

US EPA ARCHIVE DOCUMENT

Alternatives to Secondary Containment Lining

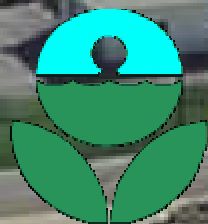
Tarik Hadj-Hamou

Phil Myers

Thierry Sanglerat

GeoSyntec Consultants

**Freshwater Spills Symposium
Cleveland - 19-21 March 2002**



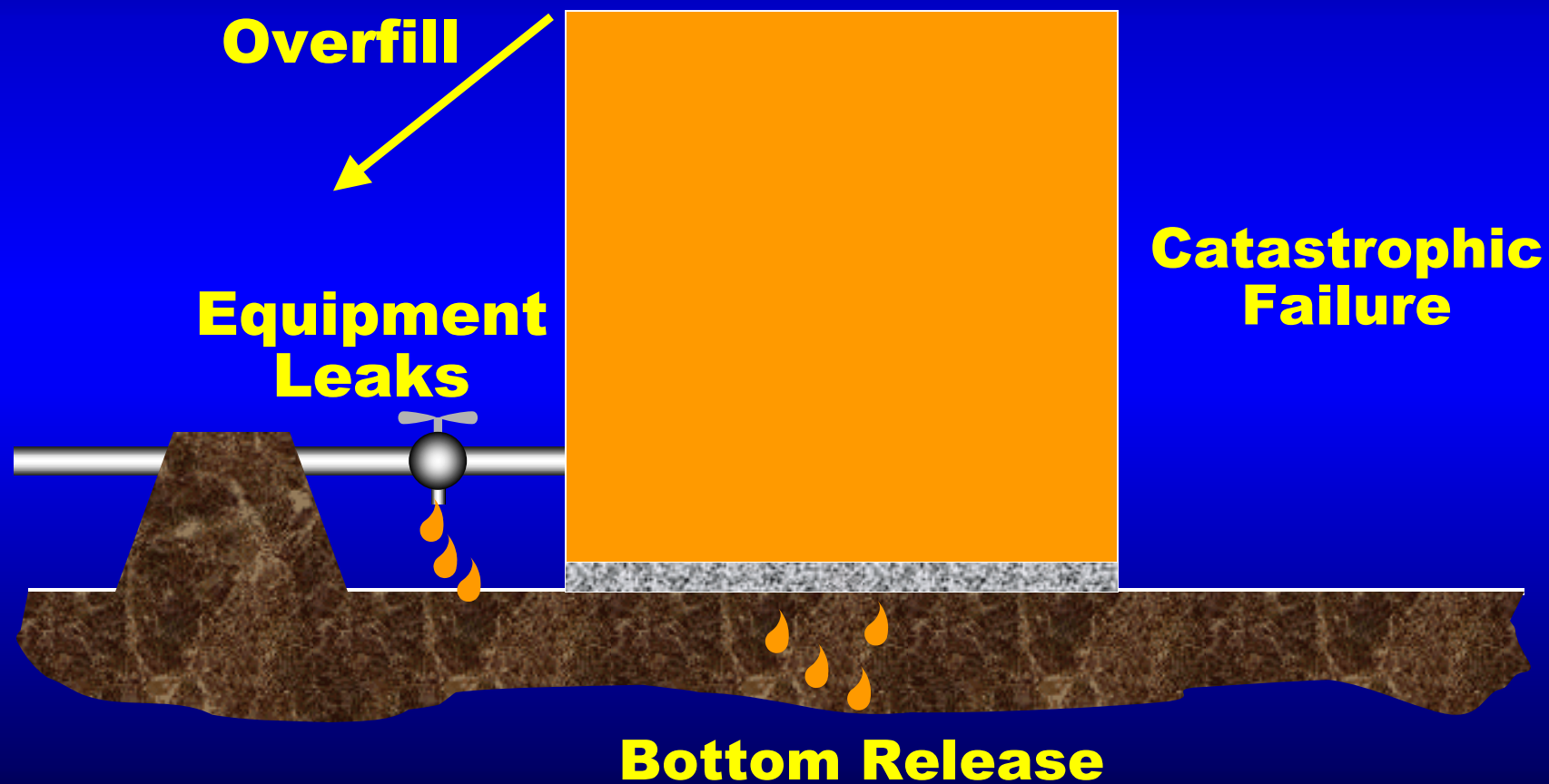
EPA

Statistics

- 
- **500,000 AST Facilities**
 - **1.8 Million ASTs**
 - **80% Without Low-Permeability Secondary Containment**



AST Releases





Pinhole



Secondary Containment

- **Purpose Is to Control, Contain a Spill Until Clean-up**
- **Historically, Concern Has Been Lateral Spreading of Spill**













Secondary Containment

- **Design Concerns**
 - **Provide Adequate Volume (largest tank plus precipitation)**
 - **Allow Operation and Maintenance**



Regulations/Guidance

- **Federal**
 - **Oil Pollutions Act of 1990 Amends Clean Water Act §311**
 - **40 CFR 110 - Discharge of Oil**
 - **40 CFR 112 - Oil Pollution Prevention**
- **National**
 - **Fire Code (NFPA 30)**
- **States**
 - **Departments of Environmental Protection, Quality**



Federal

- **40 CFR §112(e)(2)(ii):**
 - ***All bulk storage tank installation should be constructed as that a secondary means of containment is provided for the entire contents of the largest tank plus sufficient freeboard to allow for precipitation. Diked areas should be sufficiently impervious to contain spilled oil.***



State

- **No Liner Required: CA, IL, MA**
- **No Breakthrough Within 72 Hours: VA**
- **1×10^{-4} cm/sec: MD**
- **1×10^{-6} cm/sec: PA**
- **Reasonably Impervious (6" at 1×10^{-7} cm/sec): MN**



State

- **1×10^{-7} cm/sec: ID**
- **Sufficiently Impermeable: AK and LA**
- **Impervious: KS and WI**
- **Liquid Tight: AL and 32 Other States**



Goals

- **Protect Environment**
- **Using Effective Methods**

Retrofitting Options

LINER OPTIONS		ENVIRONMENTAL/CONTROL OPTIONS	
Surficial Liners	Enhanced Existing Soil Liner	Environmental Controls	Prevention and Enhancement
Geomembrane	Biological Clogging	Slurry Walls	Double Bottoms in Tanks
Geosynthetic Clay Liner	Chemical Clogging	GW Control	Leak Detection Systems
Compacted Clay	Soil Cement		Preventative Measures
Concrete	Chemical Grouting		Backflow Prevention
Asphalt	Soil Bentonite		Overfill Prevention
Spray-On Liners			Operational and Procedural Controls


GEO SYNTec

Retrofitting Options

Site Conditions	Engineering Design	Construction	Operator Issues	Cost
Existing Conditions	Product Compatibility	Constructability	Operation & Maintenance	Capital
Geometry	Desiccation Resistance	Availability of Materials	Operational Flexibility	Maintenance
Penetrations	Freeze-Thaw Resistance	Weather	Storm Water Management	Clean-up
Regulatory Acceptance	Temperature Extremes		Clean-up	Remediation
	Wind Resistance		Subsurface Remediation	
	Ultraviolet Resistance		Trafficability	
	Fire Resistance		Vegetation Control	



Retrofitting Options

GRADE	DEFINITION
A	Satisfactory Performance With Minimal Extra Effort
B	Satisfactory Performance if Specific Design Elements are Implemented
C	Significant Extra Effort May Be Required To Achieve Satisfactory Performance
D	Satisfactory Performance May Not Be Feasible
F	Satisfactory Performance Will Not Be Feasible



Example

- **Tank Farm: 7 Tanks**
 - **Total Area: 140,000 ft²**
 - **Open Area: 83,000 ft²**
 - **Area of Bottom: 57,000 ft²**
 - **Height of Dikes: 5 ft**
- **Largest Tank:**
 - **Diameter: 120 ft**
 - **H_{Product} = 46 ft**
 - **V = 93,000 bbls**



Example

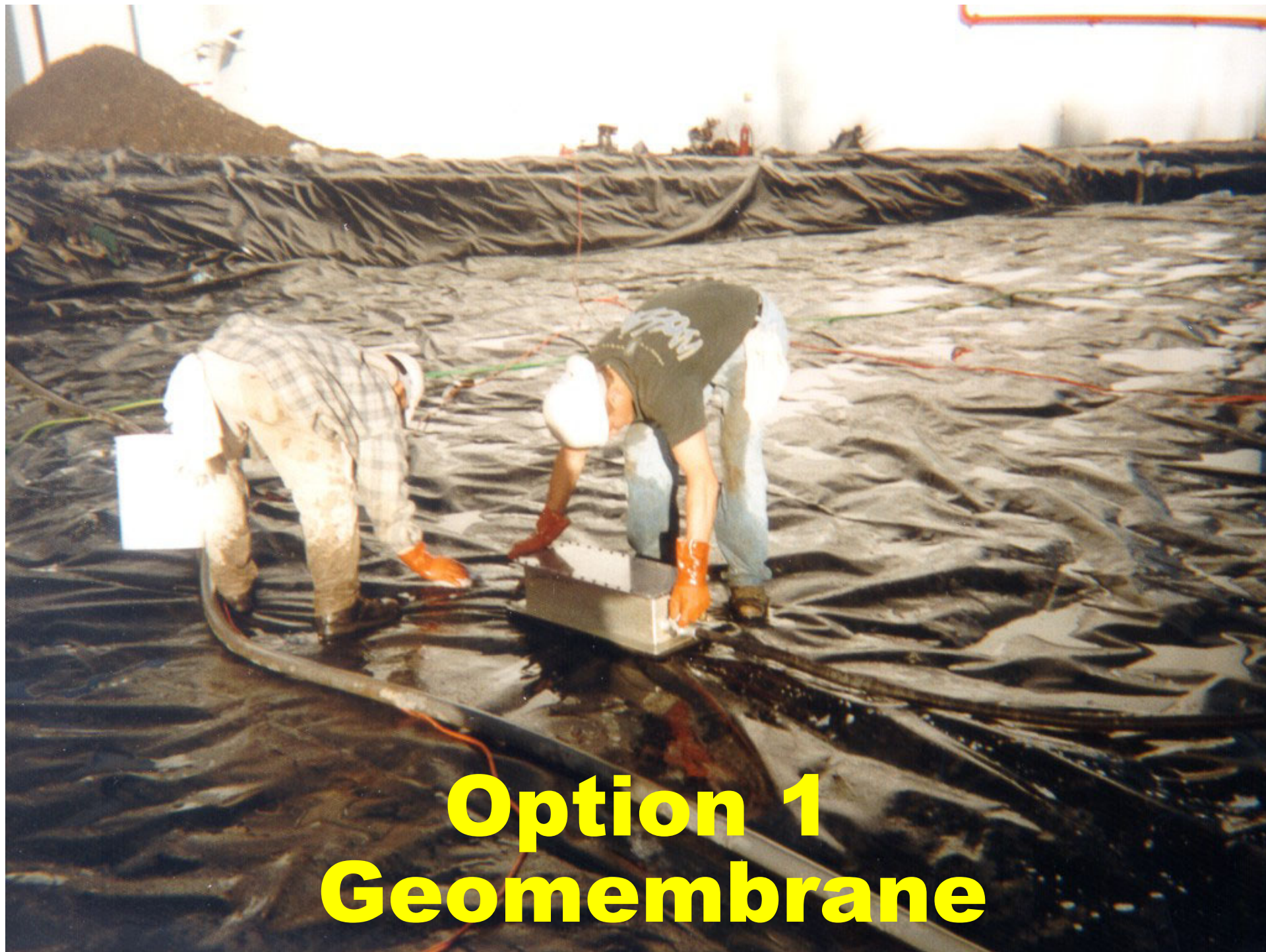
- **Soil:**
 - **Homogeneous Sand Deposit**
 - **$k = 10^{-5}$ m/sec**
 - **Porosity: 0.35**
 - **Thickness: 100 ft**
 - **Groundwater Depth: 5 ft**



Evaluation of Options

- 1. Geomembrane**
- 2. Geosynthetic Clay Liner**
- 3. Spray-On Liners**
- 4. Compacted Clay**
- 5. Concrete**
- 6. Asphalt**





**Option 1
Geomembrane**



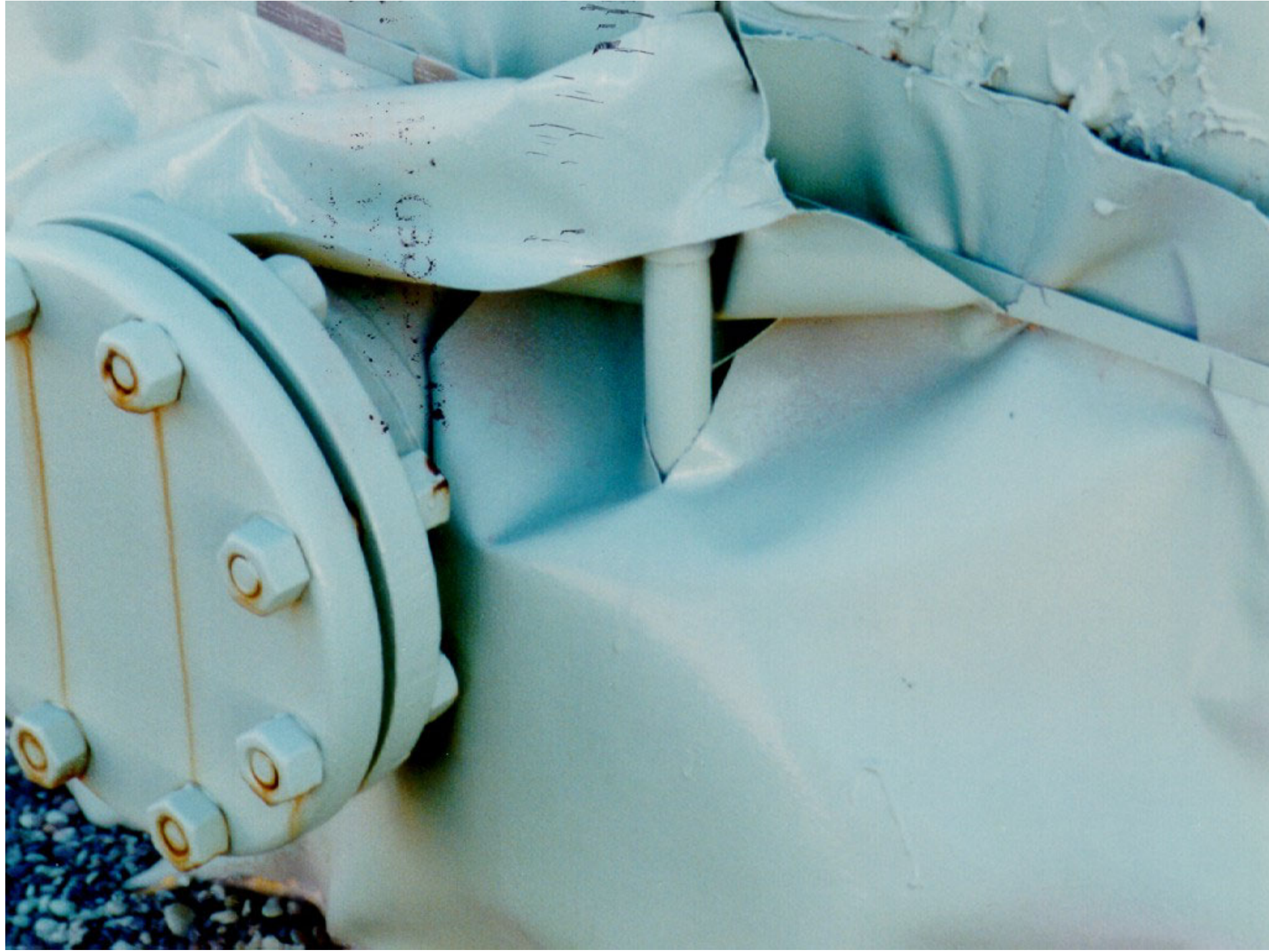
Option 2 Geosynthetic Clay Liner











Alternative Option

**Install Double Bottoms
and Overfill Protection
in Tanks and Do Not
Install Liner in the
Diked Area**



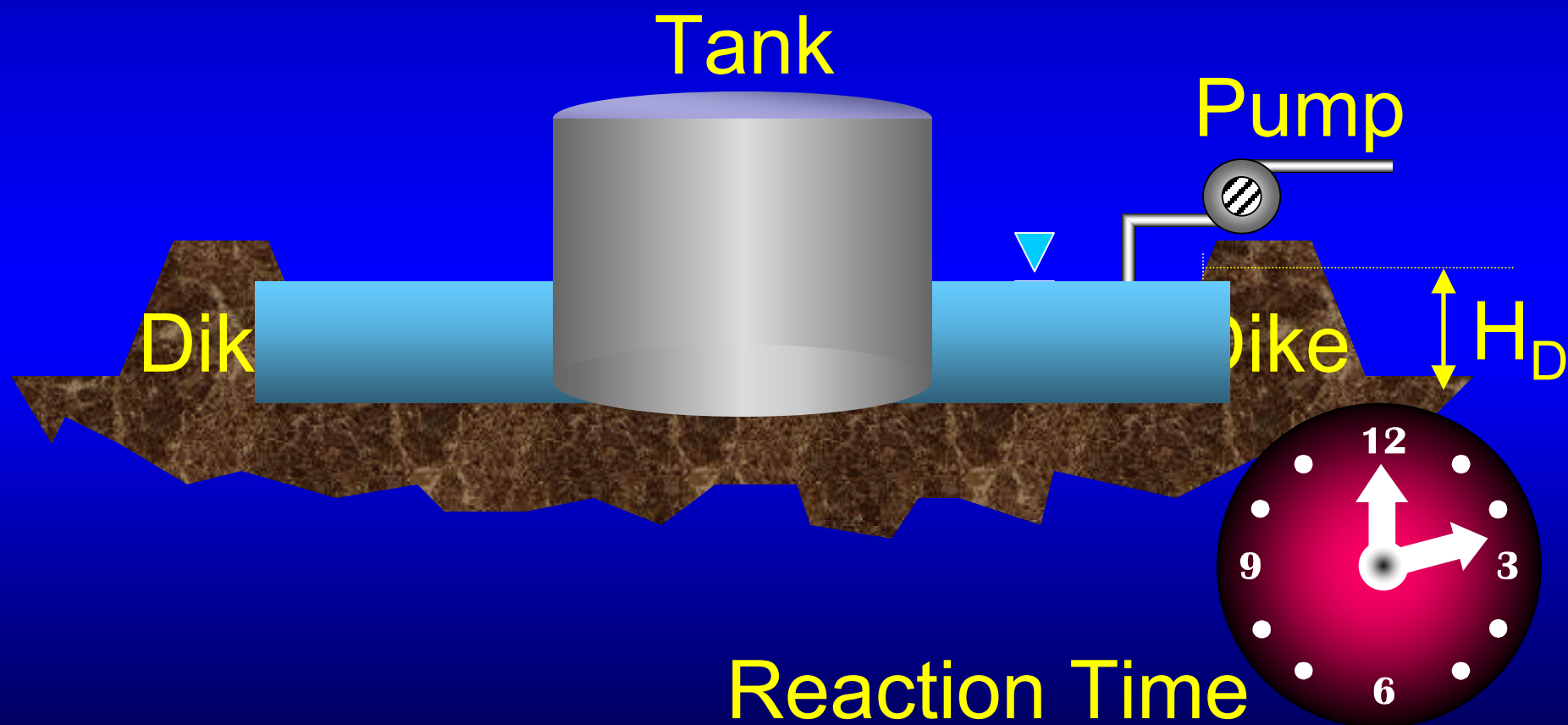
Comparison

Analyze two Scenarios:

- 1. Liner and Single Bottom**
- 2. No Liner, Double Bottom, Overfill Protection, and Product Removal System**



Scenario 2



Comparison

- **Compare Volumes of Product Released to the Environment:**
 - Leaks
 - Catastrophic Failure
- **V_1 = Volume Under Scenario 1**
- **V_2 = Volume Under Scenario 2**



Performance Ratio

$$PR = \frac{V_1}{V_2}$$

$PR > 1 \Rightarrow$ Scenario 2

$PR < 1 \Rightarrow$ Scenario 1

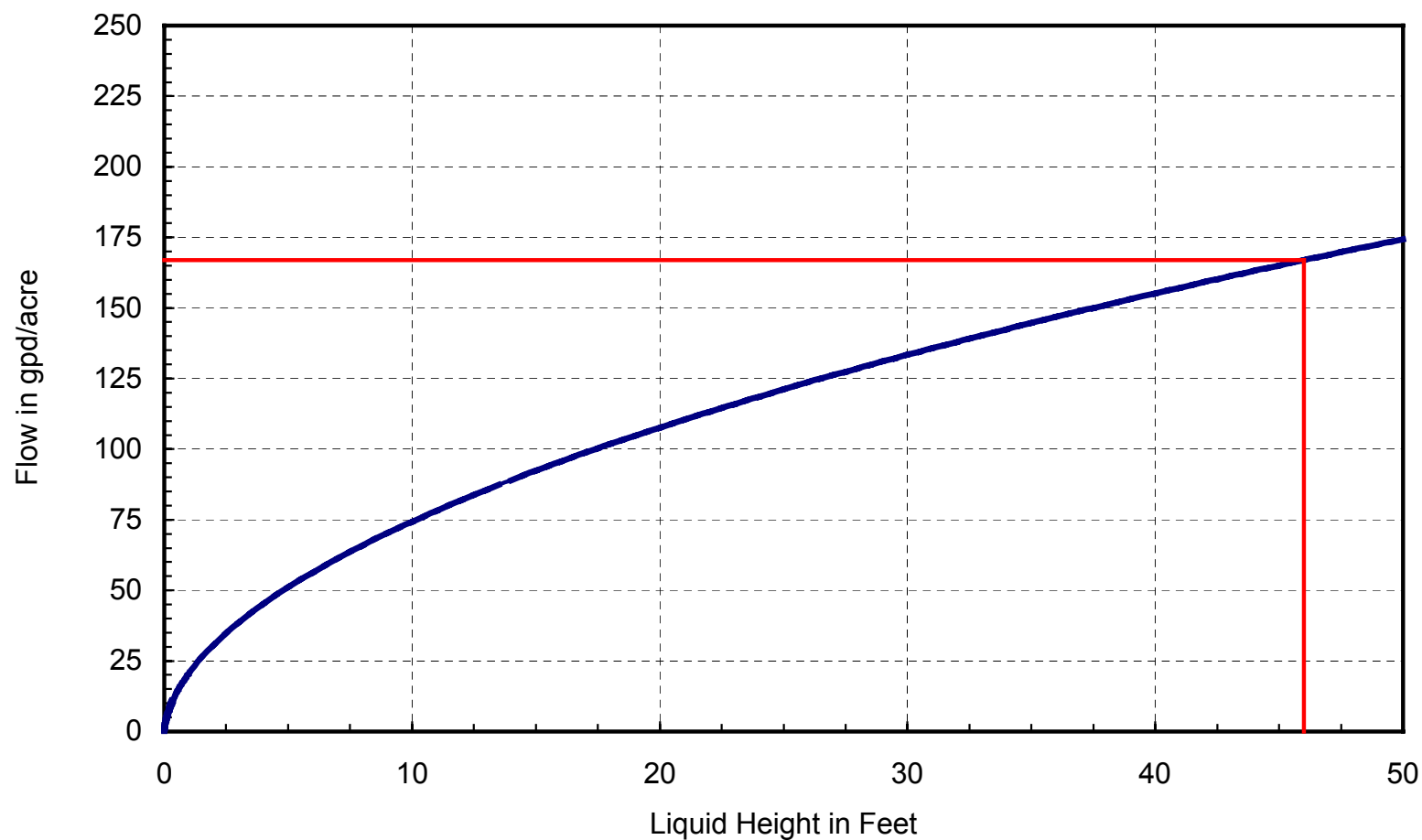


Scenario 1

- **Assume Bottom Leak:**
 - **Pinhole $d = 0.04$ in. (1 mm)**
 - **1 Pinhole / Acre of Bottom**
 - **57,000 ft² of Bottoms**
1.32 Acres
- **$V_1 = (\text{Bottom Leakage Rate})$
 $(\text{Area of Bottom})(\text{Time})$**



Pinhole Leakage Rate

**GEO SYNTec**

Scenario 1

- **From Graph Rate = 167 gpd/acre**
- **$V_1 = (167)(57000/43560)(365)(42)$
= 1,899 bbls/yr**



Scenario 2

- **Assume Catastrophic Failure of Tank**
- **Assume Leak in Double Bottom**
- **$V_2 = (\text{leakage rate})(\text{area of bottom})(\text{time}) + (\text{volume infiltrated in soil following catastrophic failure})$**

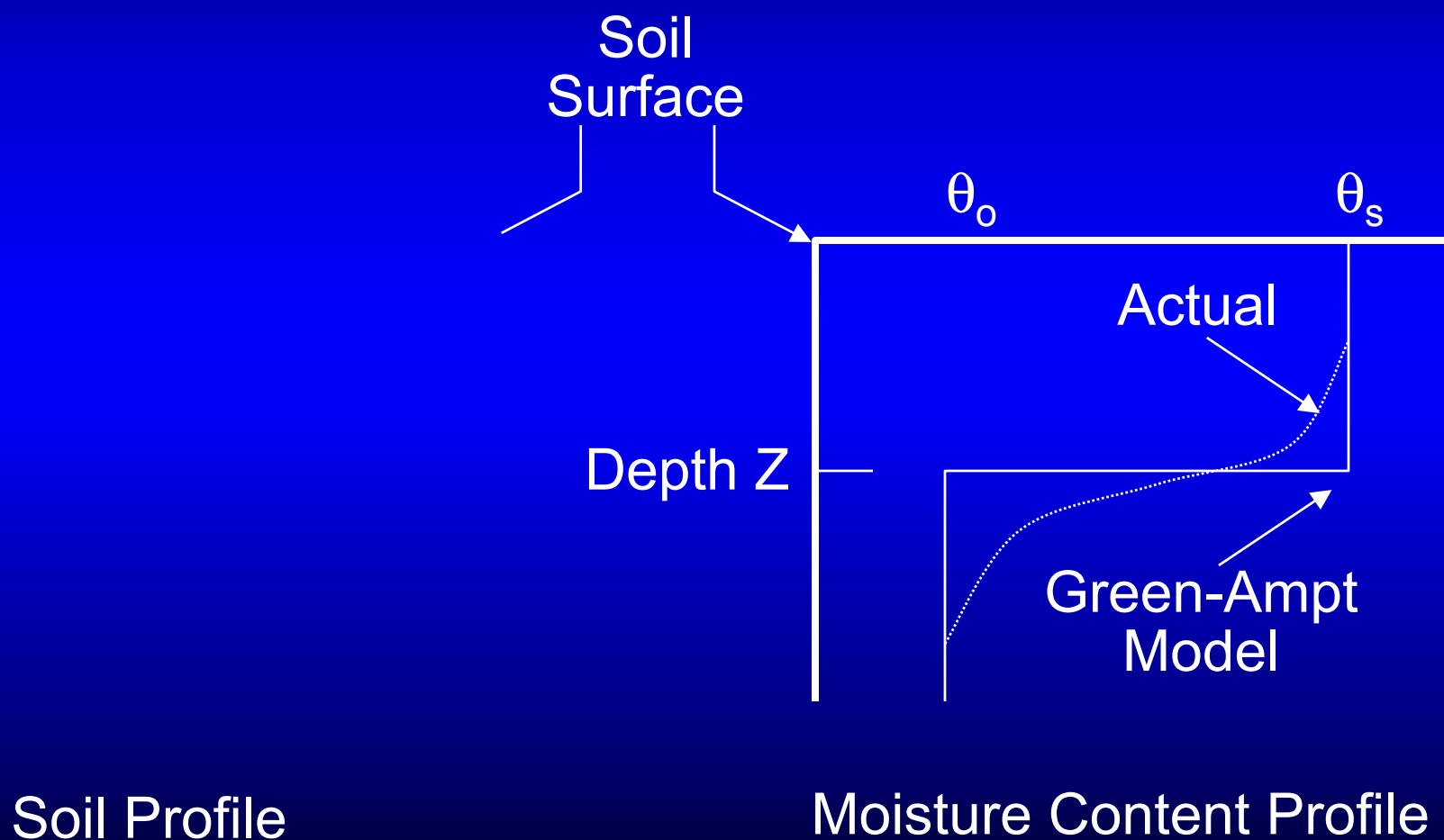


Infiltration Following Catastrophic Failure

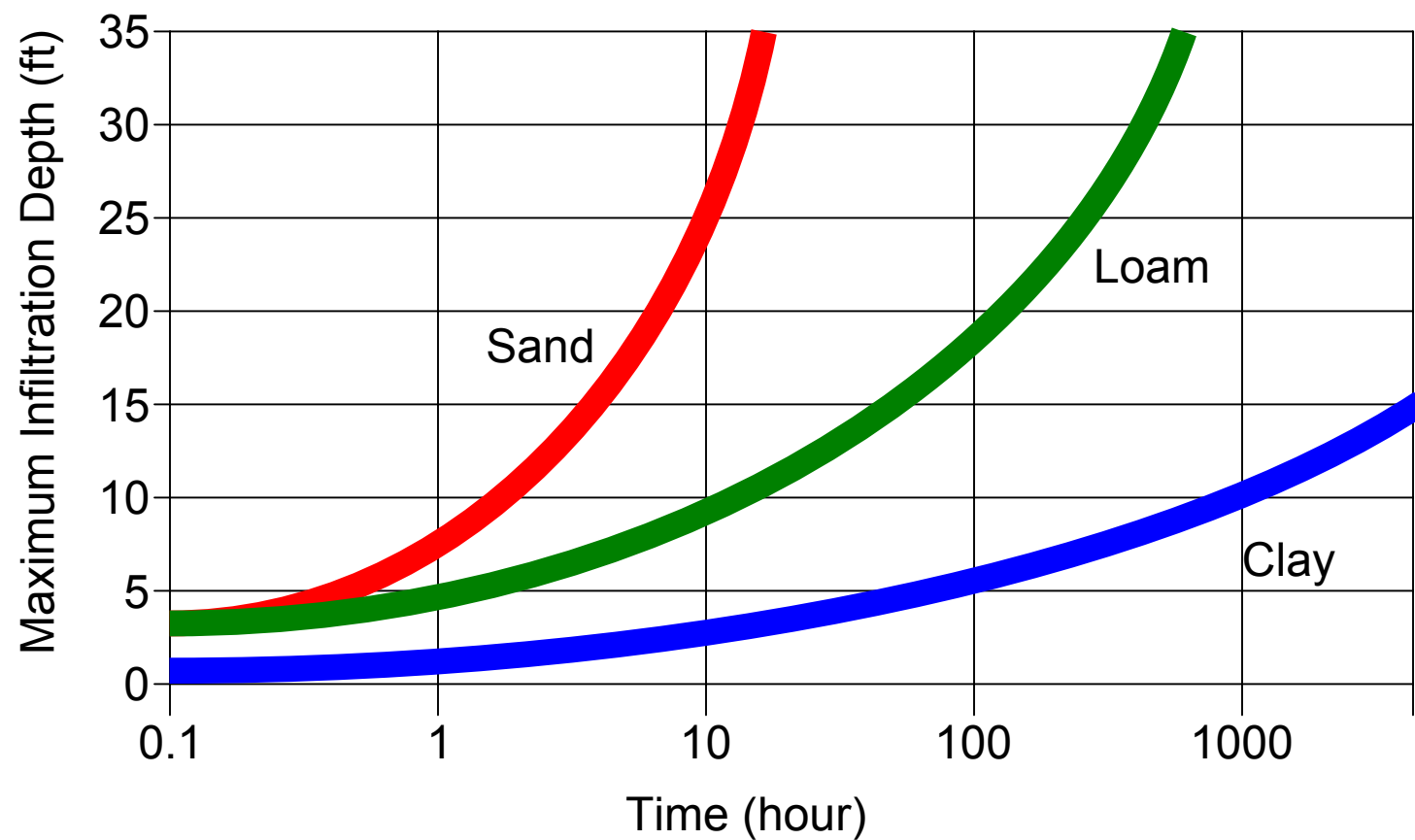
- **Using XSLIM**
 - **93,000 bbls**
 - **2,500 gpm Pump**
 - **Pumping Start in 6 hrs**
 - **Depth of Penetration: 0.54 ft**
 - **Volume of Product in Soil:**
$$(0.54)(83,000)(5.6)(0.35) =$$
2801 bbls



XSLIM - Infiltration Model



Soil Type



Infiltration Following Catastrophic Failure

- **Using XSLIM**
 - **Depth of Penetration: 0.54 ft**
 - **Volume of Product in Soil:**

**$(0.54)(83,000)(5.6)(0.35)$
2801 bbls**



GEO SYNTEC

Scenario 2

- From Graph Rate = **2.88 gpd/acre**
- $V_2 = 2801 +$
 $(2.88)(57000 / 43560)(365) / (42)$
= 2,801 + 32.8 bbls/yr



Performance Ratio

$$\text{PR} = \frac{1,899 \text{ bbls/yr}}{2,801 + 32.8 \text{ bbls/yr}}$$

PR > 1 $\Rightarrow$ Scenario 2

PR < 1 $\Rightarrow$ Scenario 1



Performance Ratio

Performance

**Unless There Is a
Catastrophic Failure Every 6
Years, the 0.5 mm Bottom
Leaks Are a Greater Risk to
the Environment Than the
Catastrophic Failure**



Conclusion

- **Select Optimum Alternative for Secondary Containment Based on:**
 - **Environmental Consequence**
 - **Multiple Criteria**
- **In Example, Work on Tank Provide Better Protection**

