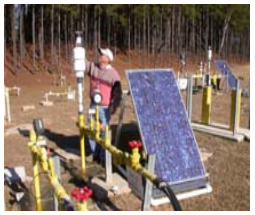
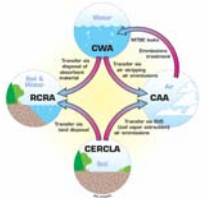
SRNL
SAVANNAH RIVER NATIONAL LABORATORY
TM

Sustainable Solutions for Soil and Groundwater Remediation

Helping the Earth Heal Itself

Ralph L. Nichols
Fellow Engineer
December 11, 2008





General Meeting of the Federal Remediation Technologies Roundtable
Arlington, VA

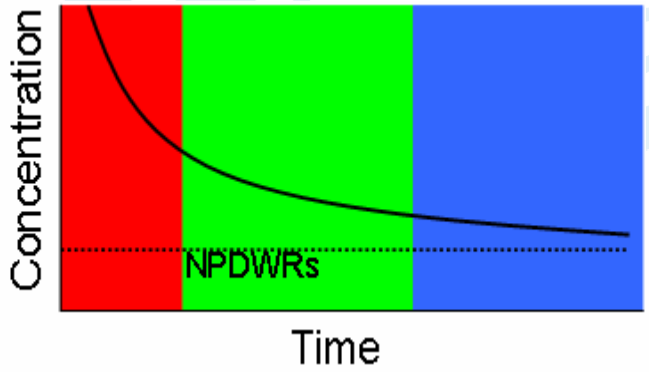
SRNS-MS-2008-00163

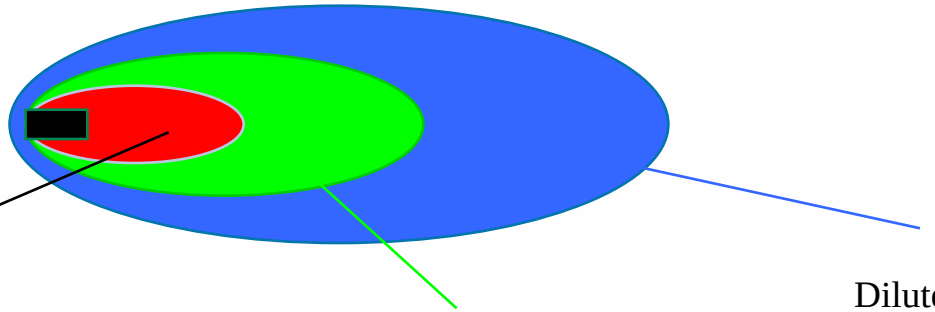
Savannah River Site

- **Aiken, South Carolina**
- **U. S. Department of Energy**
- **5 Nuclear reactors**
- **2 Chemical separation facilities**
- **50 years of operation**
- **Savannah River National Laboratory**
  - Center for Sustainable Soil and Groundwater Solutions

Anatomy of a Plume

- **Spatial variation**
- **Temporal variation**





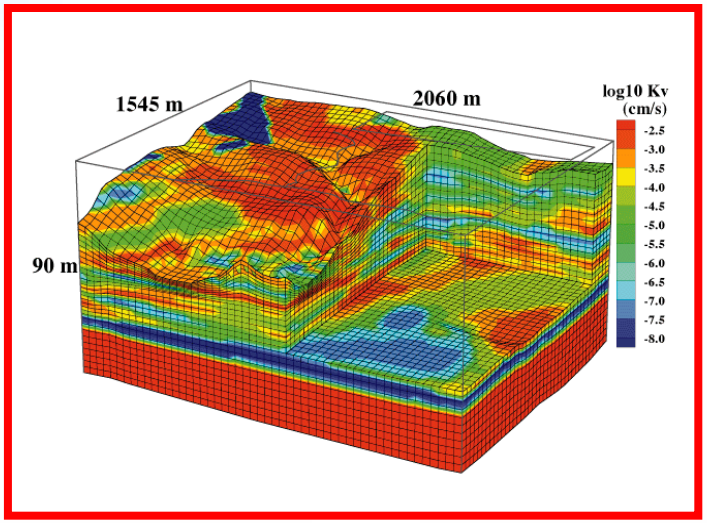
Source Zone
high conc., perturbed geochemistry
aggressive technologies, limit damage,
$/lb

Primary Groundwater Plume
moderate to high dissolved conc.
baseline technologies, $/1000 gal

Dilute Plume / Fringe
Low dissolved conc.
Innovative low-energy
sustainable technologies, $/yr

Conceptual Model

- **Processes occur at many scales**

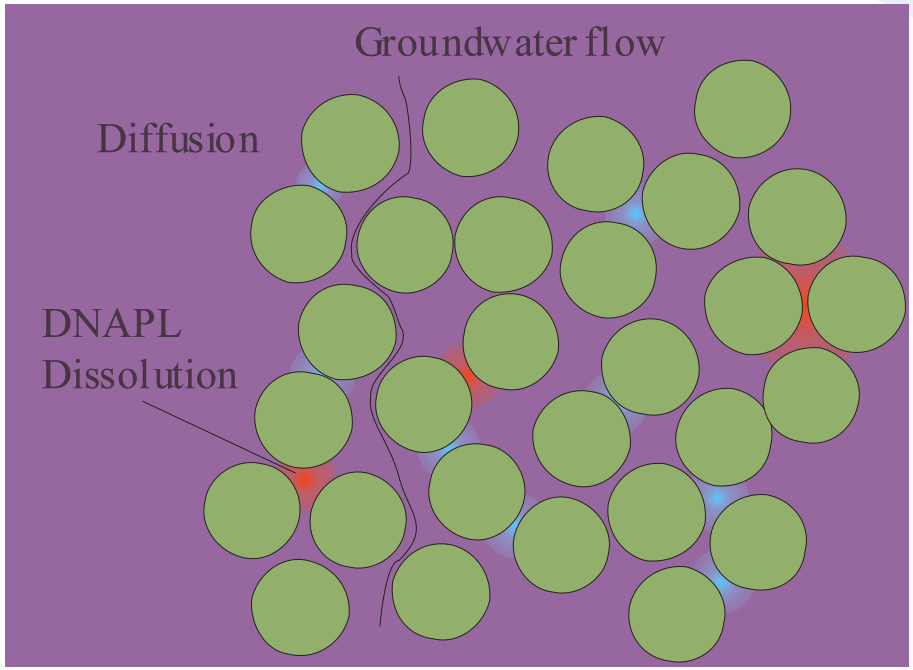


km

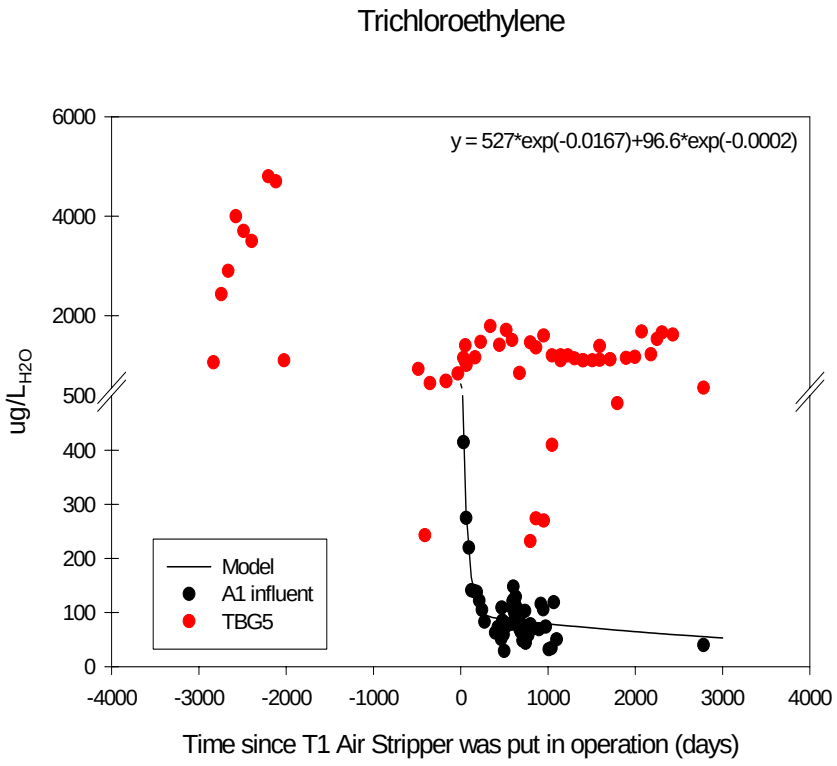
10m

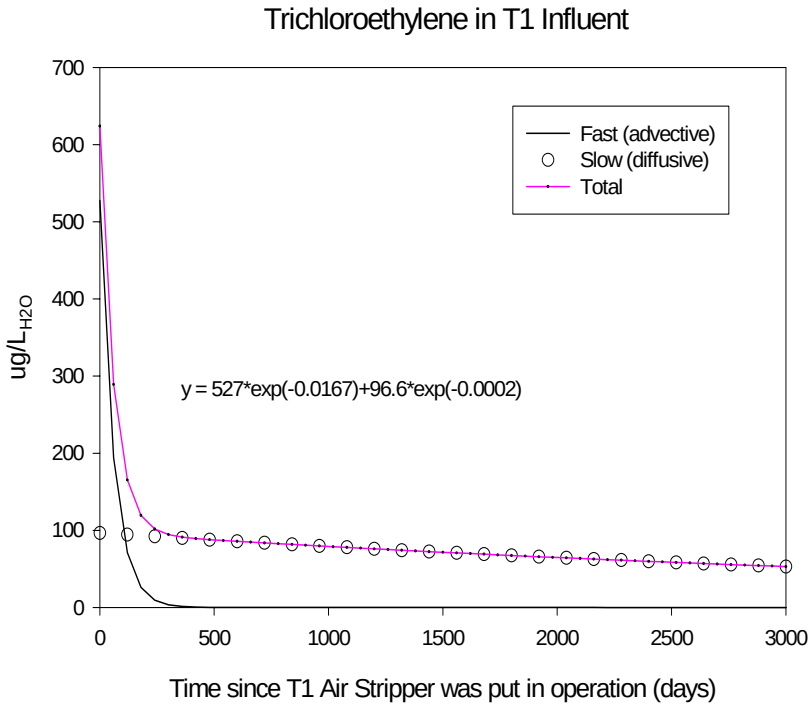
cm

Rate Limitations

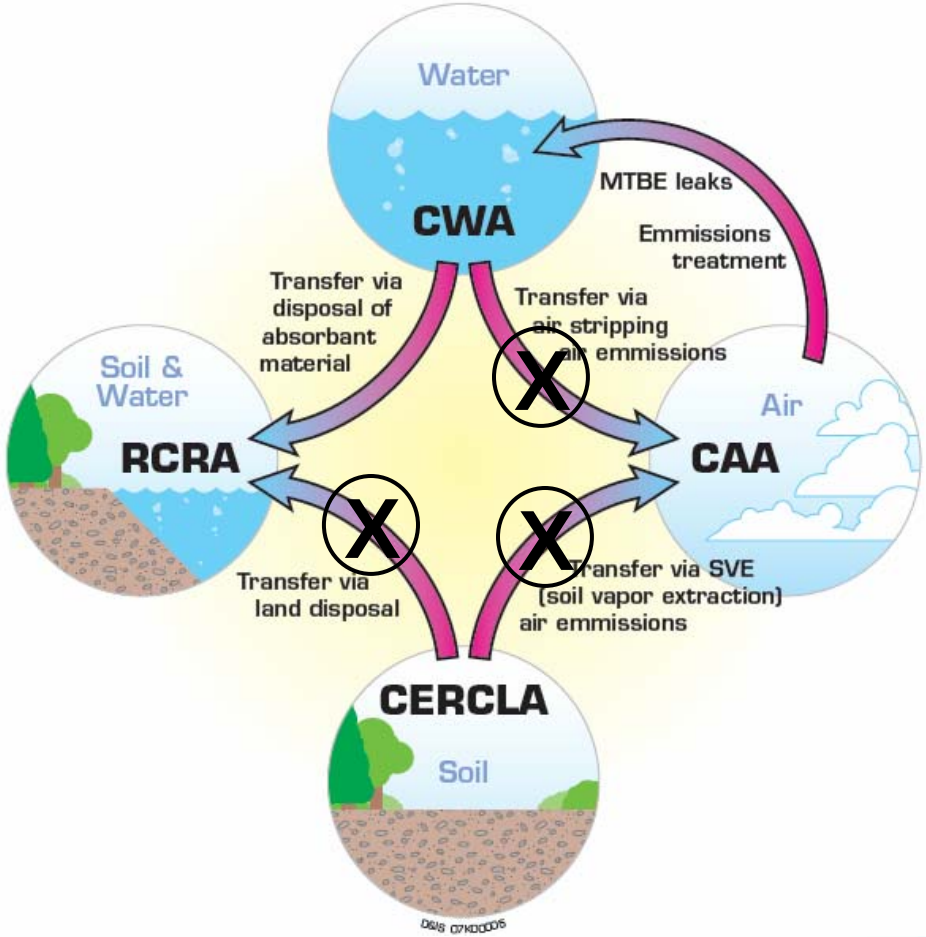


Rate Limitations





Risk Transfers

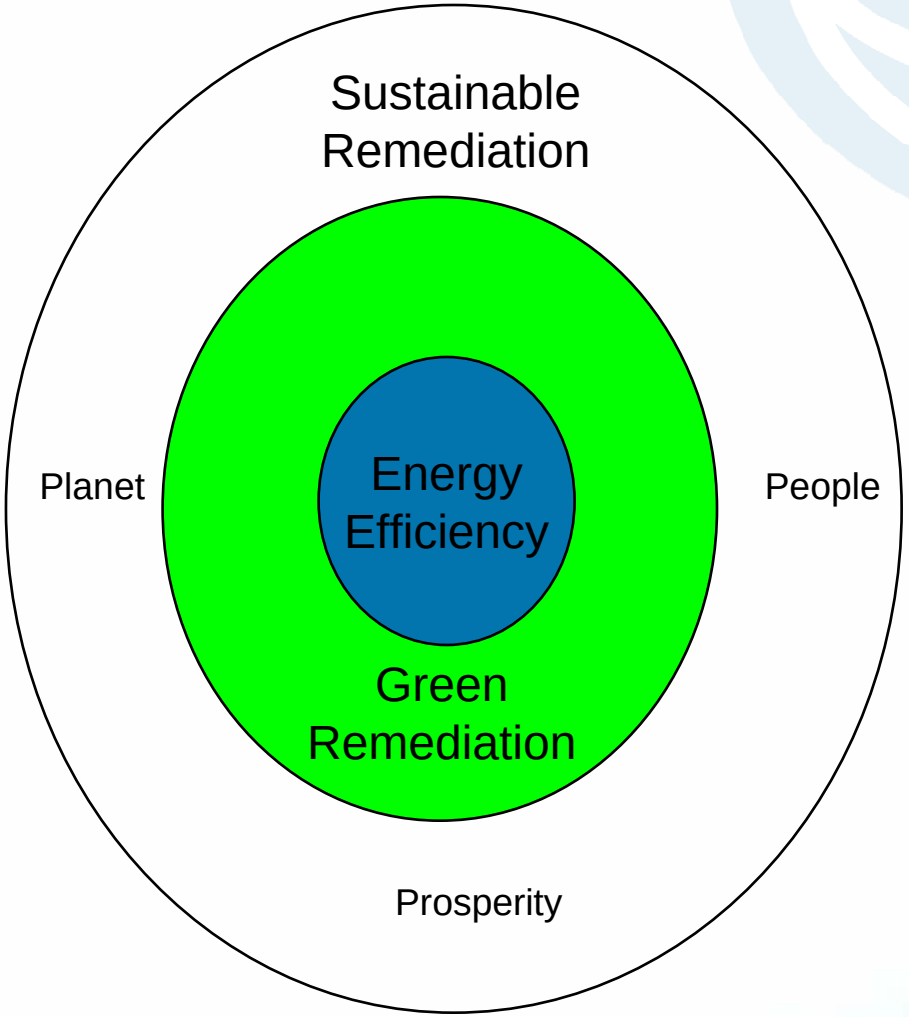


Sustainability

Sustainable development “Reconciliation of society’s developmental goals with the planet’s environmental limits over the long term”.

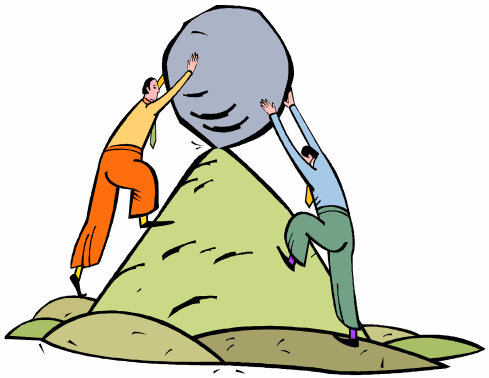
(National Academy of Sciences, 2003. Our Common Journey: A Transition Toward Sustainability)

Sustainable Remediation



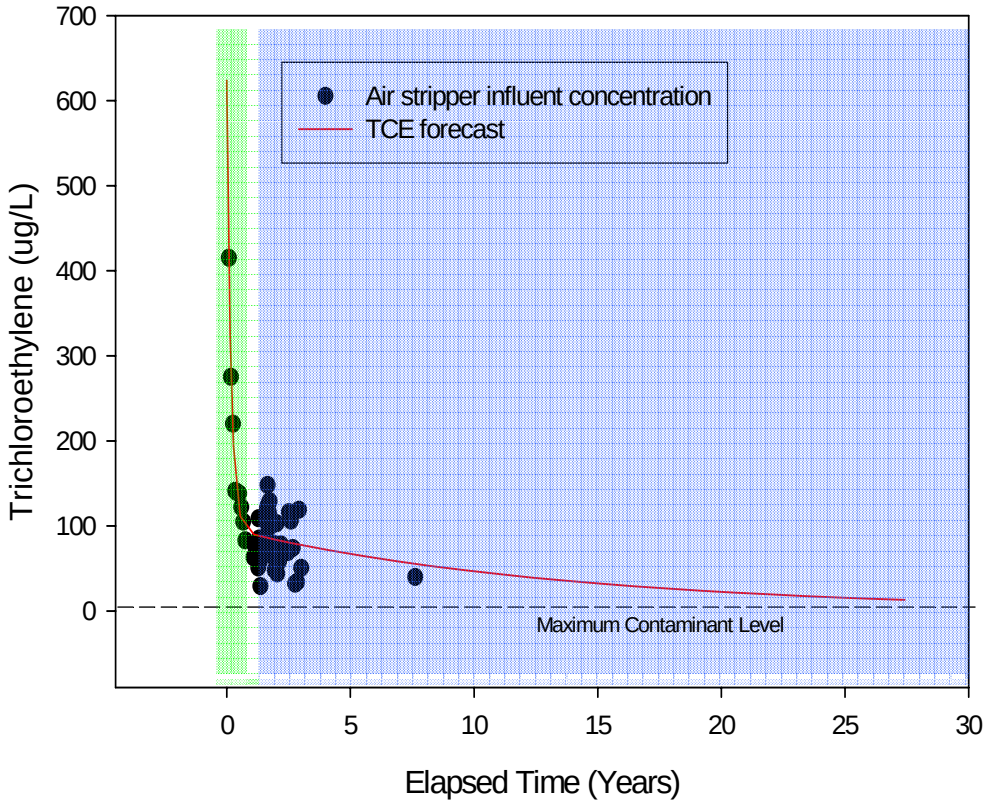
Remediation vs Sustainability

- **Remediation Goals**
  - Drinking Water Standards
  - Containment
  - Mass removal
  - Reduce flux
  - Reduce risk
- **Remediation Metrics**
  - Concentrations
  - $ / lb
  - $ / cubic yd
  - $ / 1000 gal
  - $ / yr

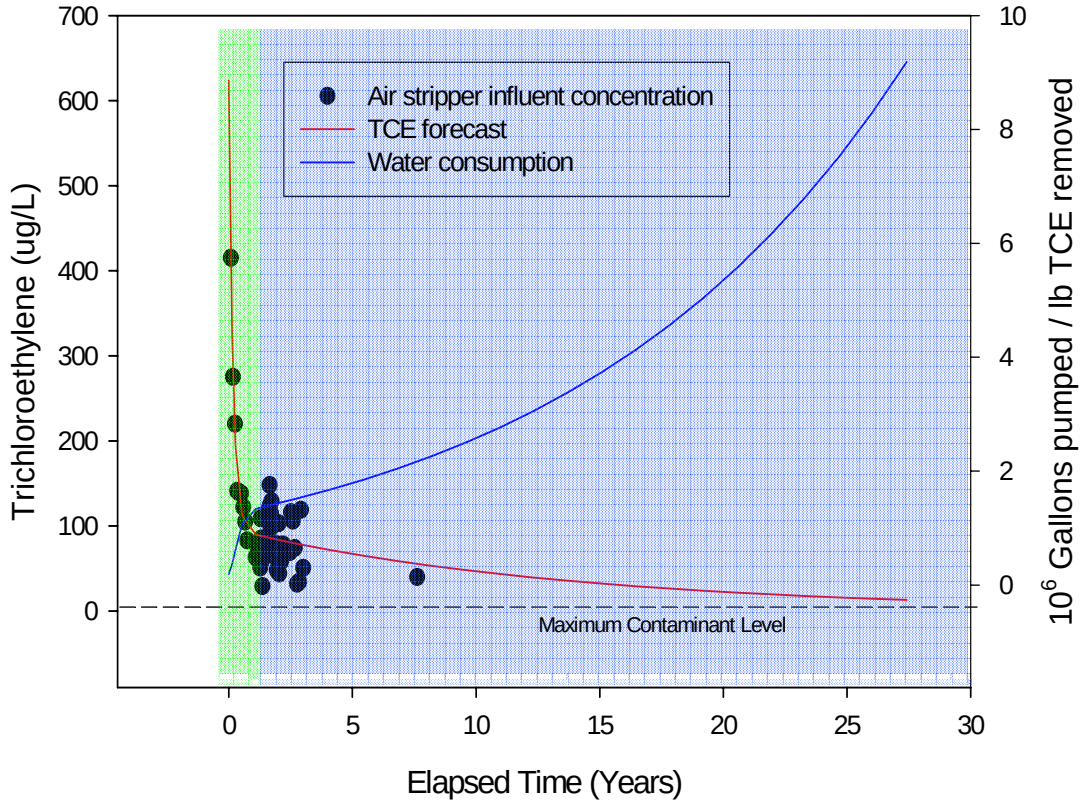


- **Sustainability Goals**
  - Preserve natural resources
  - Minimize energy use
  - Minimize CO2 emissions
  - Maximize recycle / reuse
  - Minimize footprint
- **Sustainability Metrics**
  - lb / Kwhr
  - lb / lb CO2
  - lb / 1000 gallon
  - lb / cubic yard

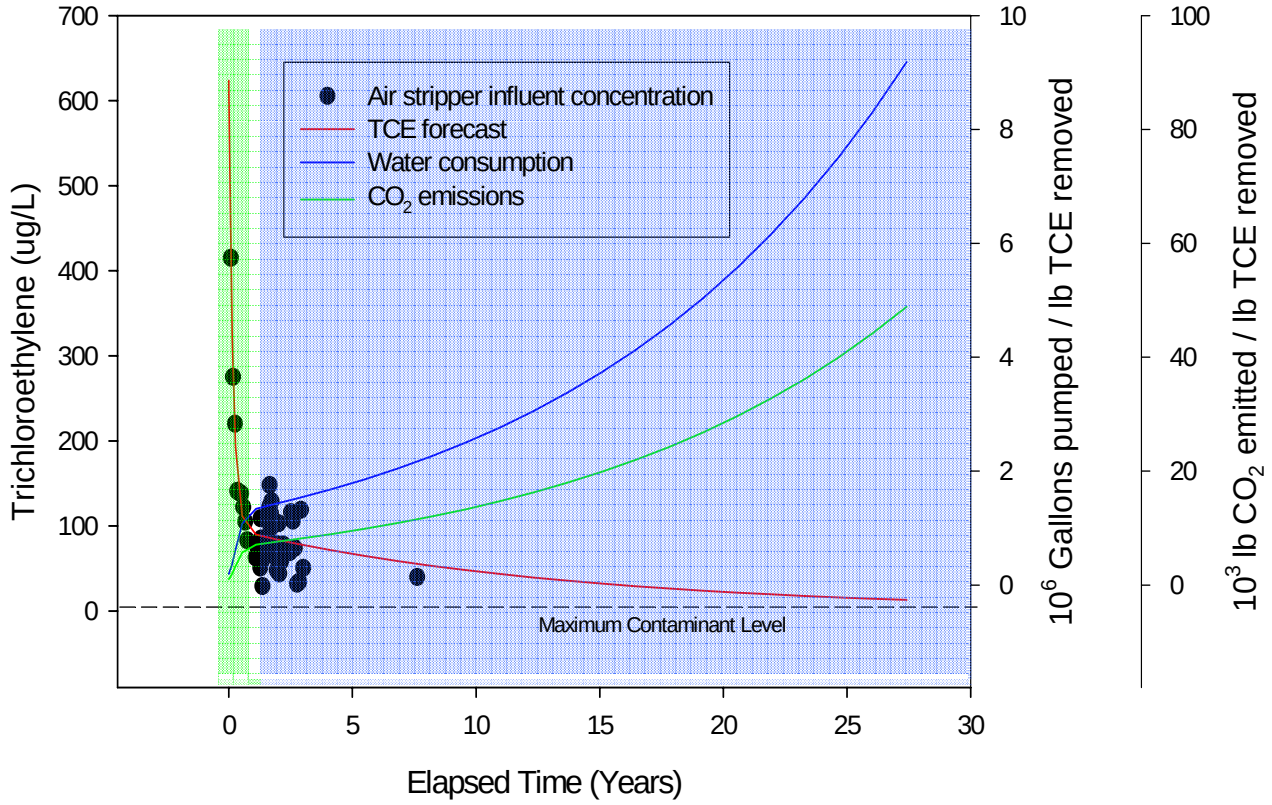
Measures of Sustainability



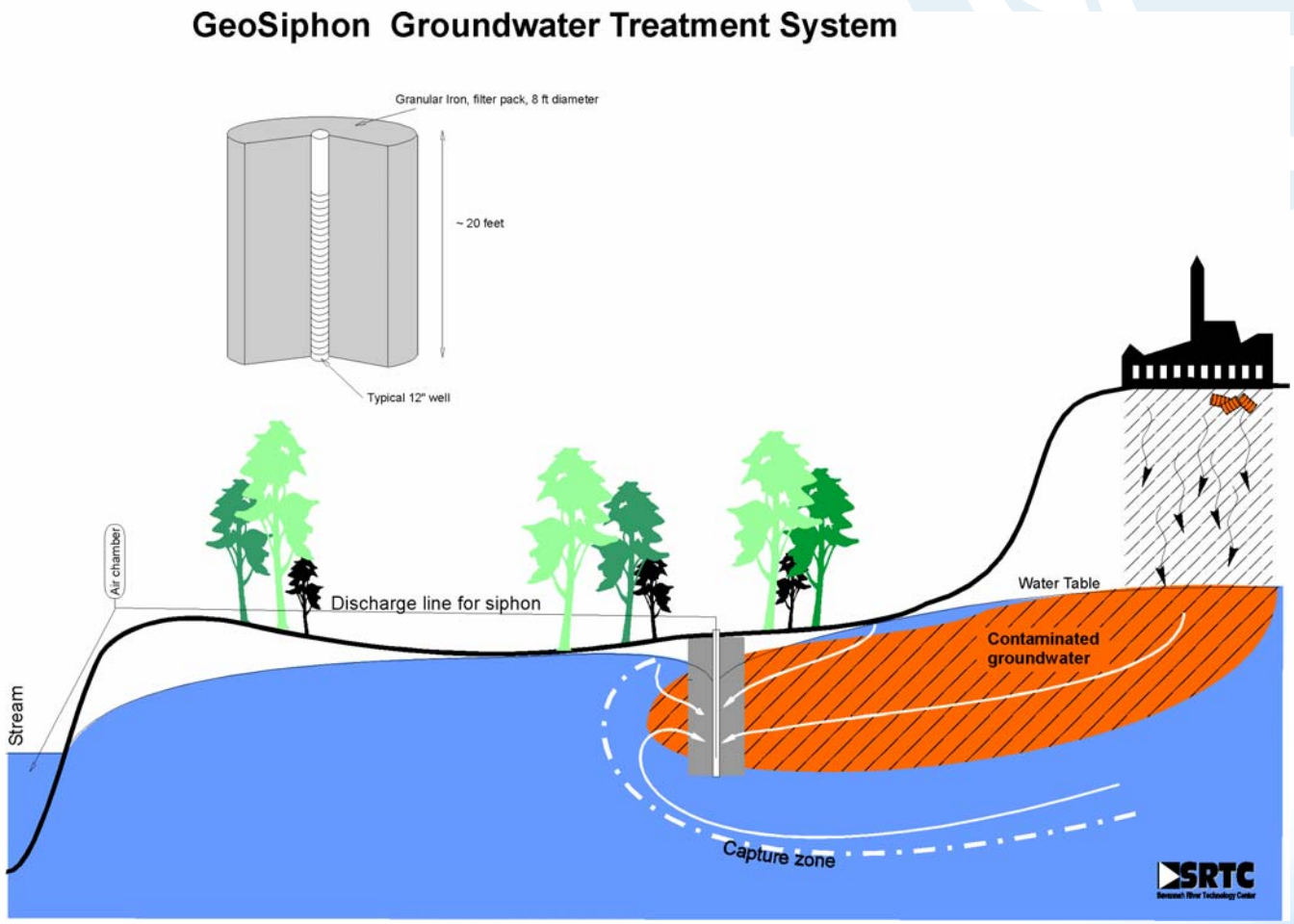
Measures of Sustainability



Measures of Sustainability

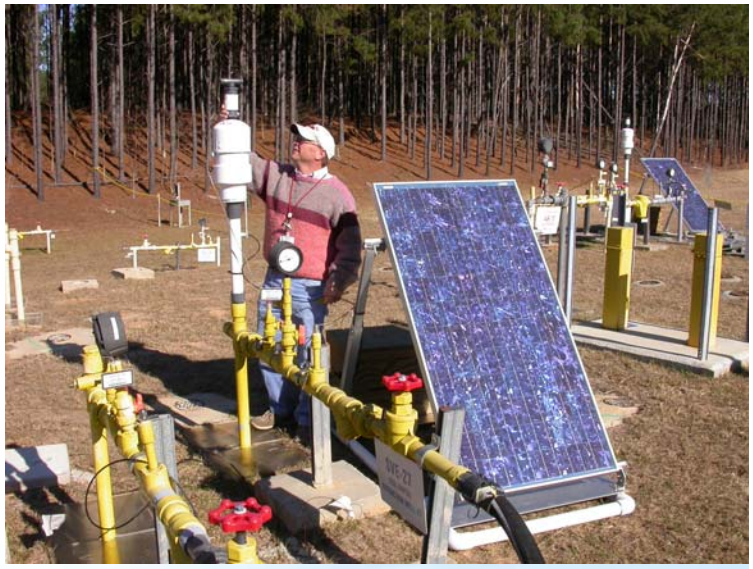


GeoSiphon


GeoSiphon Groundwater Treatment System
Granular Iron, filter pack, 8 ft diameter
~ 20 feet
Typical 12" well
Air chamber
Discharge line for siphon
Water Table
Contaminated groundwater
Stream
Capture zone
SRTC

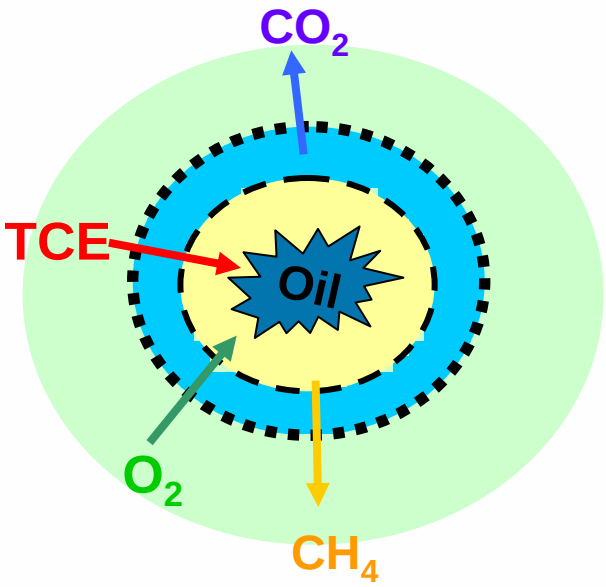
Sustainable Remediation Technologies

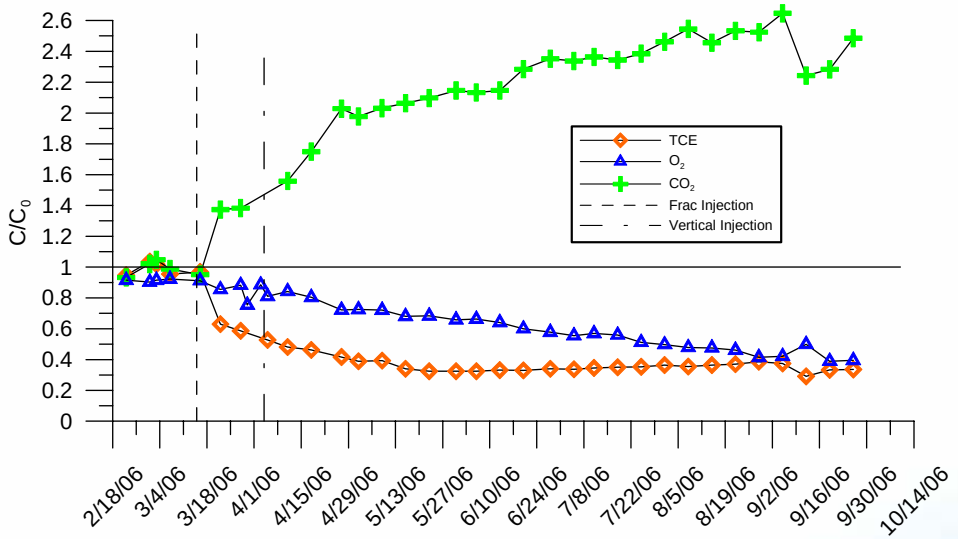
- **Horizontal wells, patented 1989, licensed**
- **PHOSter™, patented 1996, licensed**
- **Cone Sipper™, patented 1998, licensed**
- **StrataSampler™, patented 1998, licensed**
- **BaroBall™, patented 1997, licensed**
- **GeoSiphon™, patented 2001, licensed**
- **MicroBlower™ , patented 2005, licensed**



Soybean Oil

- **Sequestering agent that breaks down organic contaminants**

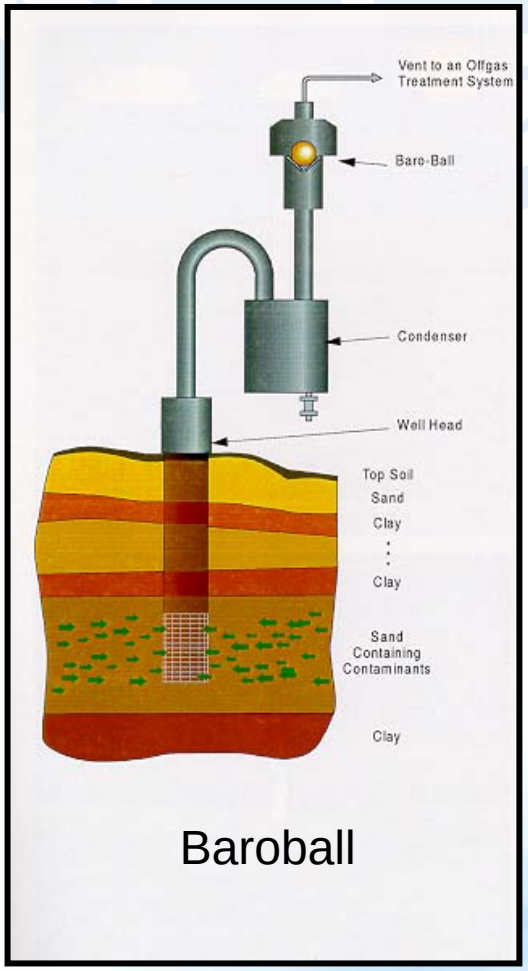




Flux reduced by 60%

Renewable Energy

- **Weather patterns**
  - Baroball, pressure fluctuations set up pressure gradient resulting in flow in to / out of subsurface
- **Wind**
  - Missouri University of Science & Technology
  - 10 kW Bergey wind turbine
  - Optimize



Baroball

Summary

- **Remediation goals and sustainability goals can be difficult to blend**
- **Determining sustainability is somewhat arbitrary, guides and standards are needed**
  - Leadership in Energy and Environmental Design (LEED)
  - Energy Star
- **Good conceptual model is important**
- **Identify naturally occurring opportunities**
  - Chemical properties
  - Site conditions
- **Keep design simple to minimize wasted energy**
- **Look for natural analogs**