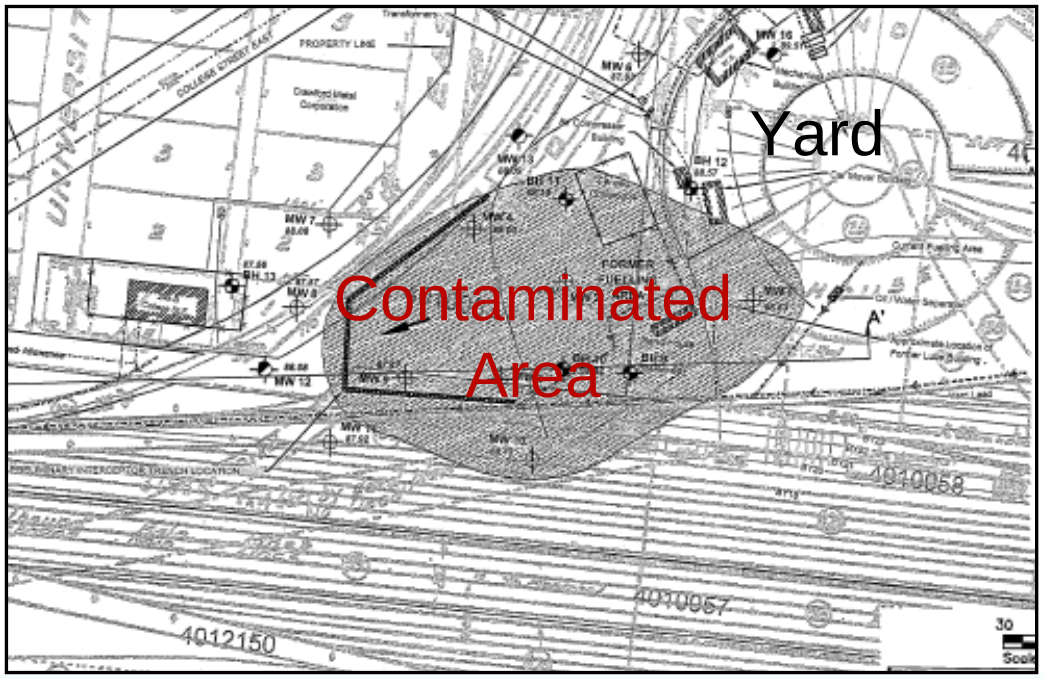
Case Study #1: Site in Western Canada

Case Study: Impacted Yard

Background:

- **Phase 2 ESA completed**
- **Baseline: currently extracting hydrocarbons with interceptor pumps**
- **Containment not currently achieved**

- Presence of a diesel plume covering approximately 11,000 m^2
- Apparent thickness ranges from sheen to 1.5 m
- Potential for off-site impacts
- Free phase product located in fractured bedrock
- Objective: Prevention of off-site migration (free product & dissolved phase)



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Case Study #2: Impacted Yard - Ontario

- Initially performance of 5 remedial technologies were explored with GoldSET:
  1. Interceptor Sumps with product recovery using a vacuum truck (baseline)
  2. Interceptor Trench with pumping, oil-water separator and biological percolation system (BPS) treatment prior to discharge
  3. MPE (Multi-Phase Extraction), with oil-water separator and BPS prior to discharge
  4. Well-Based Hydraulic Barrier with pumping, oil-water separator and BPS prior to discharge
  5. In-Situ Treatment and containment by Oxygenation Barrier

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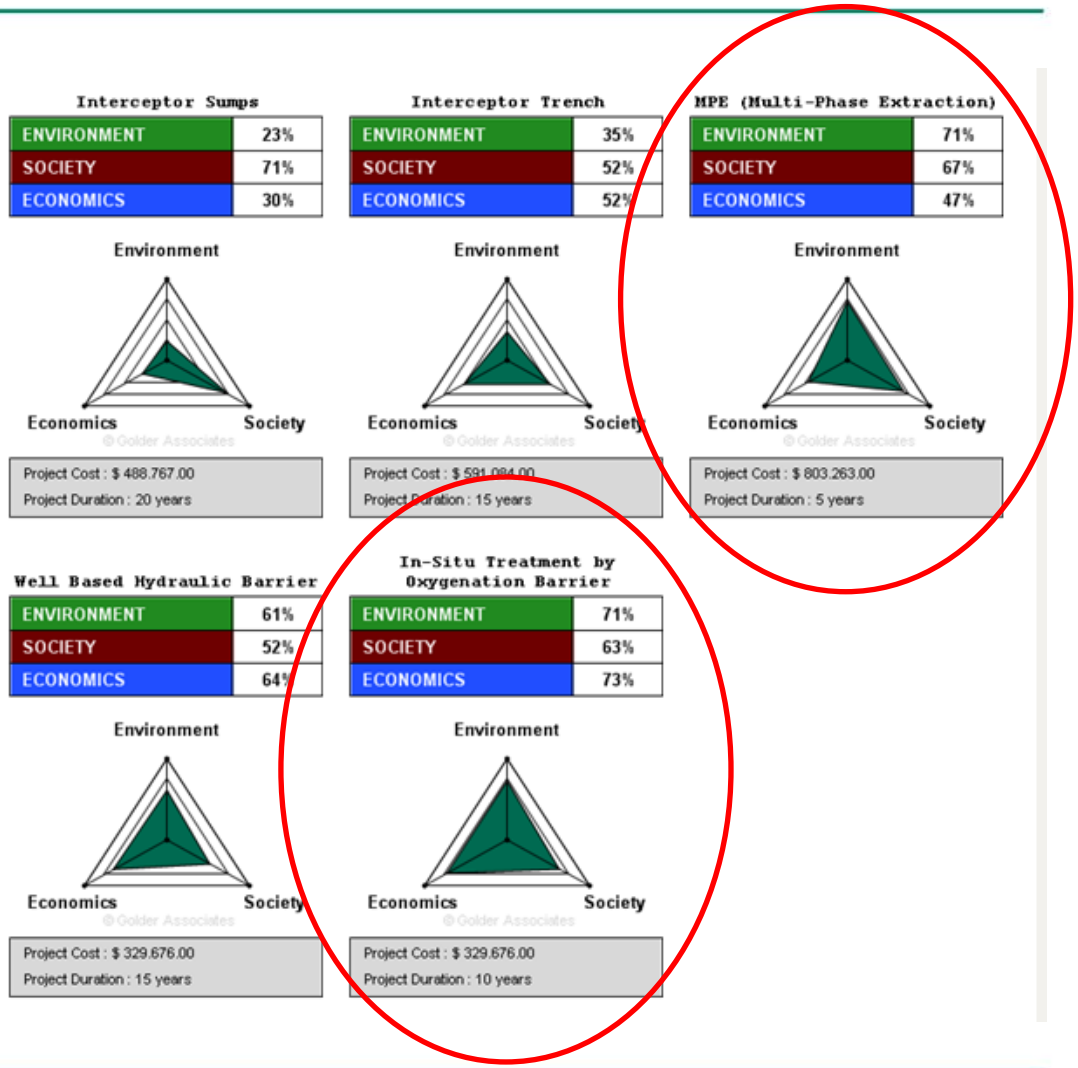
Case Study #2: Impacted Yard - Ontario

1st iteration

- Based on results, 2 options performed better:
  - MultiPhase Extraction
  - *InSitu* Treatment by Oxygenation barrier
- Pilot testing was recommended in order to validate the best option



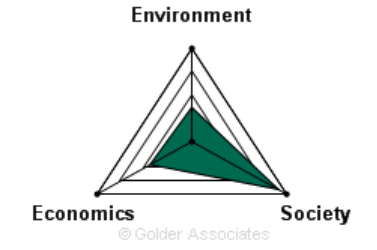
Case Study #2: Impacted Yard - Ontario

- Following the pilot testing a second SD evaluation was performed, including a new approach, Monitoring of Natural Attenuation (MNA):
  - MNA showed the best results.
  - Great difference in the economic aspect
  - Good results on the social aspect for every option of this project.

Option 1

Interceptor Sump Extraction

ENVIRONMENT	37%
SOCIETY	89%
ECONOMICS	43%

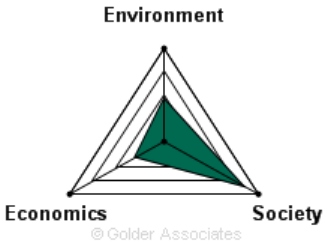


Project Cost : $ 375.000.00
Project Duration : 20 years

Option 2

Full Scale Multi-Phase Extraction System

ENVIRONMENT	46%
SOCIETY	83%
ECONOMICS	31%

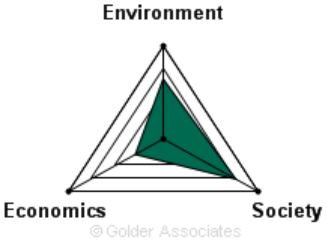


Project Cost : $ 400.000.00
Project Duration : 5 years

Option 3

Oxygenation Barrier

ENVIRONMENT	63%
SOCIETY	75%
ECONOMICS	30%

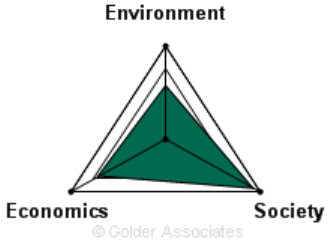


Project Cost : $ 425.000.00
Project Duration : 15 years

Option 4

Monitoring of Natural Attenuation

ENVIRONMENT	57%
SOCIETY	92%
ECONOMICS	71%



Project Cost : $ 150.000.00
Project Duration : 15 years

Summary

- GoldSET-CN-SR is a hands-on visual tool that:
  - Structures decision-making process
  - Provides transparent decision-making
  - Simplifies abstract concepts
  - Helps communicate impacts and benefits of decisions
  - Helps communicate how sustainability (i.e., environmental, economic, and social considerations) have been incorporated into decision-making
  - **But always remember that the tool doesn't give you the options**

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Summary

- GoldSET-CN-SR was designed to bring Sustainable Development at the operational level so that business can **“Walk the Talk”.**
  - Measuring sustainability of a project
  - Balanced, impartial and comprehensive, yet simple to use
  - Maximizing efficiency
  - Convincing demonstration to stakeholders & regulators
  - Transparency of the decision process

- Corporation’s requirements :
  - Transparent decision tool
  - Tailored to their activities
  - Measure direct and collateral impacts and benefits
  - Reduce overall economic impacts through re-engineering

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