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# *Solar Detoxification – Treatment of Contaminated Groundwater*

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**R&D Performed by: SAIC Canada**

**Financial Support by: PERD,**
**Environment Canada and**
**Natural Resources Canada**
**Technical Support by: Natural Resources Canada**
**Industrial Partner: Terasen Pipelines (Trans Mountain) Inc.**

Environment Canada Environnement Canada

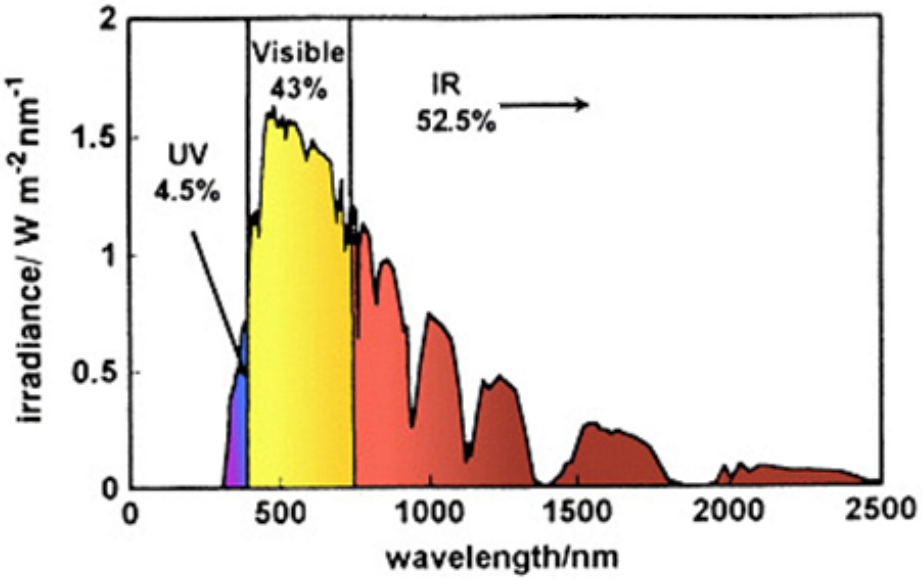
Natural Resources Canada Ressources naturelles Canada

## Conventional Photo-oxidation:

Hydrogen Peroxide + UV*

⟶ • **OH** Radicals

* UV < 300 nm




**Solar Spectral Irradiance Distribution**

**Solar Radiation +**
**Hydrogen Peroxide + Catalyst** ⟶ • **OH** Radicals

# Solar Detoxification - Solaqua® Process
(Bolton, Cater, Safarzadeh)

**Simple Process:**

- **Uses ferrioxalate as a photochemical agent**
- **Ferrioxalate absorbs UV and visible light**
  **(Ferrioxalate: complex of iron(III) and oxalic acid)**
- **Photolysis of ferrioxalate generates iron(II)**
- **Iron(II) reacts with peroxide to generate hydroxyl radical**
- **Hydroxyl radical breaks down organic contaminants**

# Solar Detoxification - Project Background

**Treatment of groundwater contaminated with target organic compounds.**

**This technology could contribute to the reduction of the environmental footprint from oil and gas production and at the same time demonstrate an innovative approach in alternate energy source application.**

**The goal of the reported work was to develop the Solaqua® technology further through bench-scale and field-scale work and provide a basis for technology commercialisation.**

# Solar Detoxification - R&D Activities

## Project Objectives:

1. **Demonstrate Contaminant Destruction**
2. **Field-scale Demonstration**
3. **Develop Performance Predictive Model**

# Solar Detoxification - R&D Activities

1992 Developed at University of Western Ontario
(Bolton, Cater, Safarzadeh)
2000 Bench-scale testing at SAIC Canada (spiked solution)
2001 Field-scale testing at a landfill site

2001 Bench-scale testing treating BTEX, MTBE and MMT *
2002 Field demonstration treating benzene and MTBE *

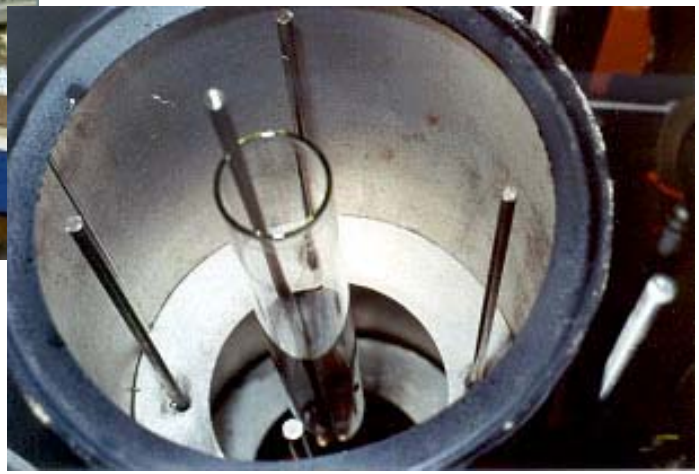
* With support from PERD

# Solar Detoxification - R&D Funding

| Phase | PERD | NRCan and EC | Industry | Total |
|---|---|---|---|---|
| I (2001) | $50k | $30k | 0 | $80k |
| II (2002) | $75k | $30k | $50k | $155k |

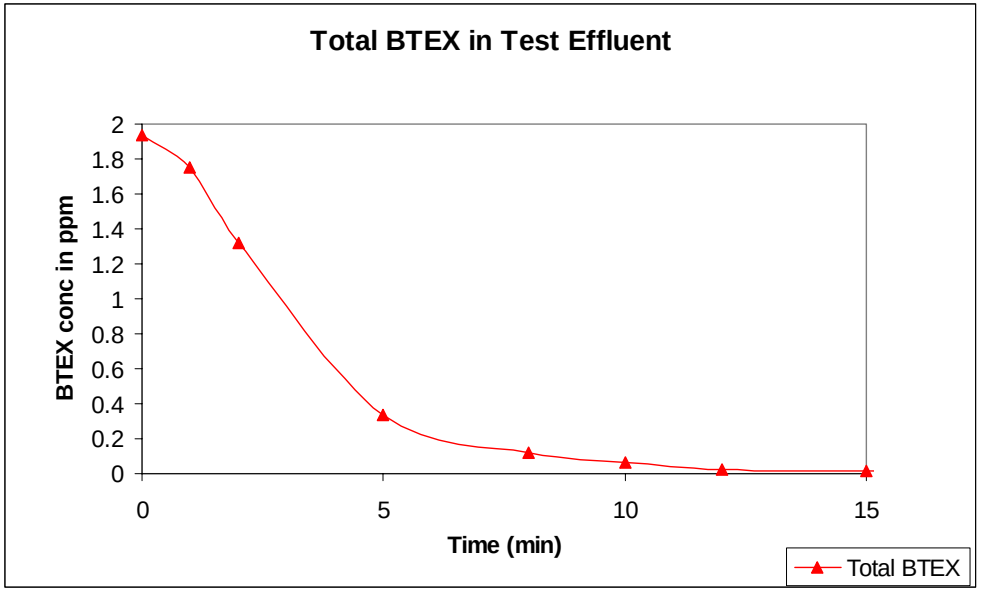
## Compounds Tested:

- BTEX
- MTBE
- MMT



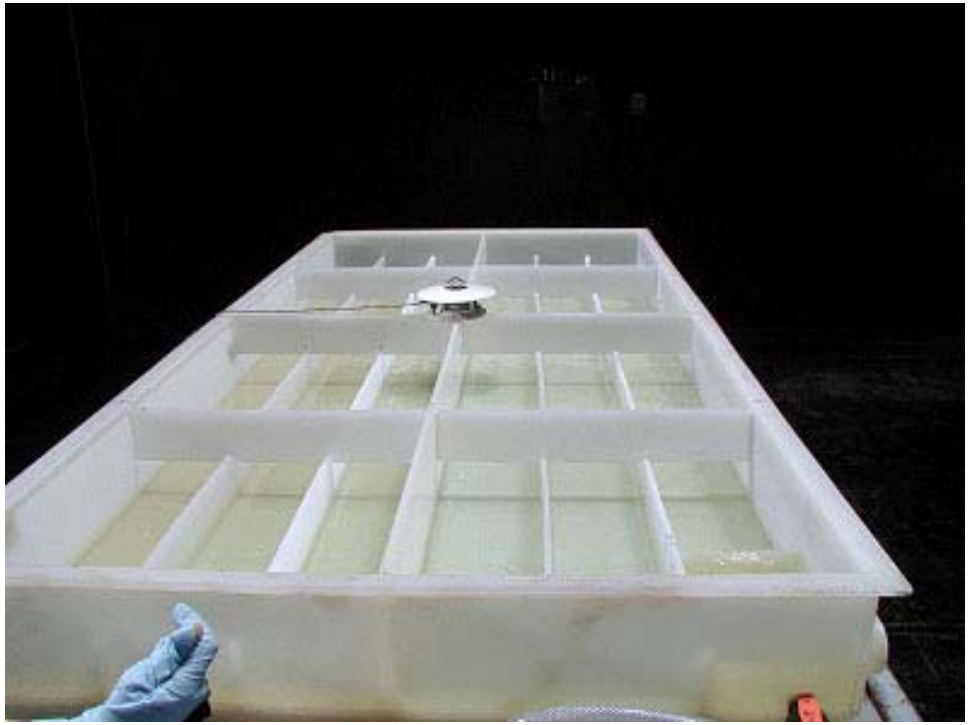
Bench-scale Advanced Oxidation Process (AOP) system
Pyrex sleeve over mercury vapour lamp
pH control, recirculation pump, plumbing, sampling port

# Typical BTEX concentration vs. exposure time

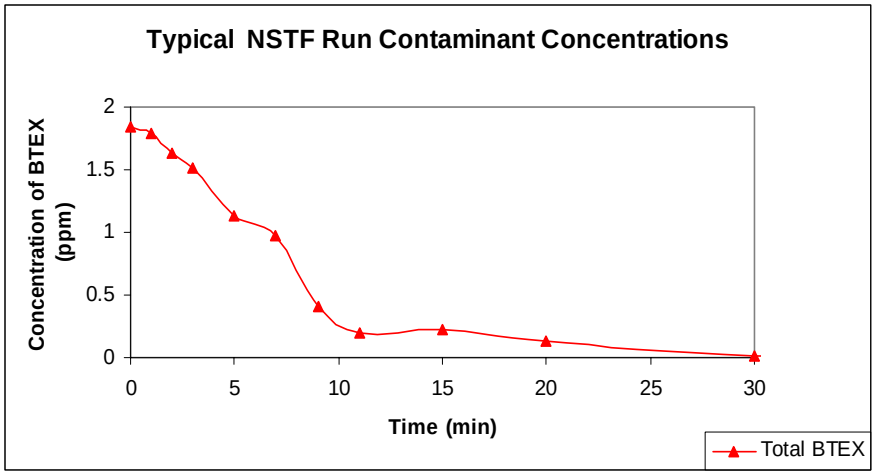



Process Parameters: 25 ppm FeOx, 350 ppm hydrogen peroxide at pH 4

National Solar Testing Facility (NSTF)
150 kW Vortek solar simulator
(150-1120 watts per square meter)



# Typical Results from Tests Conducted at the National Solar Test Facility (NSTF)

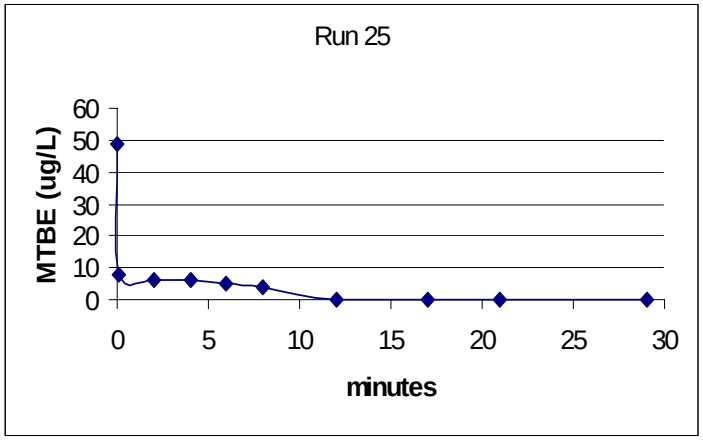


# Field Demonstration

## Trans Mountain's Sumas Pump Station

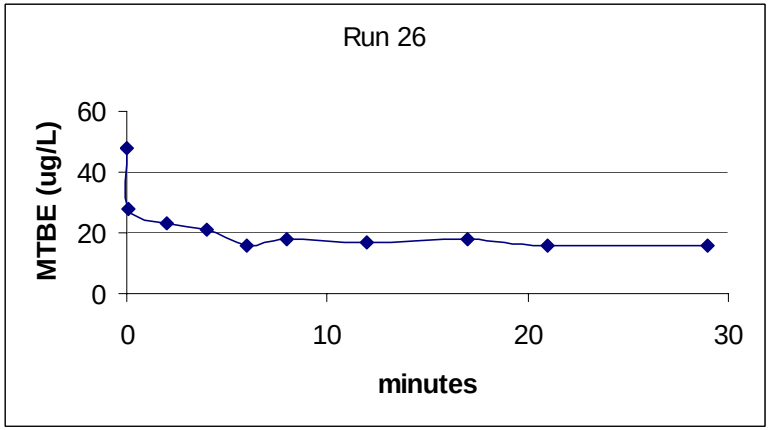
Abbotsford, British Columbia (August-September 2002)

# Typical Results from Field Tests Conducted at Sumas Pump Station

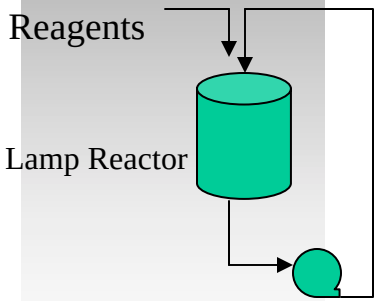



Run 25
pH 4
$H_2O_2$ 100 ppm
FeOX 0.1 ppm

Run 26
pH 5
$H_2O_2$ 10 ppm
No FeOX

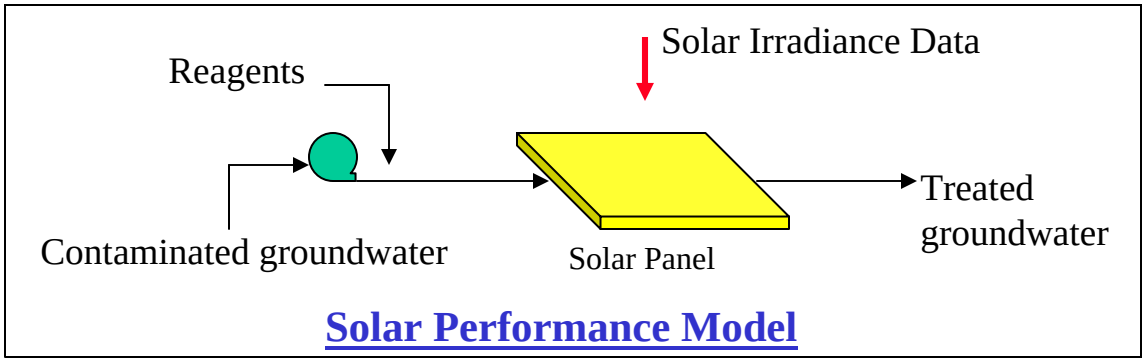


# Solar Detoxification Performance Prediction Model




Bench-scale Equipment
with artificial photon source
treating contaminated water

**Lamp Model**
**(fluid characteristics, pollutants, process parameters)**




**System Design and Performance Prediction**

## Implications for Industry :

- Renewable energy based technology for contaminant destruction in groundwater

## Future Work (2003):

- Performance prediction model validation / testing
- Solar treatment panel design
- Design notes
- Arranging for additional field tests

## Other environmental applications:

- Remediation of industrial wastewater

## Status:

Project on schedule and on budget.
Deliverables (reports) issued on time.

## Acknowledgements: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## Researchers:


| | |
|---|---|
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