Sustainable Environmental Solutions in Remediation, Wastewater, and Landfill Applications

optimizing resources | water, air, earth

Presented by AquAeTer, Inc.

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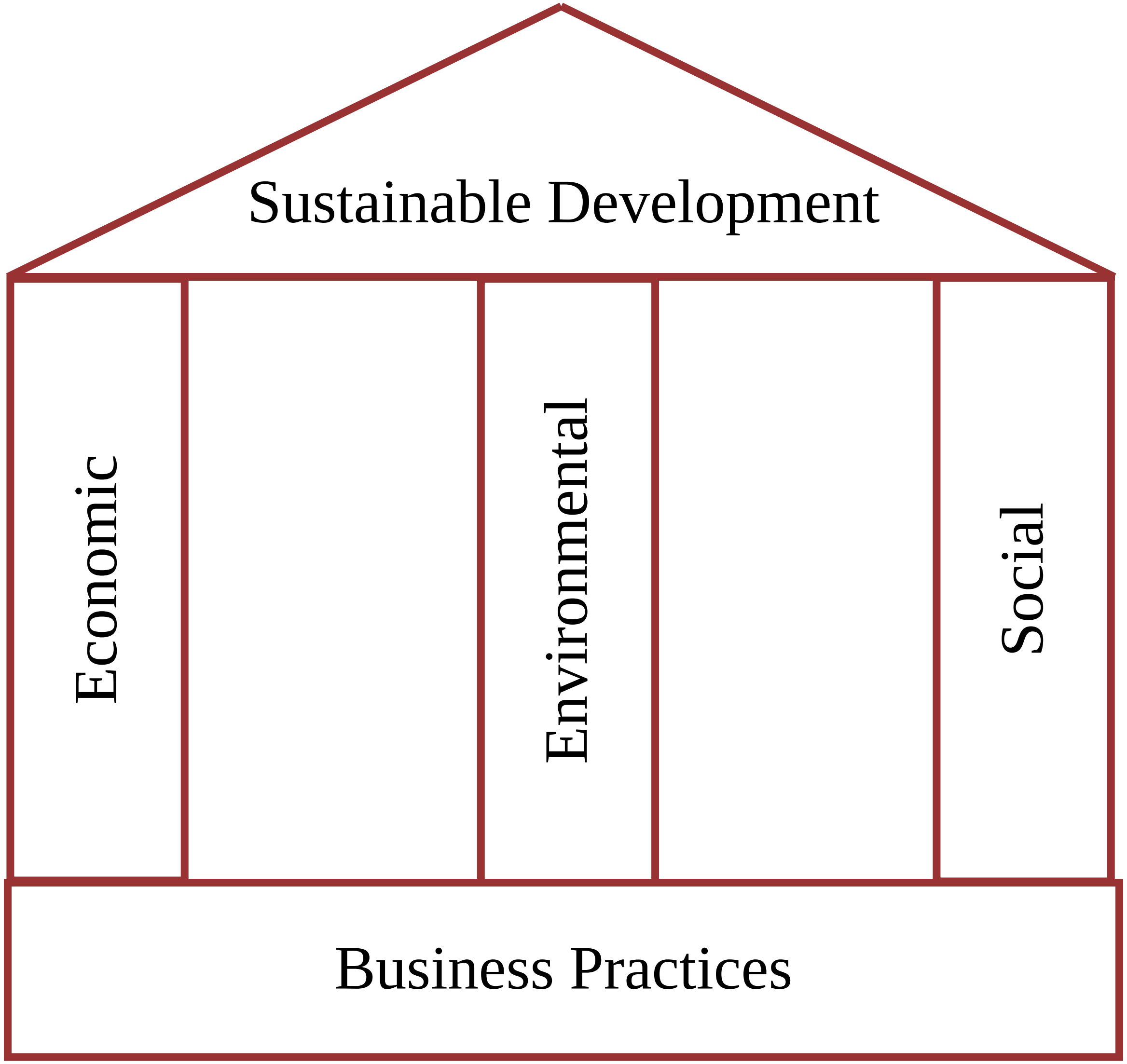
Three Pillars of Sustainability



Sustainable Development

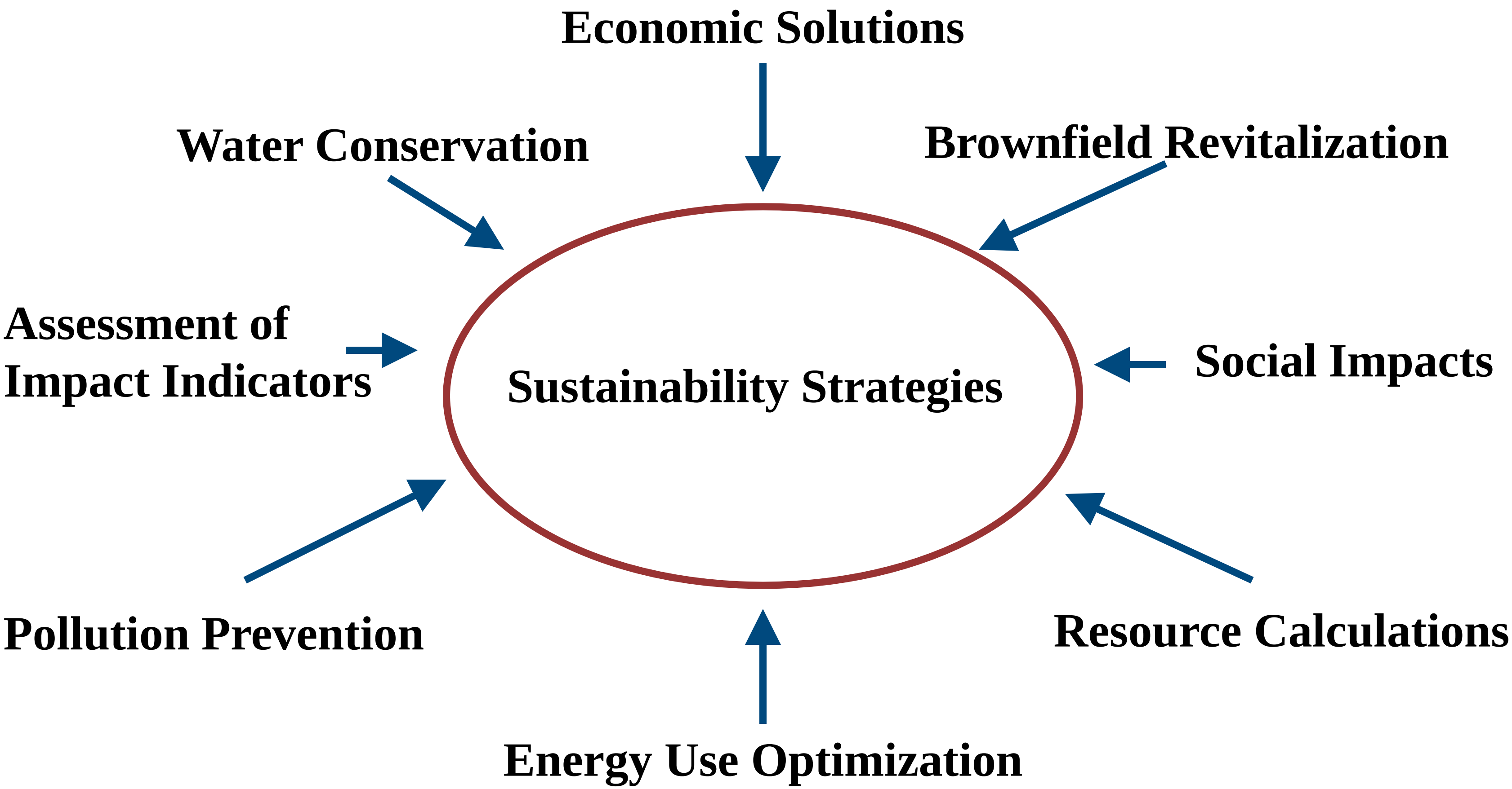
Economic

Environmental

Social

Business Practices

AquAeTer's Sustainability Elements



Economic Solutions

Water Conservation

Brownfield Revitalization

Assessment of
Impact Indicators

Sustainability Strategies

Social Impacts

Pollution Prevention

Resource Calculations

Energy Use Optimization

Case Studies

1. Groundwater Remediation System
2. Wastewater Treatment System
3. Alternative Landfill Cover

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Case Study #1:
Groundwater Remediation System

The Situation

Former creosote wood treating facility

- Operated over 90 years
- 1500 sq ft area with PAH and Petroleum contamination
- Impaired stream flowing through contaminated area
- No electricity access
- No personnel onsite
- Contamination for PAHs were over the state risk-based values in groundwater

Possible Solutions

- **Pump and Treat**
- **Excavation**
- ***In Situ* Biostimulation**

Chosen Solution: Bioremediation

Liquid *In Situ* Bioremediation Solution, AquAeTane

Patented AquAeTane aerobically stimulates microorganisms present in groundwater to break down chemical compounds

- **Consists of:**
    - Liquid, low molecular weight hydrocarbon
    - Oxygen source
    - Nutrients

Client approved of conducting pilot study over a 1,500 sq ft area

AquAeTane Advantages

- Chemical compounds are broken down using aerobic microorganisms present in groundwater
- By products are non-toxic compounds such as organic acids, carbon dioxide, and water
- Treatment quantities are low, reducing overall cost
- Maintenance is low; uses little or no electricity, and relatively low amounts of oxygen and nutrients

In Situ Biostimulation

Pilot studies demonstrate that AquAeTane can treat:

PAHs	Volitiles	Chlorinated Solvents
Naphthalene	Acetone	Perchloretheylene (PCE)
Benzo(a)Pyrene	Benzene	Trichloroethylene (TCE)
	Toluene	
Fluorene	Ethylbenzene	Dichloroethylene (DCE)
Pyrene	Total Xylenes	Vinyl Chloride (VC)
(and others)	(and others)	

Information Needed

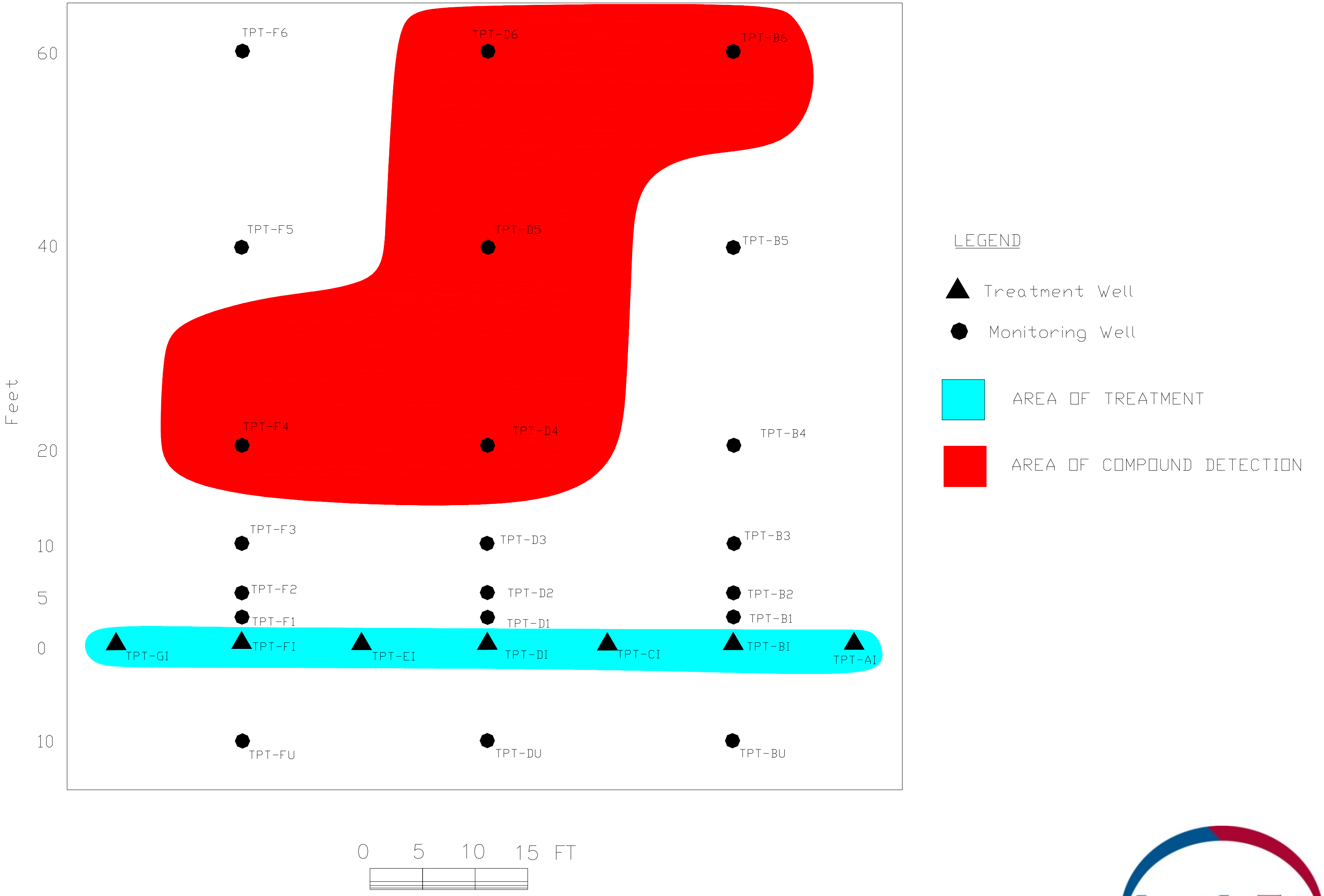
- **Define the Goal**
  - Containment
  - Treatment
- **Hydrogeology – which way does the groundwater flow and how fast?**
- **Injection system can be as simple or as complex as it needs to be**
  - Power
  - Site access/security
  - Labor availability

Injection Methods for Biostimulant

REMOTE SITE: SURFACE BIOSTIMULATION INJECTION

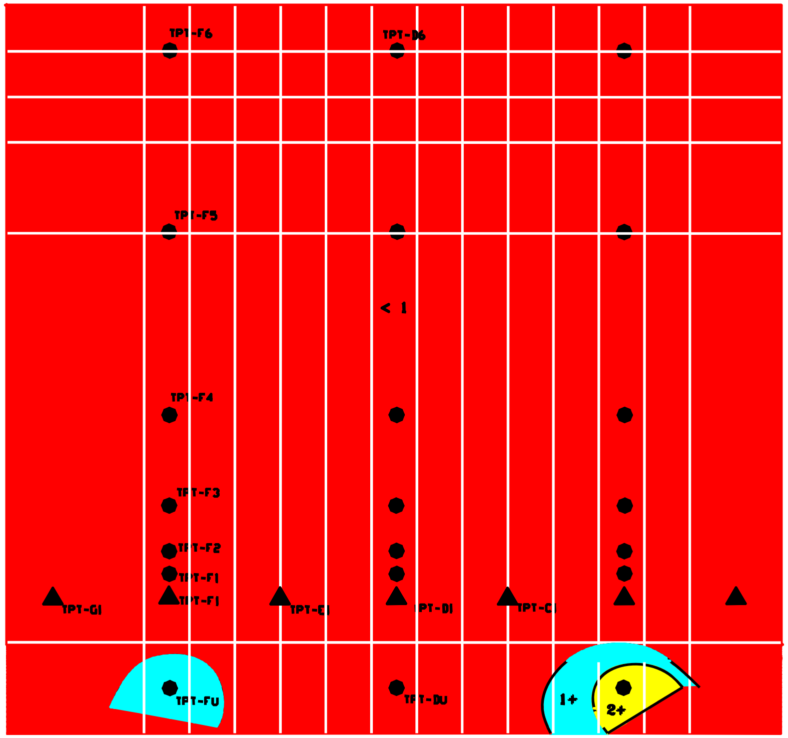
DOWN-HOLE INJECTION FOR WELL WITH LIMITED SURFACE ACCESS

Treatment Zone and Elevated Groundwater PAH Zone

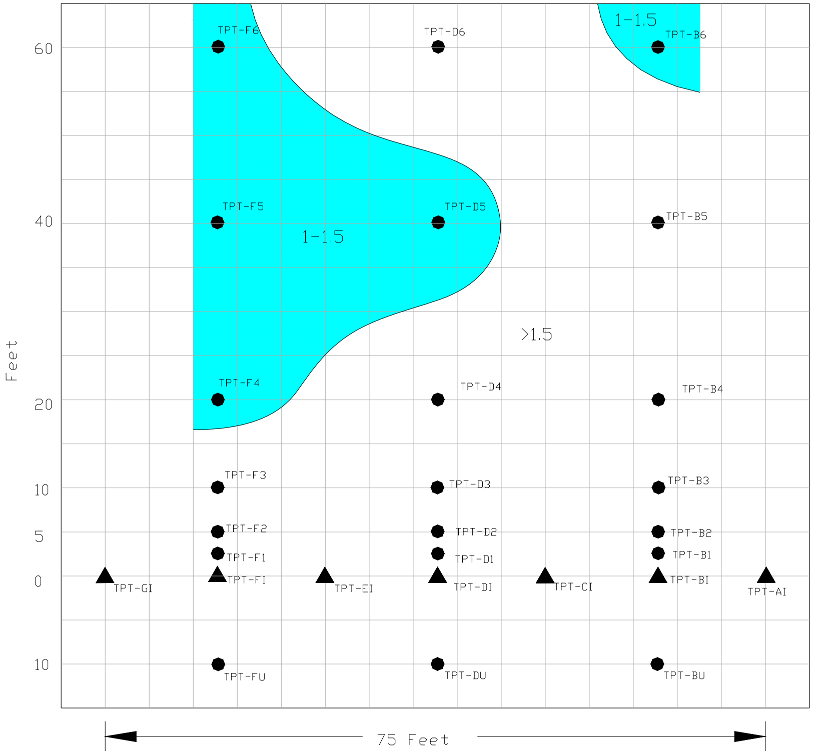


Dissolved Oxygen Contours Before and After Inoculation

INITIAL DISSOLVED OXYGEN CONTOUR



DISSOLVED OXYGEN 5-MONTH AVERAGE CONTOUR



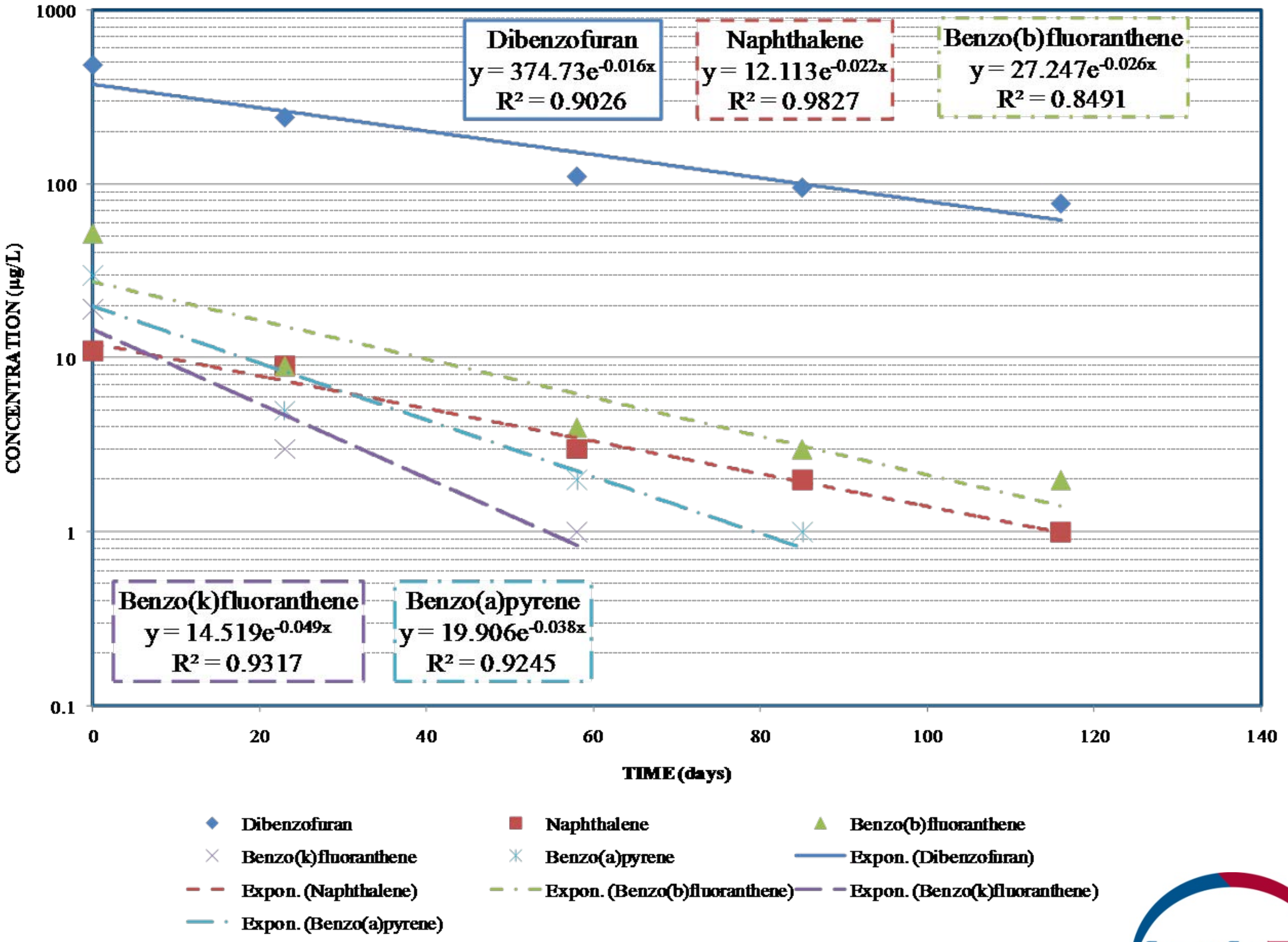
LEGEND

▲ Treatment Well

● Monitoring Well

🟥 0-1
🟦 1-1.5
⬜ >1.5

Degradation Rates from Well D-4



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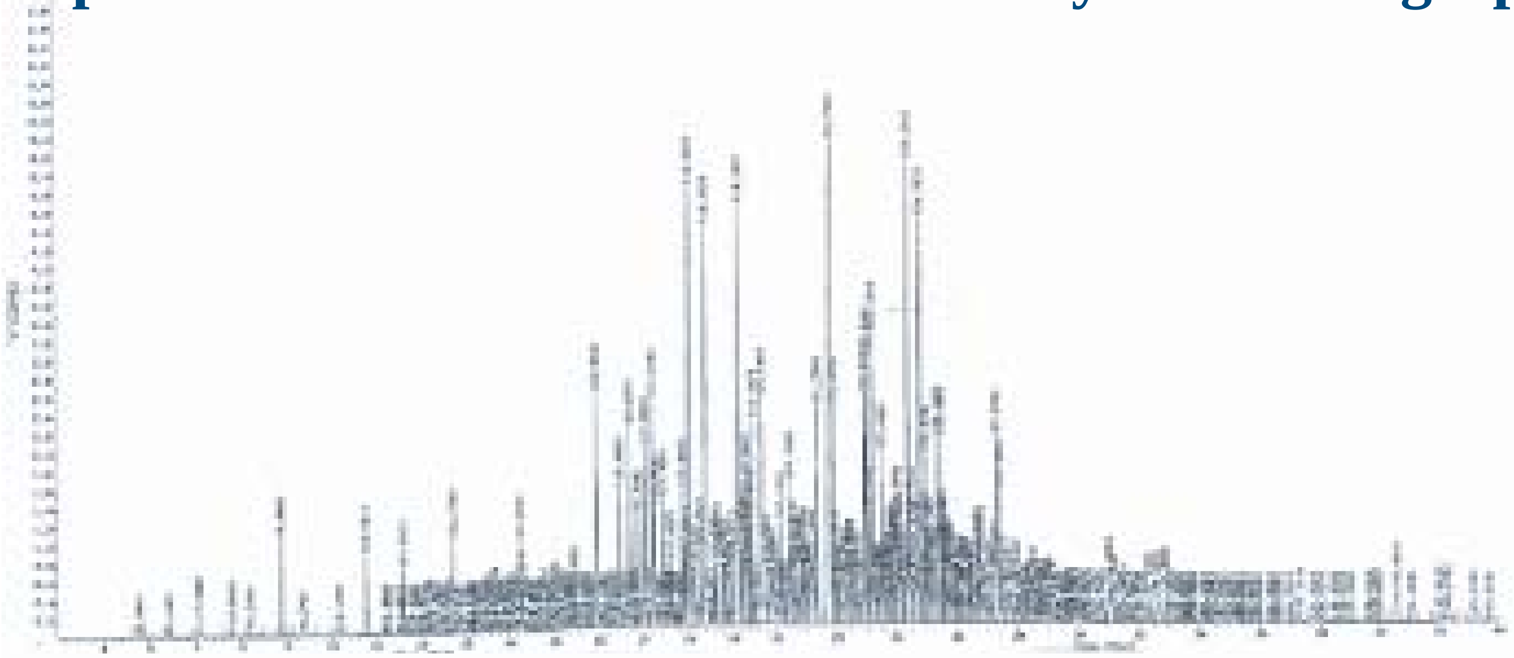
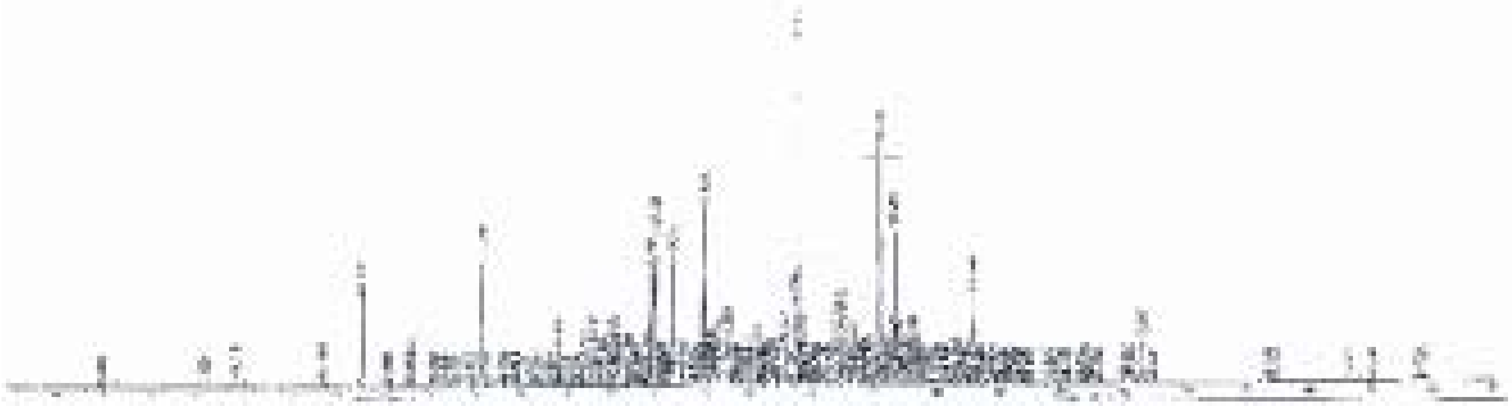
Comparison of Initial and Post Pilot Study Chromatographs



Initial Chromatograph



Final Chromatograph

Chromatograph Scales are 7:1

Well D-4 Groundwater Concentrations

CONSTITUENT	CONCENTRATION (µg/L)						
	7/28/2003	8/20/2003	9/24/2003	10/21/2003	11/21/2003	12/17/2003	11/17/2004
Dibenzofuran	480	240	110	95	77	90	-
2-Methylnaphthalene	1	N.D.	N.D.	N.D.	16	N.D.	-
Naphthalene	11	9	3	2	1	1	N.D.
Acenaphthylene	7	3	1	N.D.	N.D.	N.D.	N.D.
Acenaphthene	500	280	130	97	86	95	N.D.
Fluorene	600	280	140	110	130	100	N.D.
Phenanthrene	1600	550	210	170	96	150	N.D.
Anthracene	130	34	19	15	13	16	N.D.
Fluoranthene	720	160	73	55	39	57	0.43
Pyrene	430	92	45	35	25	34	N.D.
Benzo(a)anthracene	110	18	9	6	4	7	N.D.
Chrysene	97	15	7	5	4	6	N.D.
Benzo(b)fluoranthene	52	9	4	3	2	3	N.D.
Benzo(k)fluoranthene	19	3	1	N.D.	N.D.	1	N.D.
Benzo(a)pyrene	30	5	2	1	N.D.	2	N.D.
Indeno(1,2,3-cd)pyrene	11	2	N.D.	N.D.	N.D.	N.D.	N.D.
Dibenz(a,h)anthracene	4	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	9	1	N.D.	N.D.	N.D.	N.D.	N.D.

Case Study #2:
Wastewater Treatment System

The Situation

Kraft Pulp and Paper Mill

Due to economic demand, production increased

Received NOV for functioning over the discharge permit limits for BOD_5 (3 mg/L)

Mill requested solutions to prevent overloading of BOD_5

Mill requested conduct a BMP in mill

Proposed Solution

- **Abandon the existing facultative lagoon system**
- **Install a mechanized biological wastewater treatment system**
  - Cement ponds
  - DAFT (dissolved air floatation)
    - High maintenance / high energy use

Very expensive to install and maintain

Mill requested AquAeTer to review the proposed solution

Alternative Solution

Keep existing treatment system

- Install aeration mixers to improve efficiency
  - Solar Powered Aeration/Mixers
  - Wind Powered Aeration/Mixers
  - Electrical Aeration/Mixers
- Stagnant water brought to the surface from the lagoon bottom will aerate via diffusion

Implement Best Management Practices reduce loading to the treatment pond (by about 15%)

- Reuse wastewater
- Improve mill efficiencies

Solar Powered Mixers

- Low maintenance
- No cost to run
- Easy to install
- Most effective at improving DO in water at this Mill

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Solution Evaluation

- **Treatability Investigation**
  - BOD_5 decay rate
  - Determined retention time required to meet treatment efficiency
- **Aeration Evaluation**
  - DO
  - Temperature
  - Redox potential
- **Benthic Feedback**
  - Quantify BOD_5 and nutrient feedback from lagoon sediment
  - Quantify oxygen uptake from lagoon sediment

Results

- **Aerating the existing treatment ponds reduced the BOD discharge from the Mill**
  - Of the three aerators tested, the solar-powered mixer was the most effective at improving DO

- **Cost savings from improving the existing wastewater treatment system enabled the Mill to perform maintenance upgrades on the Mill**

- **Mill is now operating within permit limits**

Case Study #3:
Alternative Landfill Cover

The Situation

RCRA Solid Waste Management Unit

Former wood treating plant process area

- Process cylinders
- Drip track
- Tank farm
- Inpoundments

Cover needed to be sufficiently high to not be breached or eroded by the 100 year flood

Federal and State Regulations

Solid and hazardous waste regulations include landfill closure requirements

Other Solid Waste Management Units might be closed "as landfills"

Cover performance requirements:

- Minimize liquid migration
- Design and construct to:
    - Promote drainage
    - Minimize erosion
    - Accommodate subsidence
    - Maximize evapotranspiration
- Minimum maintenance

Long-Term Care for Closed Landfill

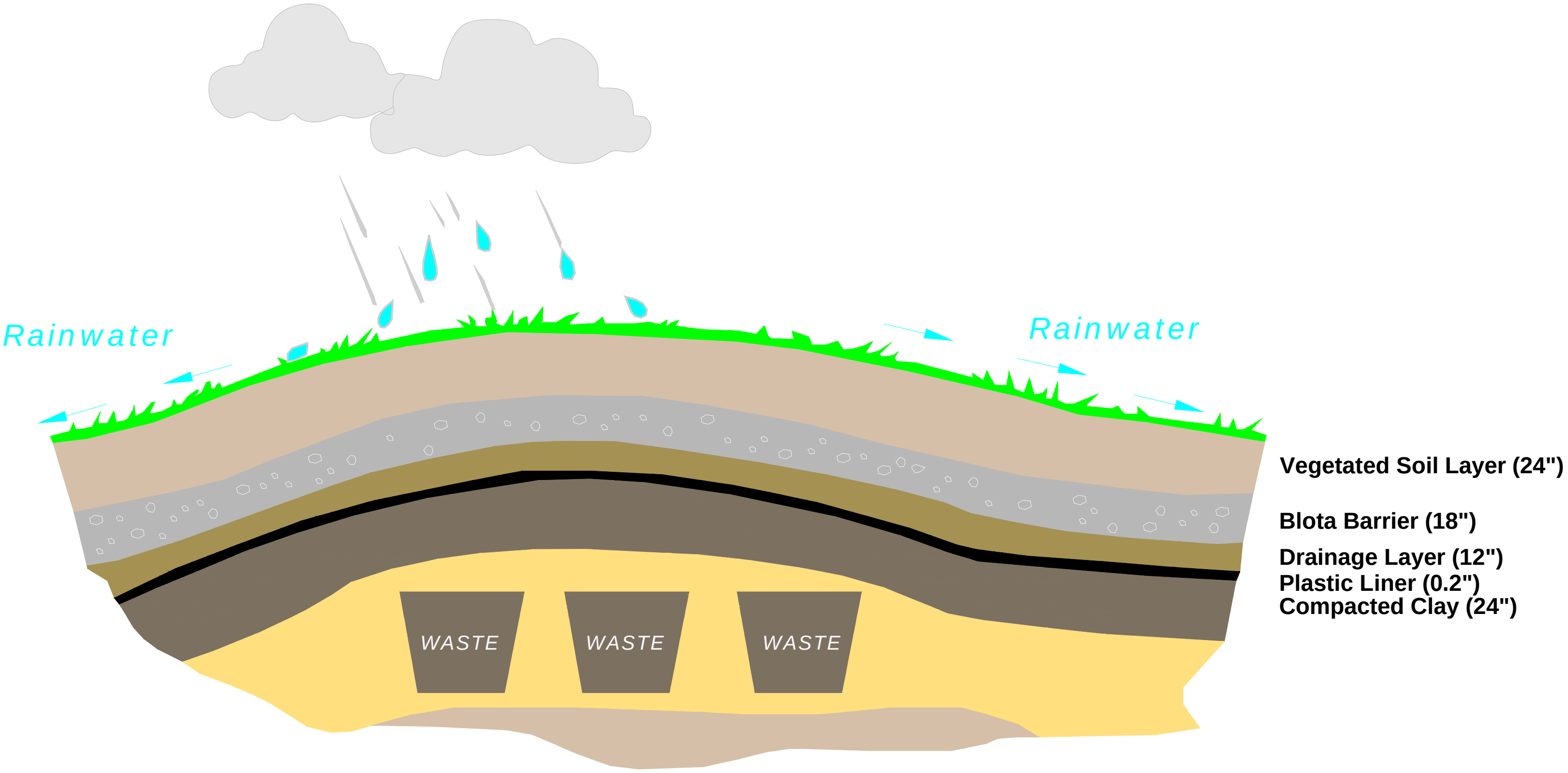
Typically applicable to any closed landfill

Post Closure Care (PCC):

- Inspection
- Maintenance
- Monitoring
- Reporting

Fiscal assurance for 30 year PCC period

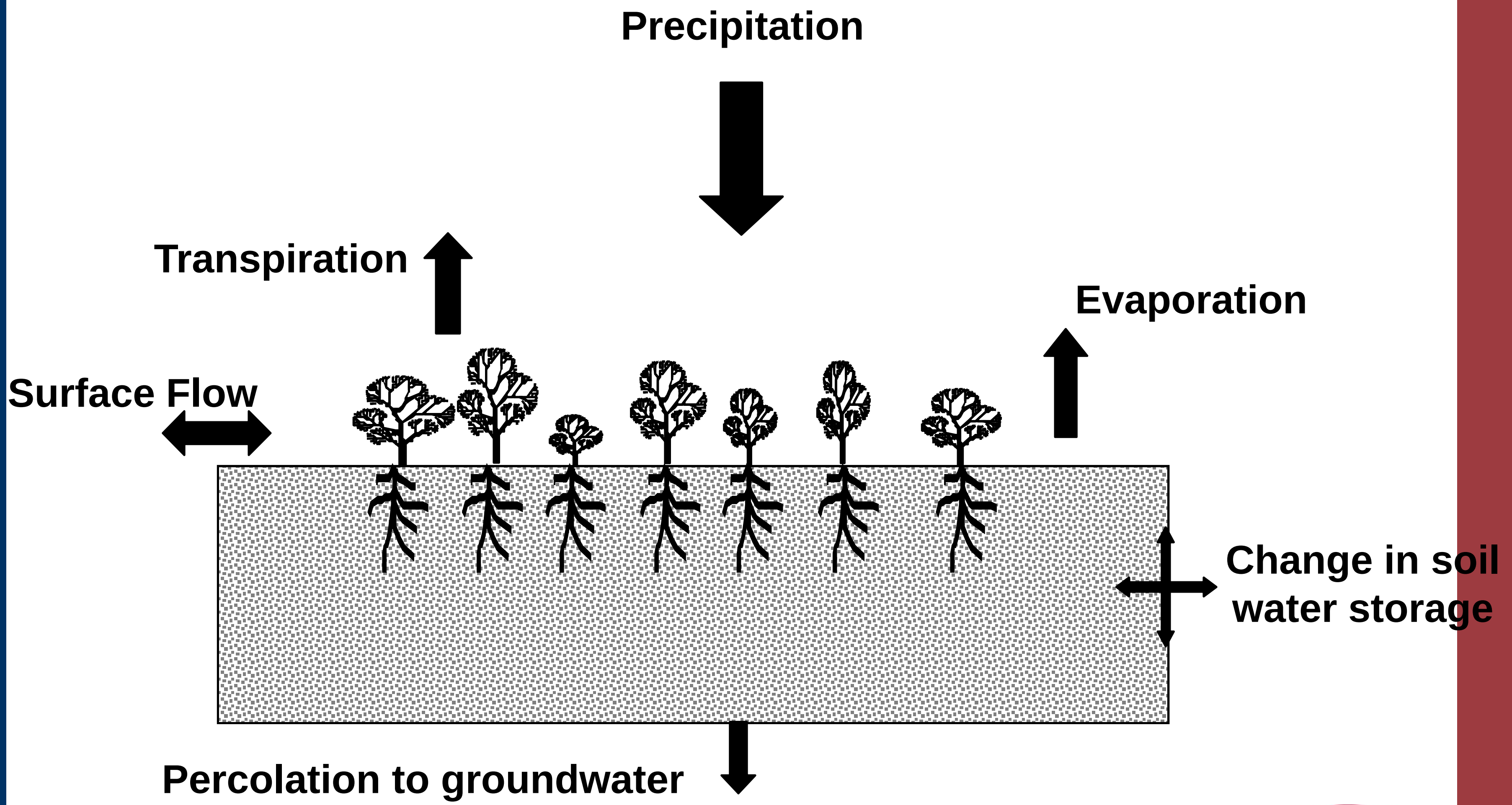
Typical Conventional RCRA Cover



Typical Prescriptive RCRA Cover

Source: ITRC, 2003

Landfill Cover Hydrology



Precipitation

Transpiration

Evaporation

Surface Flow

Change in soil water storage

Percolation to groundwater

Regulations Allow Effective Alternatives

Hazardous waste covers

- If the alternative design will prevent hazardous constituent migration to groundwater or surface water

Solid waste covers

- If the alternative achieves an equivalent reduction in infiltration
- Provides equivalent protection from wind and water erosion

What is an Alternative Landfill Covers?

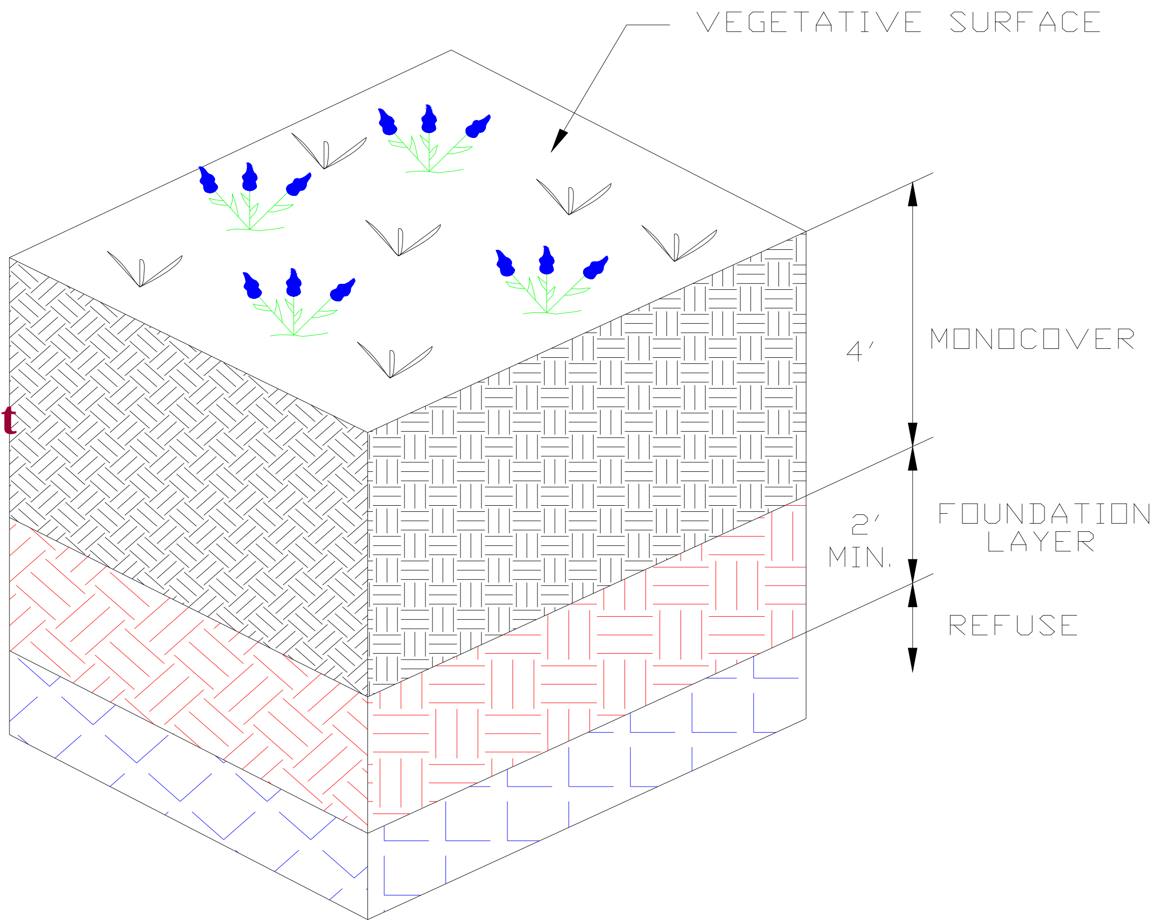
An AFC can be any surface covering of the regulated unit that satisfies the regulatory requirements

AFC's could include:

- Exposed geomembrane covers
- Asphalt or concrete covers
- Monolithic soil covers
- Soil covers incorporating capillary barriers
- Vegetated or evapotranspiration (ET) covers

A Typical Vegetated AFC or ET Cover

- ✓ **Soil provides a water storage reservoir**
- ✓ **Evaporation and plant transpiration empties the reservoir**



Typical ET Cover System Schematic

Source: ITRC, 2003

Proposed Solution

Installation of an alternative (ET) cover over a grouping of RCRA Solid Waste Management Units at a former Missouri wood treating facility

Applicability of Vegetated or ET Covers

Can satisfy long-term performance requirements in most areas of the United States

The initial – screening - performance determination can be made from a simple evaluation of:

- Climatic conditions
- Maintenance friendly (adding repairs to surface, elevation survey to test)
- Available soil materials

Benefits of Alternative Final Covers

AFCs can control infiltration better than conventional final covers

AFCs can offer significant short-term and long-term economic advantages

AFCs offer the potential for improved post-closure groundwater protection

Lower AFC post-closure care costs can reduce financial assurance requirements

Reduced cover costs

- Use of locally available soil
- Reduced design and engineering complexity
- Elimination of expensive cover elements (geosynthetics)
- Reduced QA/QC costs and testing
- Reduced construction cost (less mixing, wetting, compacting)
- Reduced construction time

Improved Groundwater Protection

Without a low-permeability layer, landfill gases are less likely to accumulate and migrate

Reduces groundwater contamination from migration of landfill gas

Methane is degraded in a permeable, vegetated cover, resulting in reduced emissions to the atmosphere

Significance to Financial Assurance

The potential for groundwater problems caused by landfill gas can be reduced under a gas-permeable cover

If a groundwater problem is caused by landfill gas, the corrective measures will be different that when the cause is leachate

Corrective measure and post-closure care requirements that might be less costly and of shorter duration

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Regulatory Acceptance?

Engineering evaluation and design can confirm that long-term performance requirements are satisfied

The AFC can offer economic superiority over conventional covers

However, regulatory acceptance is not assured because the technology is not yet in broad use and might not be well-understood by some regulatory agencies

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Conclusions

- **Strive for economical, socially responsible, and environmental solutions**
- **Complex environmental problems can meet all three pillars of sustainability**
- **Knowledge of environmental systems is important to be able to sustainably resolve problems**