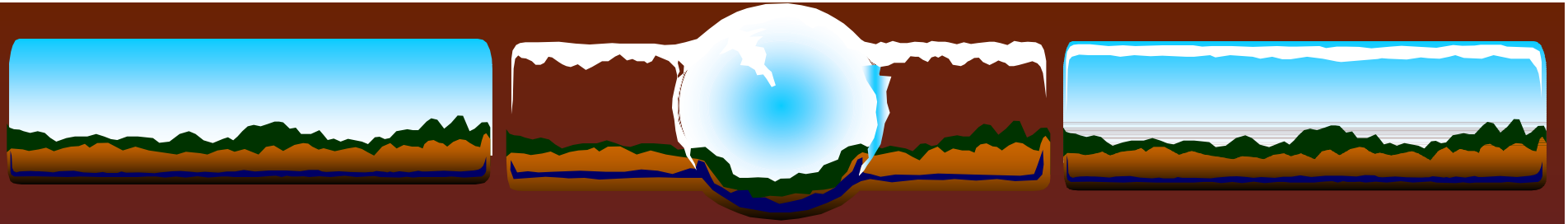
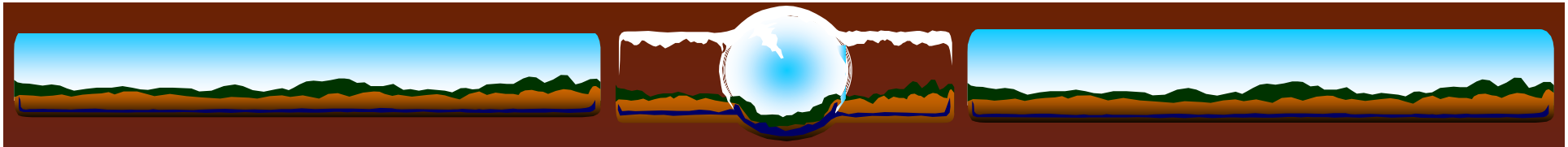


# PROPOSED CLEANUP GUIDELINES for SMALL CRUDE OIL SPILLS using BIOREMEDIATION

## (PROCESS SELECTION FLOW CHART)*

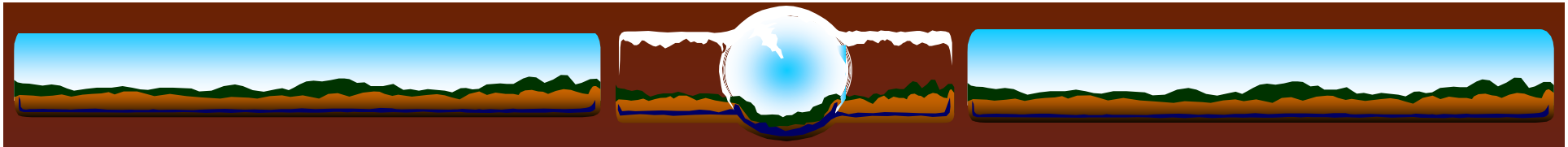
James Brown, Lockheed Martin/REAC
Harry Allen, USEPA/ERT

***Prerequisites for Acceptance by Small Independent Oil Producers are that Guidelines be SIMPLE, EFFECTIVE & LOW COST**



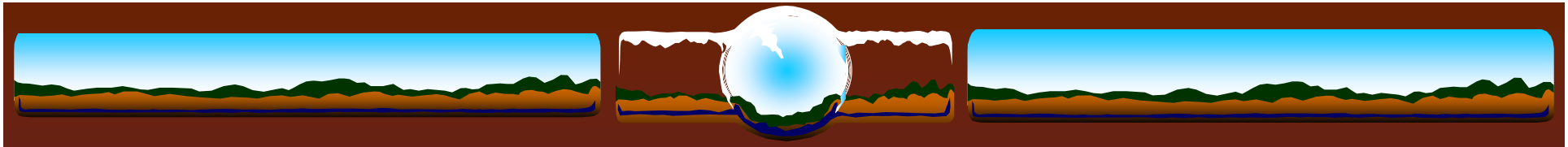
# Type of Treatment

## Ex-Situ Bioremediation using a Small Consolidated Treatment Cell



# How Clean is Clean?

- Absence of Petroleum Odor?
- 1% Petroleum Hydrocarbons?
- 1000 mg/kg Petroleum Hydrocarbons?
- State ARARs
- Removal of Carcinogenic PAHs
  (4-6 Ring PAHs Absent)



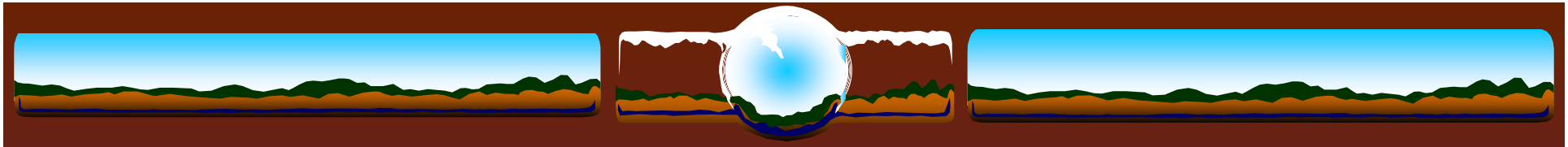
# Site Selection

## (Requires Tech. Support)

**Select a Moderately Well Drained, Accessible Site at Least 300 Feet from the Nearest Potable Water Supply Well, and 100 Feet from the Nearest Surface Water.**

**The Required Area is Proportional to the Volume of Petroleum-Contaminated Soil to be Treated**

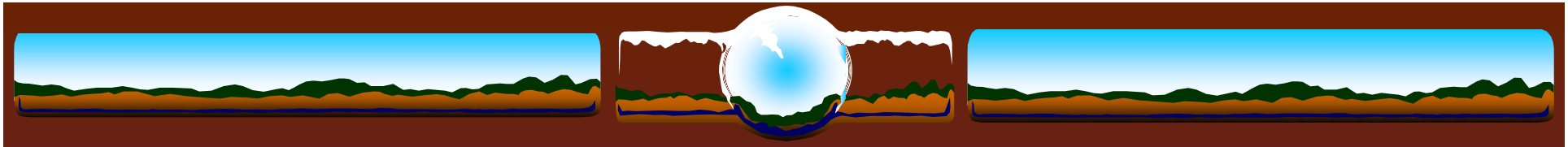
**(2,000 $ft^2$ average)**



# Soil Excavation & Consolidation

**Excavate Petroleum-Contaminated Soil & Transport to the Consolidated Treatment Cell.**

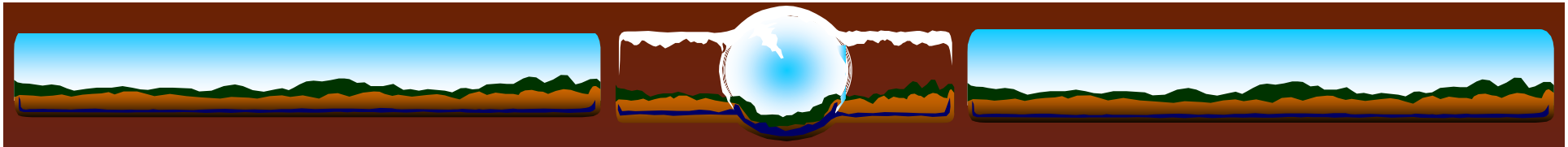
**Cover soil prior to treatment to prevent loss of VOCs.**



# Treatment Cell Construction

**(requires tech. support)**

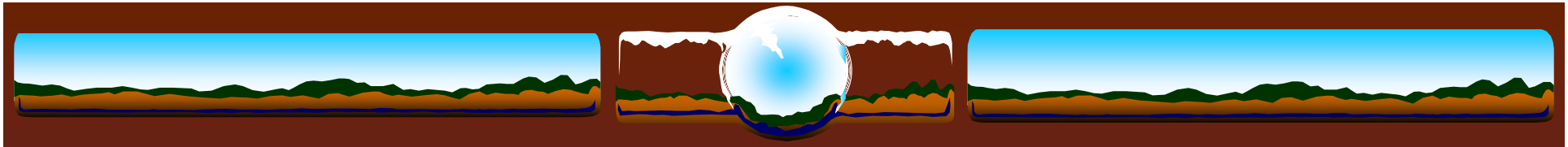
- **break up subgrade surface to prevent compaction**
- **add 2 inches of composted hardwood bark or chopped hay/straw**
- **add 500 lb finely pulverized agricultural limestone per 1,000 $ft^2$ (12 Ton/Ac)**
- **add 2 inches of sand (or clean soil, sandy loam or coarser (USDA)**



# Treatment Cell Construction

## (continued)

- add 2 inches of petroleum-contaminated soil/sediment
- add 1/4 of total N + all required P & K, based on a C:N:P:K ratio of 50:1:0.2:0.1 and 75% C in petroleum residues
- rototill until soil and bulking agents are well blended (6-7 times)



# Select a Preferred Treatment Option

- Active Land Treatment

(weekly tillage)

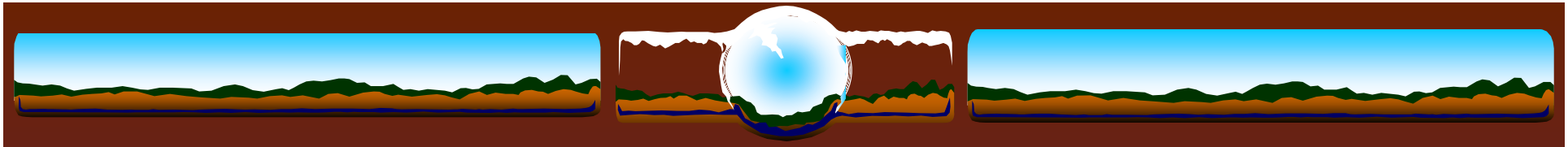
(or)

- Phased Treatment

(2 months weekly tillage, then seeded to TPH tolerant grasses)

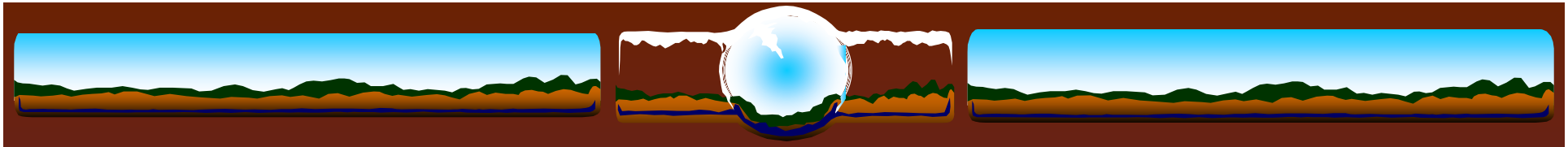
(or)

- Passive Treatment, seeded to TPH tolerant grasses



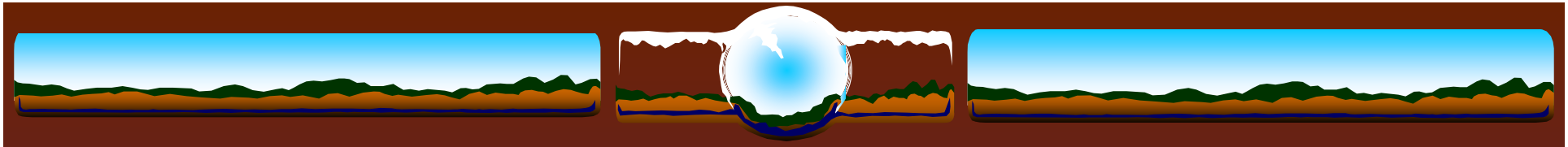
# O & M Requirements

- Add N Fertilizer Monthly
- Till to a full 6-inch working depth



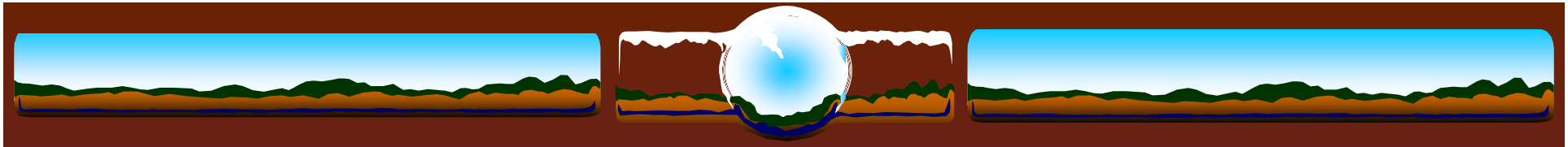
# Treatment Cell Reuse

- Use one half the original TPH loading
- Soil quality improves with time
- Cell can be reused indefinitely



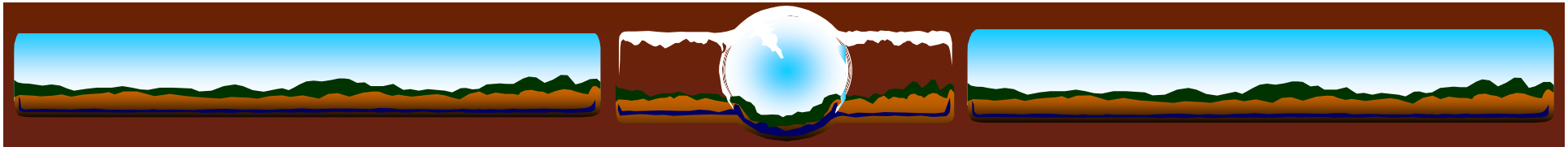
# Assumptions

- **Initial Soil TPH**
  **4 to 6% (est.)**
- **Estimated Time for Treatment**
  **About 1 Year**
  **(based on 1 full-scale field study)**
- **How Clean is Clean? – Absence of Petroleum Odor After 4 Months**



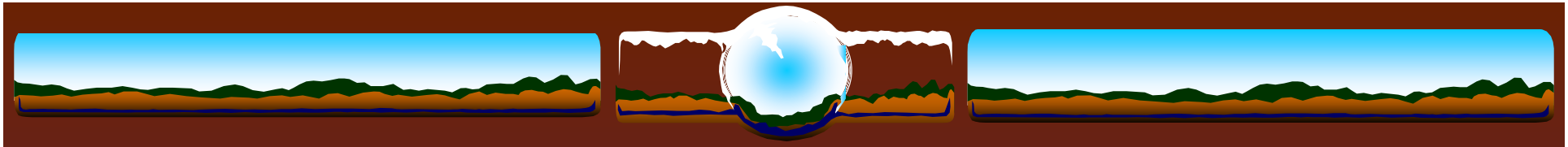
# Allegany, New York Site

- Develop Simple, Effective, Low-Cost Bioremediation/ Phytoremediation Methods to Independent Oil Producers for Treatment of Small Crude Oil Spills



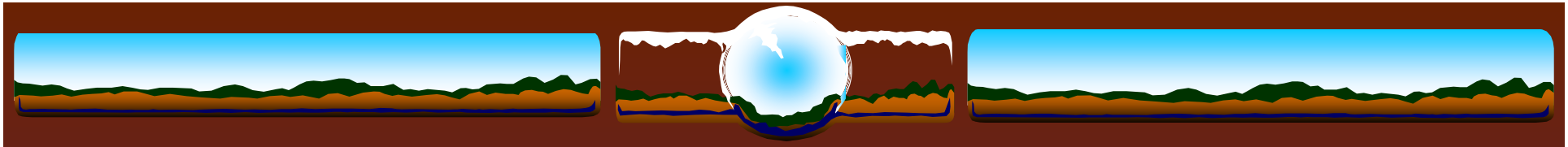
# Objectives – Allegany, New York Site

- Field Testing of Proposed Guidelines
- Treatment Effectiveness Comparison



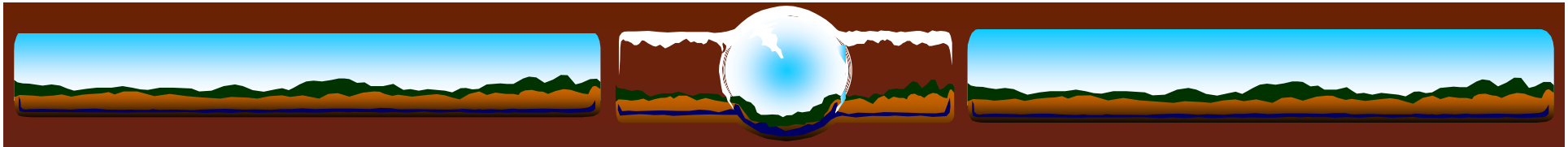
# Adverse Effects of Petroleum Hydrocarbons on Soil Quality

- Soil Effects
  - Hydrophobic
  - Degraded structure and consistence
  - Poor aeration
  - Reduced pH and nutrient buffering



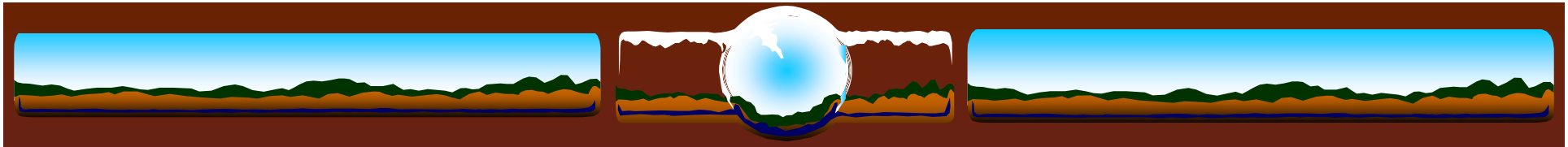
# Soil Quality Improvement

- Avoid compacting treatment cell surface/loosen if required
- Add large quantity of bulking agents (1:1 ratio or more)
- Add large quantity of limestone (10 tons/acre 6 inches)
- Add fertilizer to attain C:N of 40:1 using Monthly Additions - Avoid High Soil Salinity



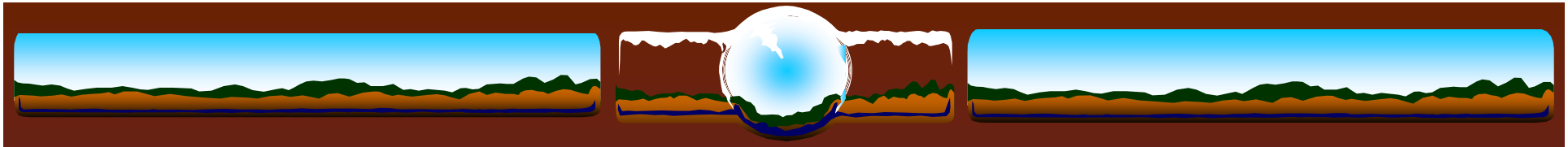
# NY and PA Crude Oil Highly Treatable by Bioremediation

- 93% n-alkanes
- 90% TPH removal in 5-month treatability study



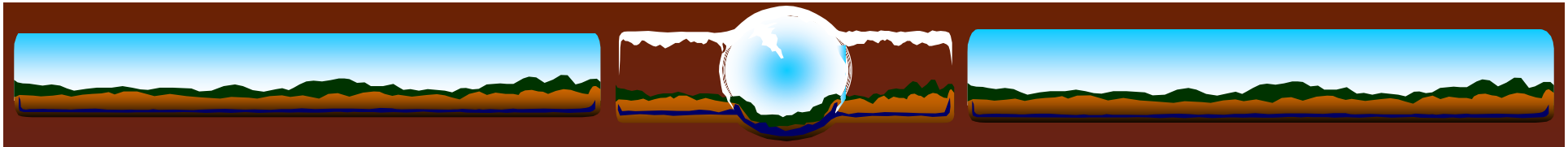
# Regional & Soil Limitations

- 4-month treatment season
- fine textured soil
- poor drainage



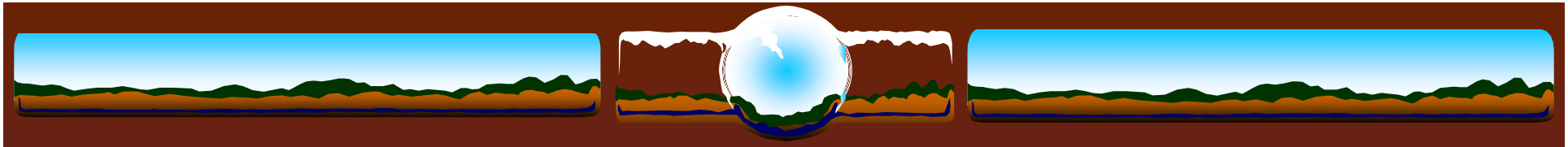
# Requirements for Success

- DRAINAGE
- Soil Quality Improvement (SQI)



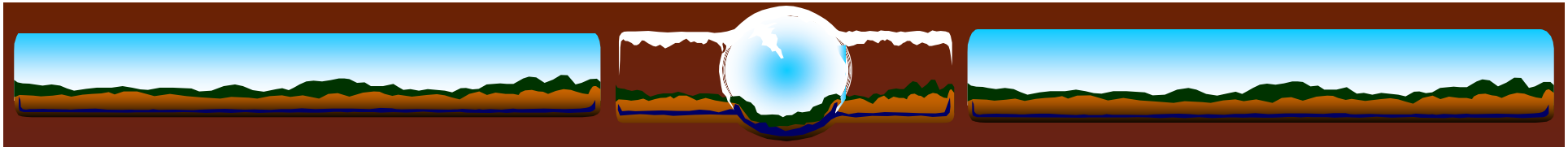
# Treatments Tested in 2004/2005

- Active land treatment
- Phased treatment
- Passive treatment with vegetative cover



# Treatment Effectiveness Comparison

- 2-Year Field Test (2004/2005)
- Experimental design - randomized block design/4 blocks
- First Year/Results
  - 3.2% TPH $\rightarrow$ < 1%
  - No significant difference between treatments



# Guidelines for Independent Oil Producer Cleanups

- **MUST BE:**
  - SIMPLE
  - EFFECTIVE
  - LOW COST

# Initial Soil Stockpiles
# September 2003

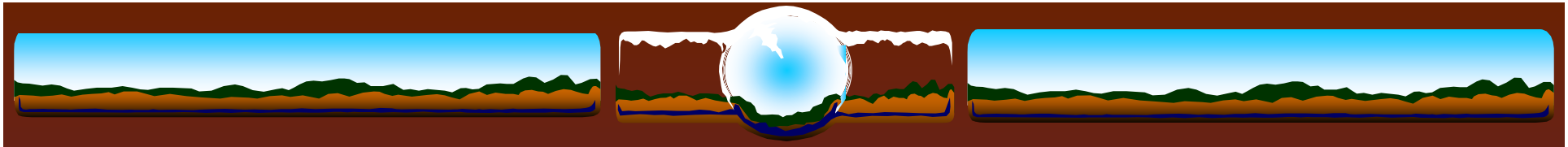
# Weathered Hay as Bulking Agent

# Loosening Compacted Subgrade

# Liming

# Treatments
# October 2003

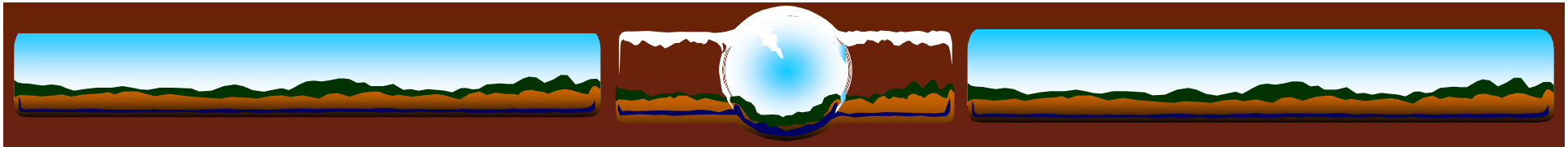
# Mulched Surface (Piezometer in Foreground)



# Treatment Cell Construction Issues:

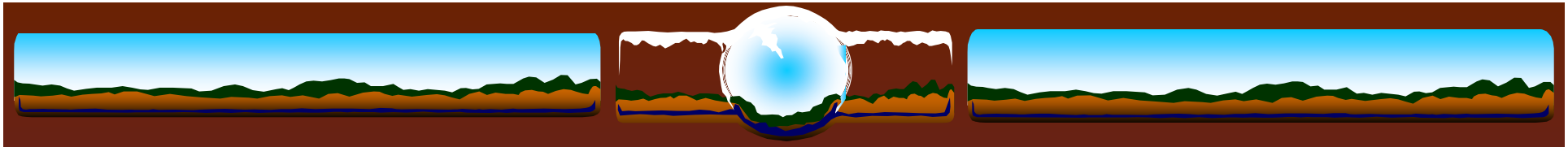
## (do it right the first time)

- Some construction management required
- Raised sand bed for poorly drained sites
- Bulking agent [1/3 vol] - commercial compost ($) vs grass hay (binds on tiller)
- Blended on-site soil (stony) vs sand ($) [1/3 vol)

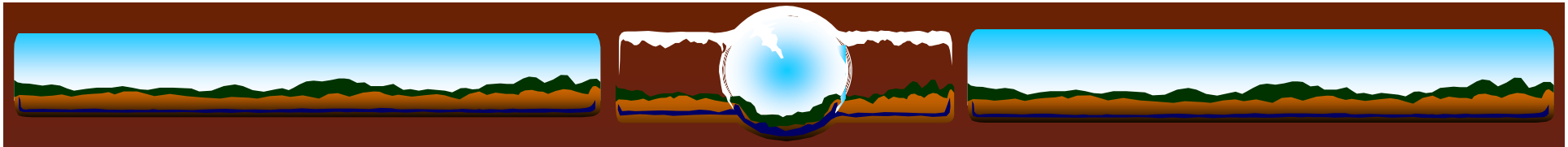


# Monitoring?

- TPH in soil VOCs in groundwater (state issue)



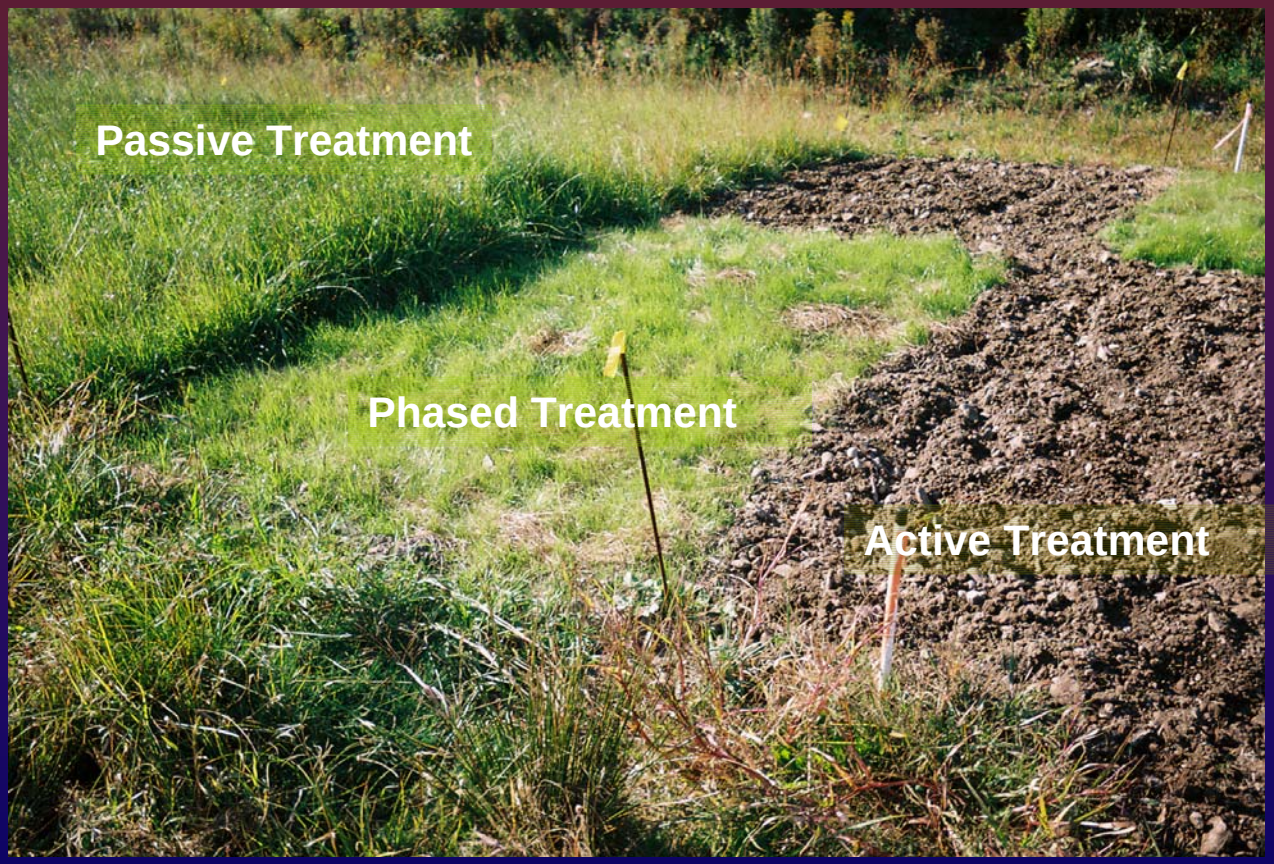
# Piezometer for BTEX Monitoring



# Preferred Treatment? Based on Cost + Labor vs Rate of Treatment

- **Passive, vegetated = low cost; low labor**
- Active = higher cost; higher labor
- Phased Treatment = Moderate cost and labor
- Rate of Treatment – No difference after 1 year

# End of Year 1 – October 2004

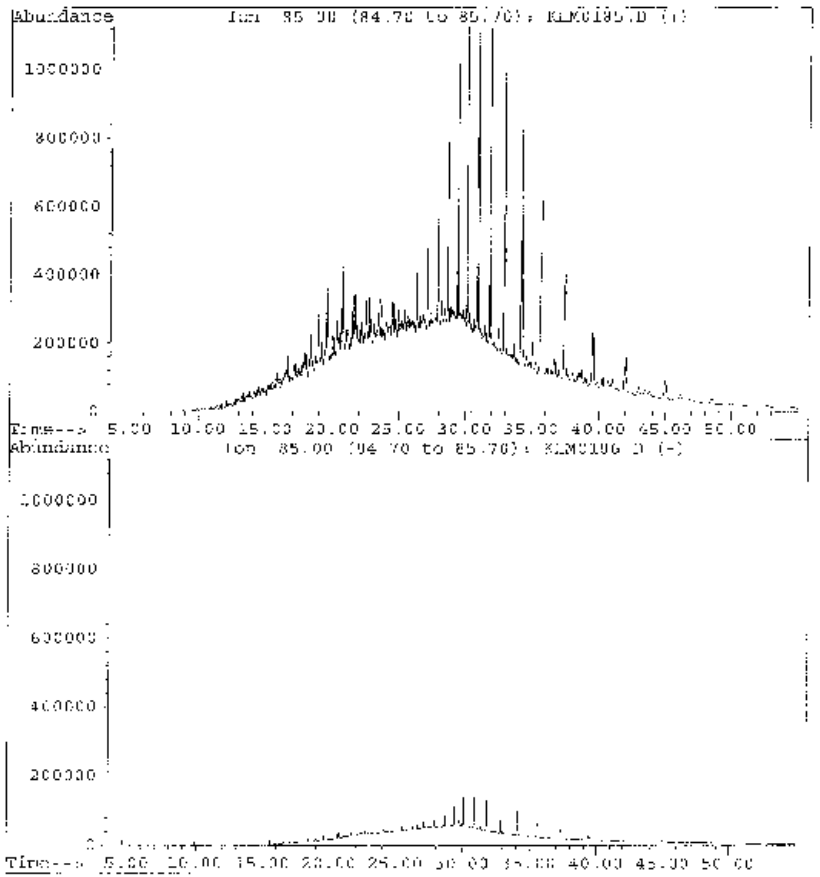


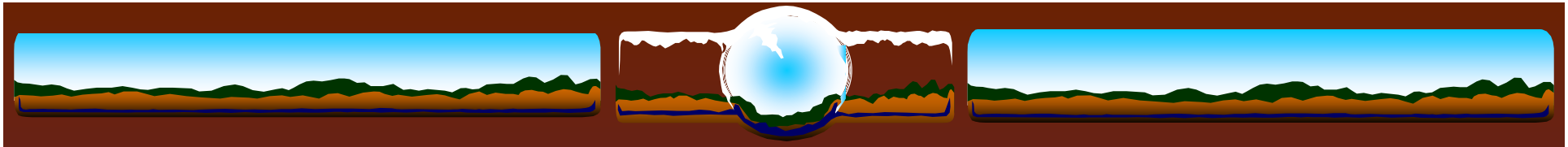
# October 2004

TPH Tolerant Grasses:

- annual ryegrass
- perennial ryegrass
- tall fescue

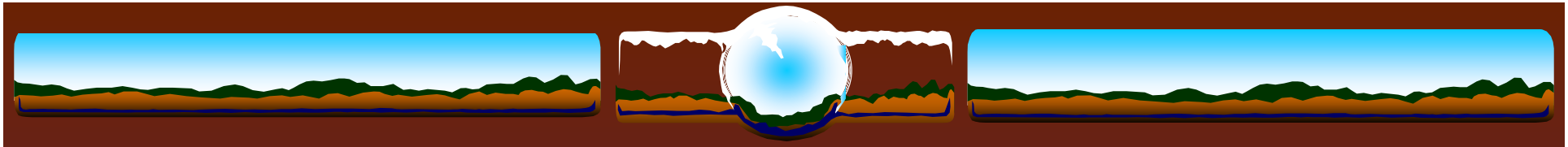
File : I:\DATA\022706\KLM0106.D
Operator : Sysin
Acquired : 28 Feb 106 10:50 am using AcqMethod OCCL1706
Instrument : 5972 Slic
Sample Name: 151-0309 2xd
Misc Info : TRAC 4 5858
Vial Number: 3





# Time to Attain 1% TPH Endpoint?

- 1 year - 2004
- Reuse indefinitely if soil TPH is 1% to 2%



# Treatment Cell Reuse Benefits

- Low Cost
- Soil Quality Improved
- Increased Soil Organic Matter
  - Improved structure, aeration, permeability
  - Improved drainage with time