Liquid Systems and Monitoring

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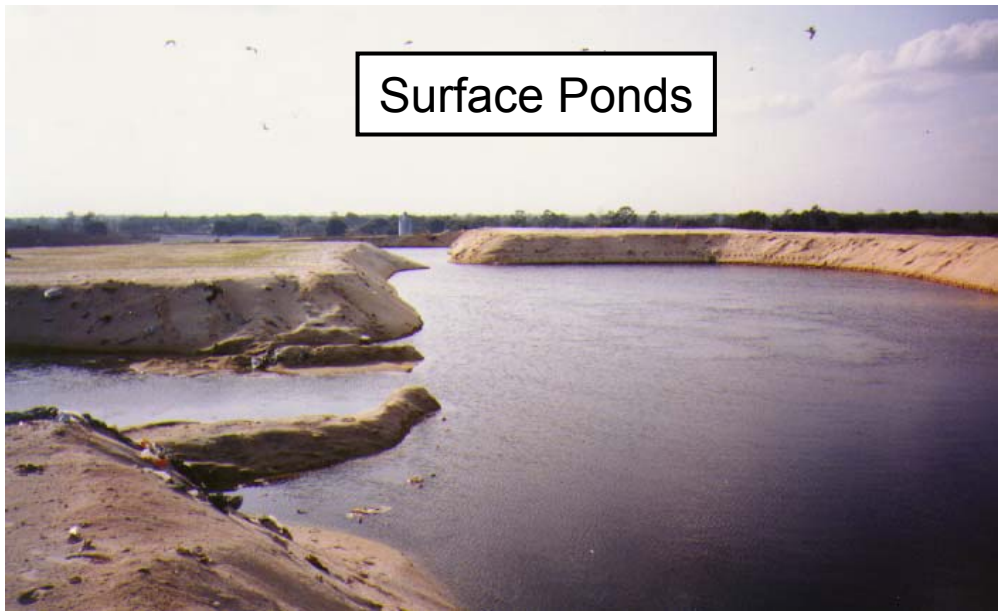
Topics

- Leachate recirculation systems
  - Surface Systems *vs* Subsurface Systems
  - Retrofit *vs* As-built
- Moisture distribution issues
- Monitoring

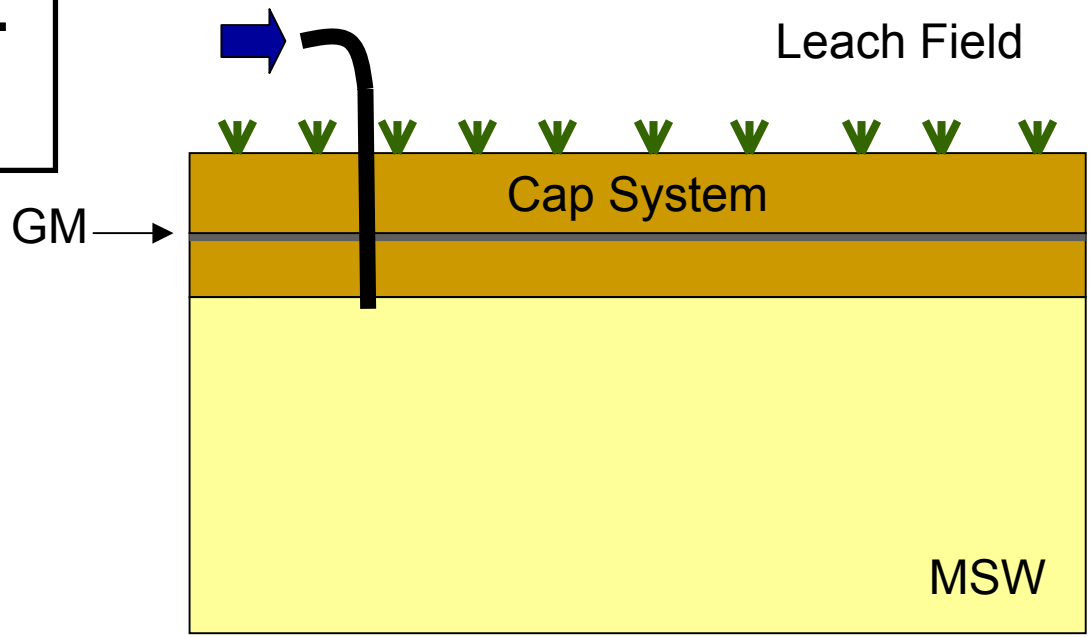
Surface Methods: Pre-Cap

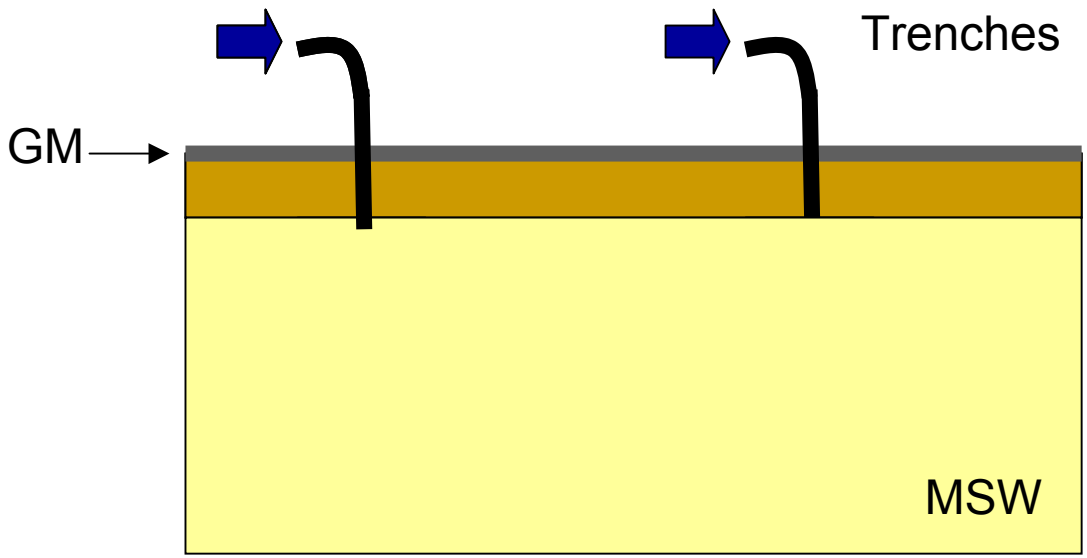
- Spray Irrigation
- Drip Irrigation
- Tanker Truck Application
- Infiltration Ponds



Surface Methods: Post-Cap

- Leach Field
- Trenches
- Drip Irrigation





Subsurface Methods

- Vertical Injection Wells
- Horizontal Trenches
- Buried Infiltration Galleries

As-Built *vs* Retrofit

As-Built

- Surface application methods as waste is filled up. Focus on working face.
- ***Horizontal trenches*** buried in the landfill as waste is deposited.
- Surface systems when complete.

Retrofit

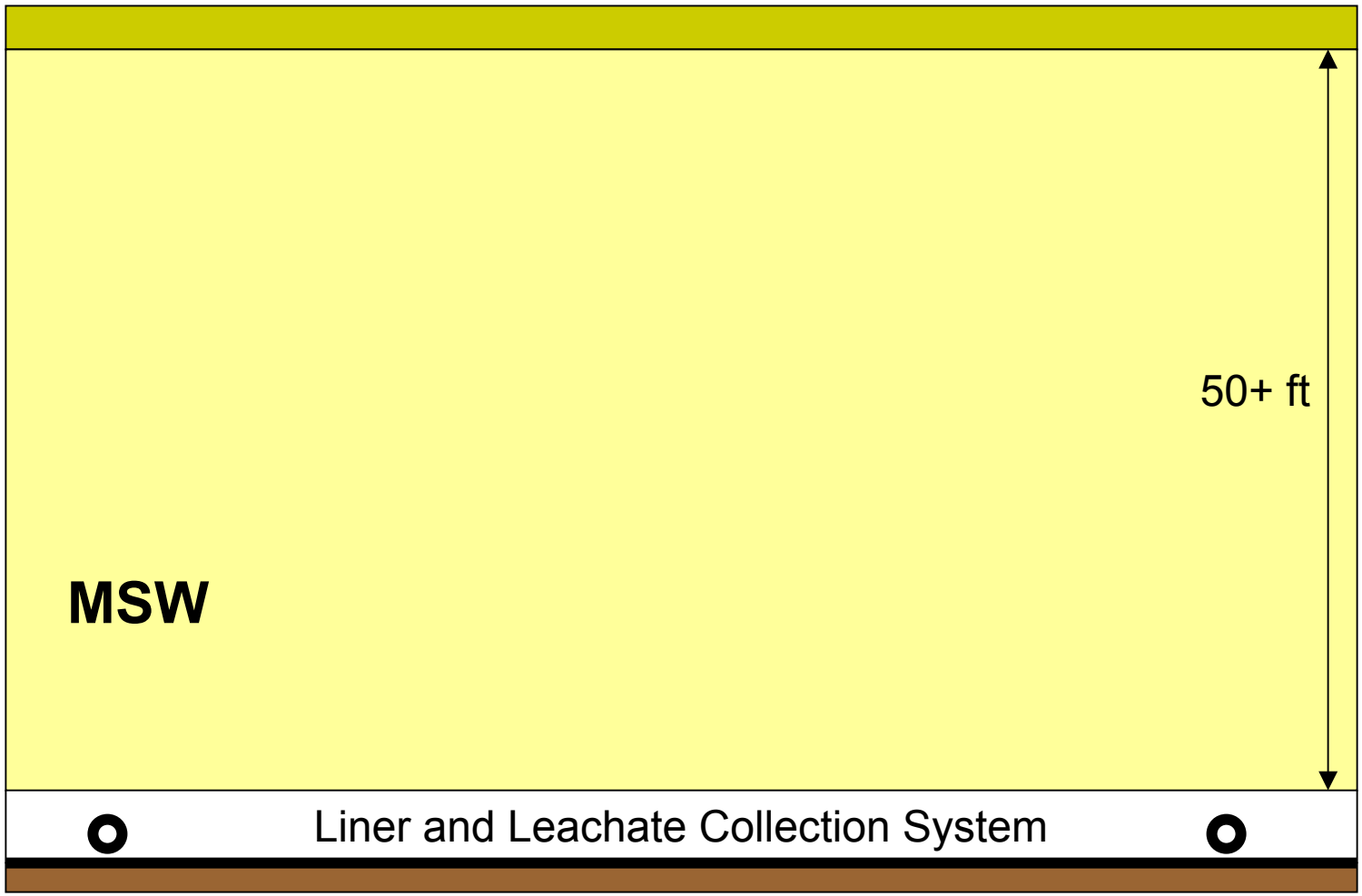
- Surface systems on completed waste fill.
- ***Vertical wells.***
- Shallow subsurface horizontal trenches.

Focus on Two Subsurface Methods

- Horizontal Trenches
  - Shallow systems
  - Deep systems
- Vertical Injection Wells
  - Large diameter systems
  - Small diameter systems

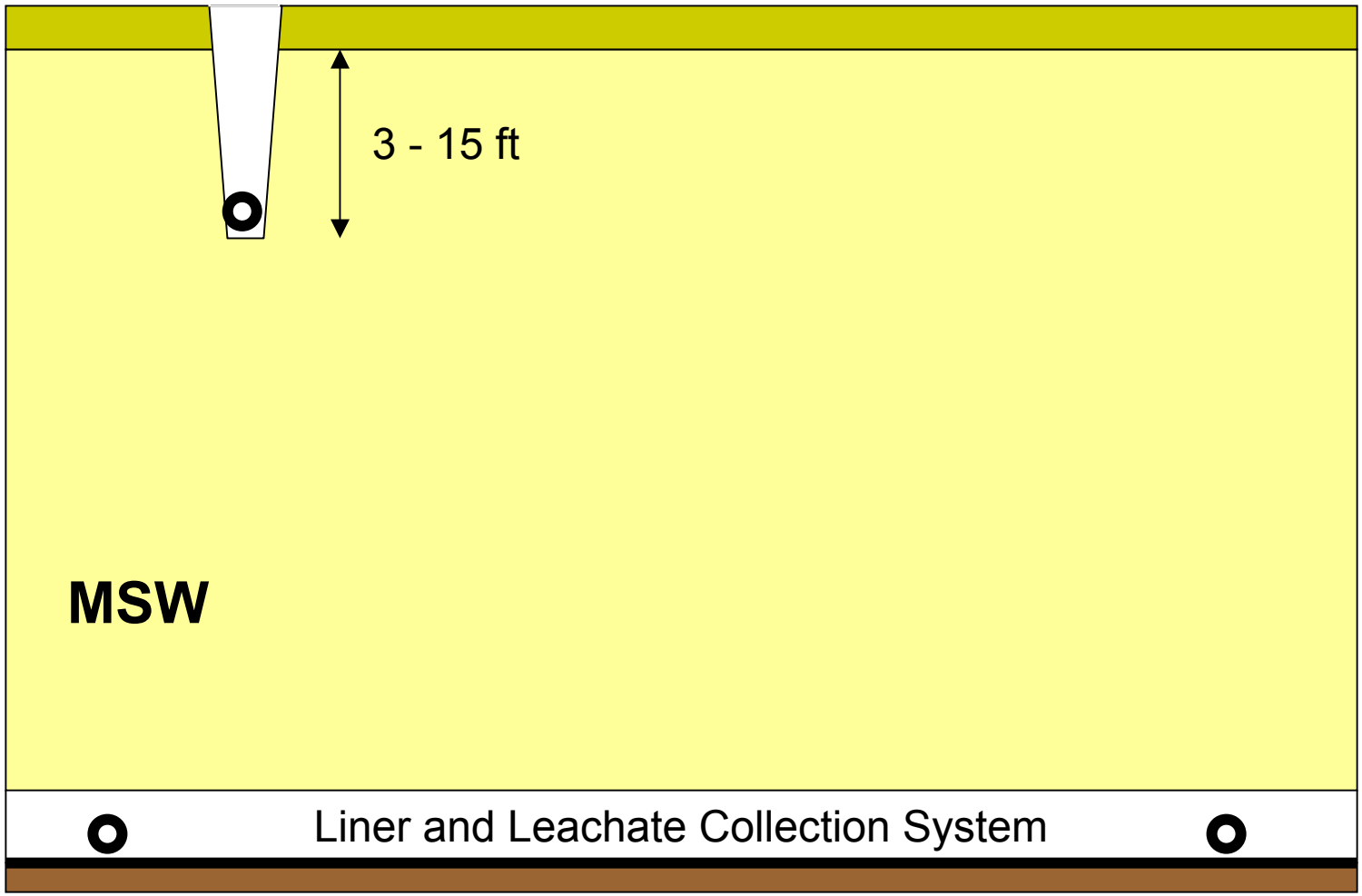
Shallow Horizontal Trenches

1. Existing Landfill at Grade



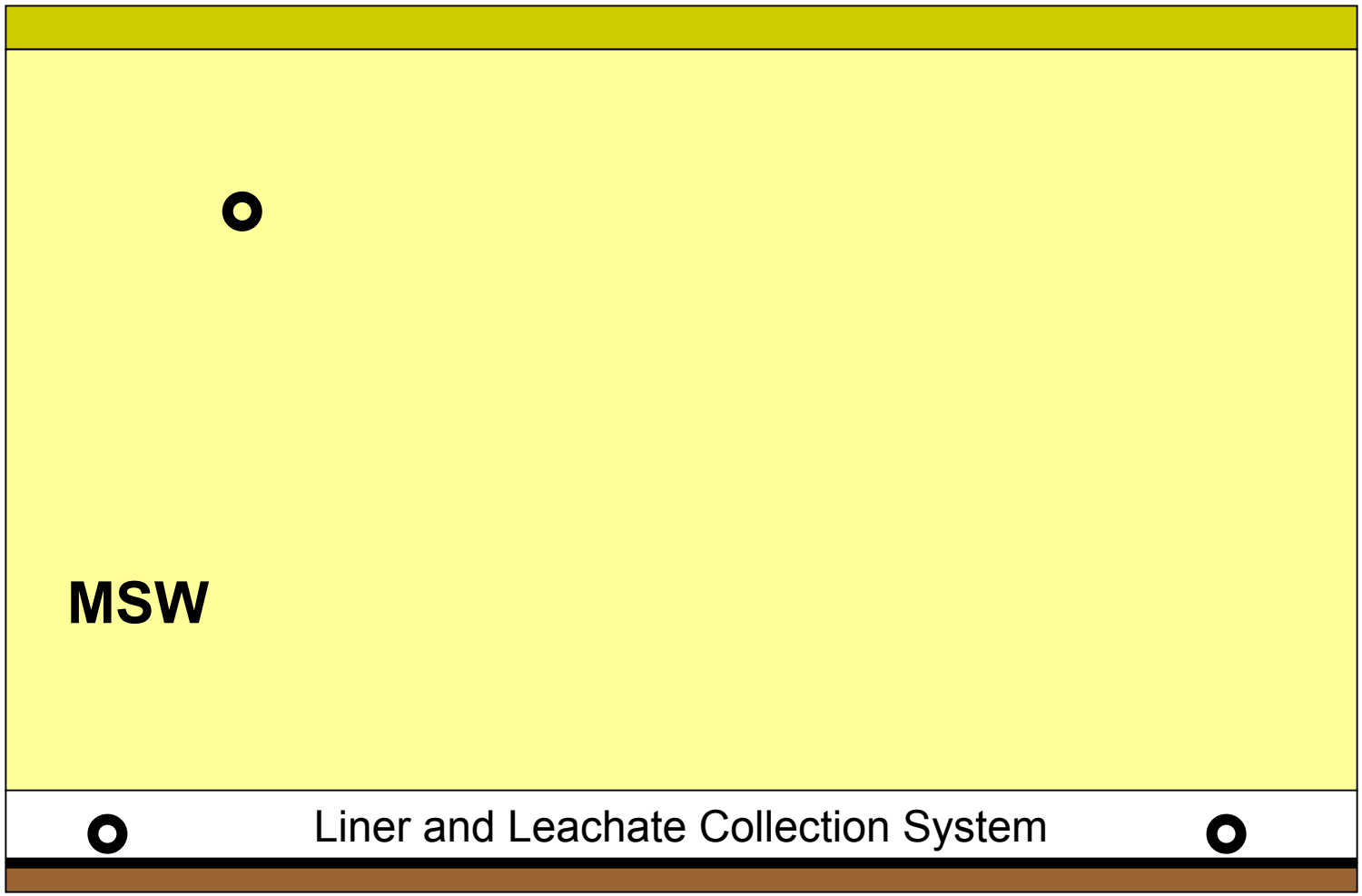
Shallow Horizontal Trenches

2. Excavate Trench and Install Bedding and Pipe



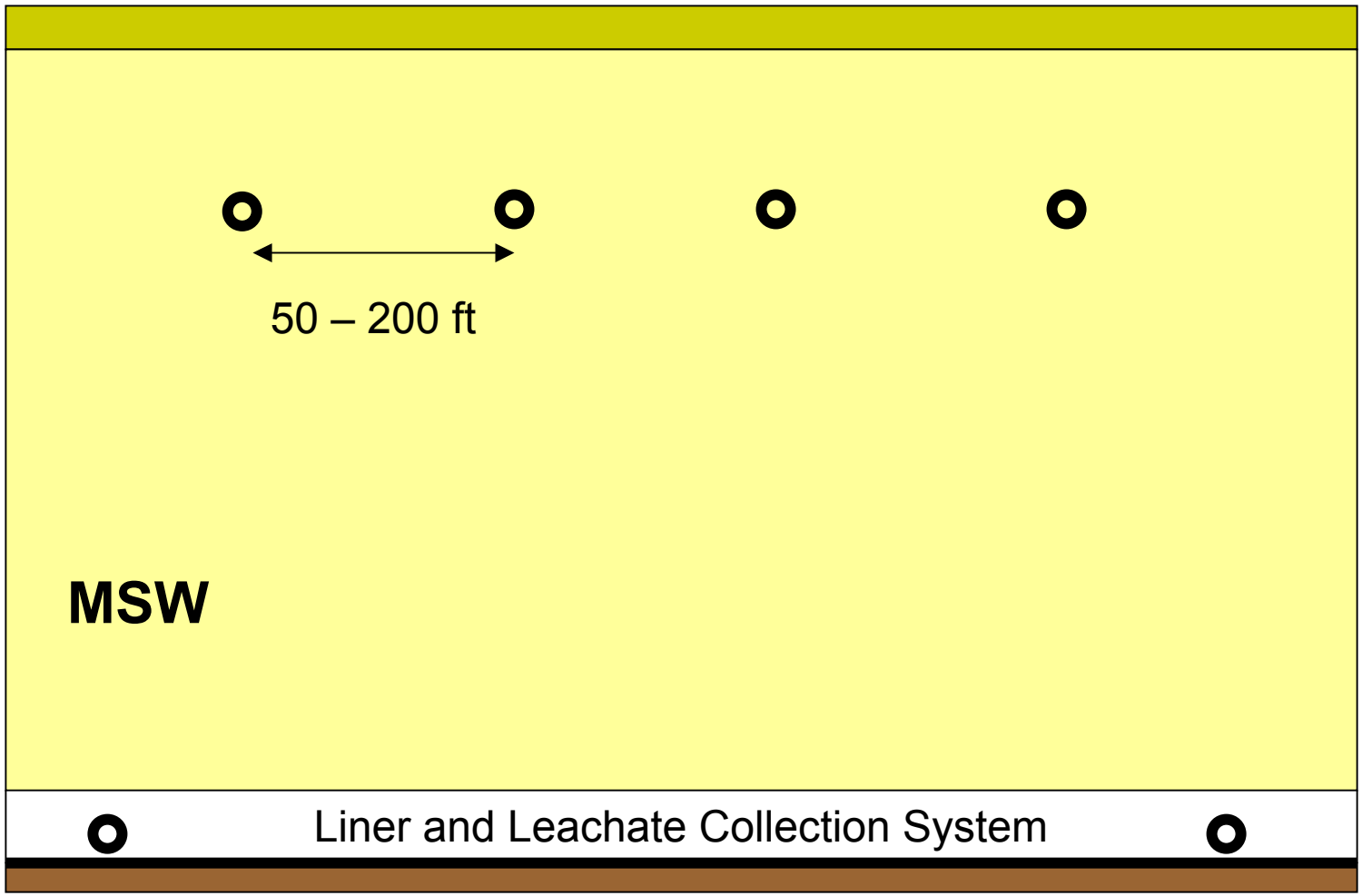
Shallow Horizontal Trenches

3. Backfill



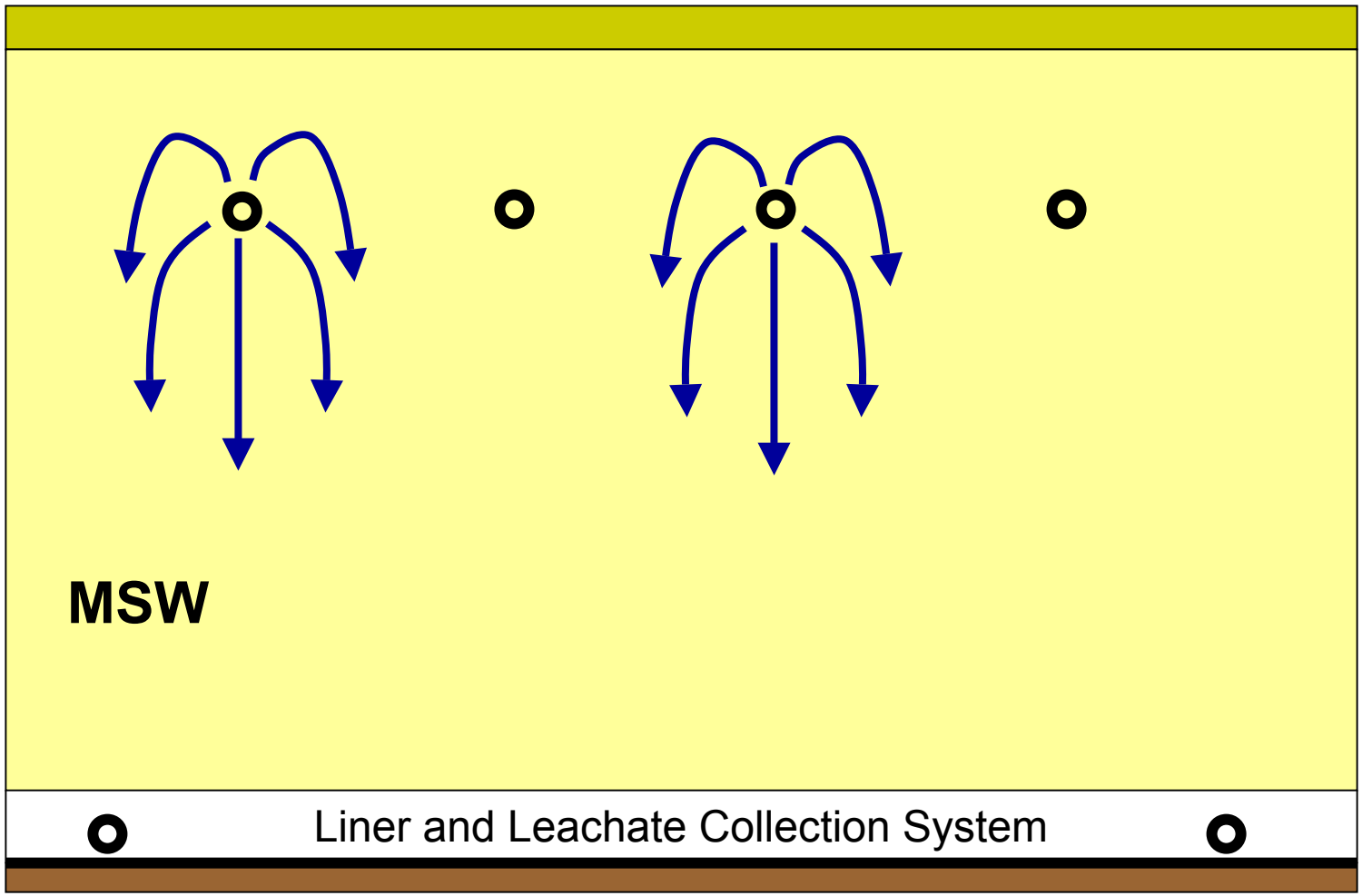
Shallow Horizontal Trenches

4. Additional Trenches



Shallow Horizontal Trenches

5. Recirculate



Shallow Horizontal Trenches

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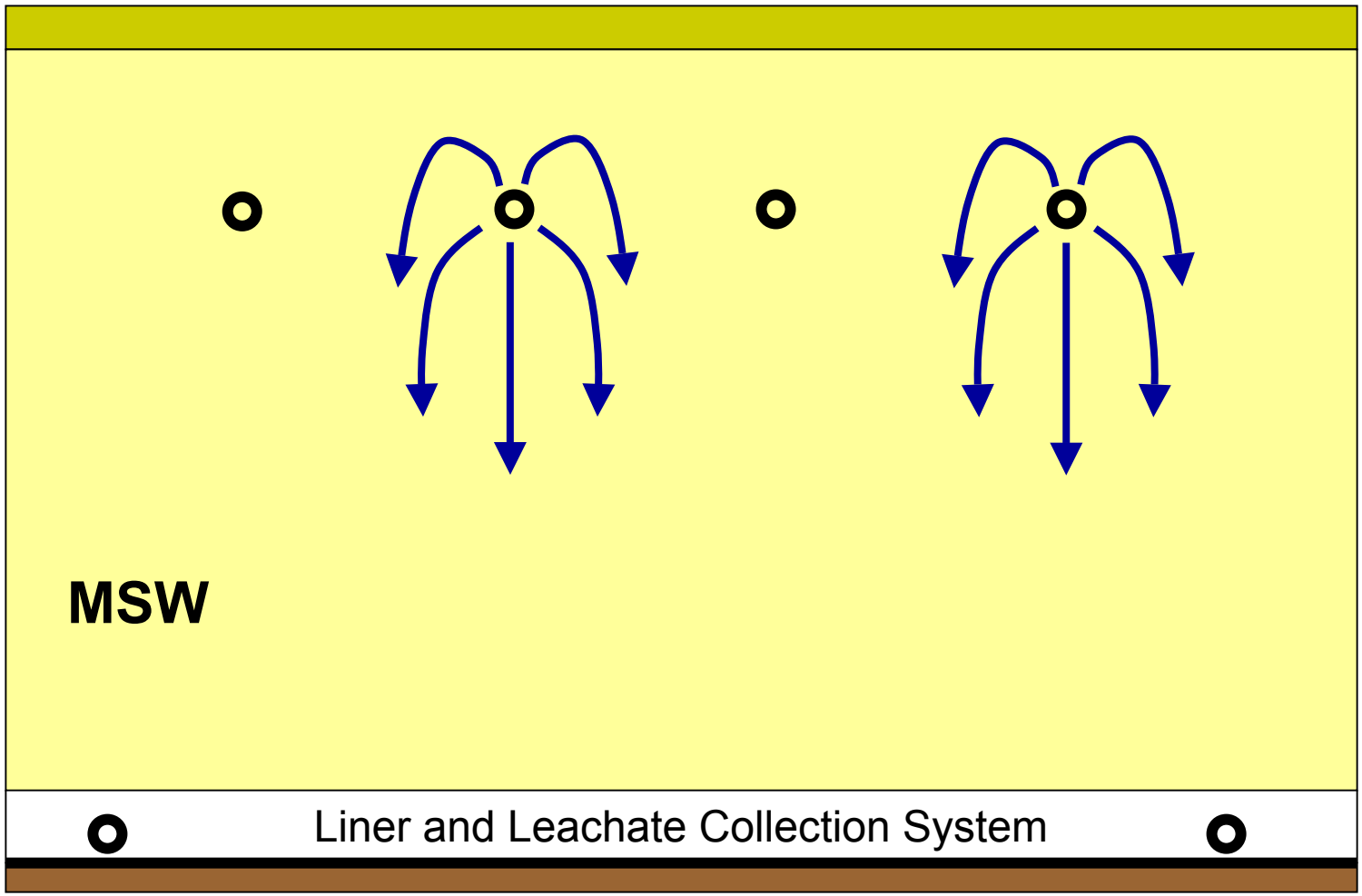
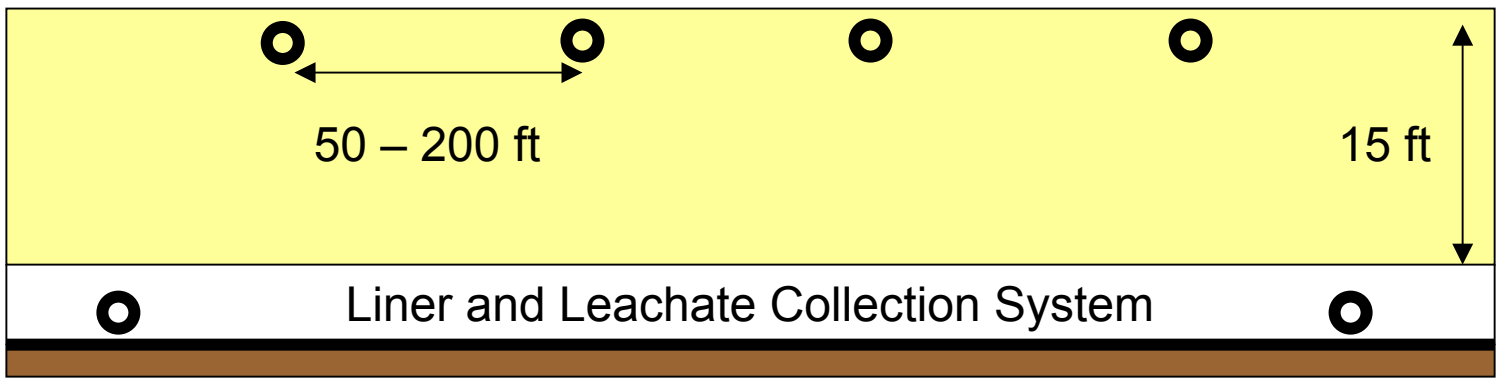


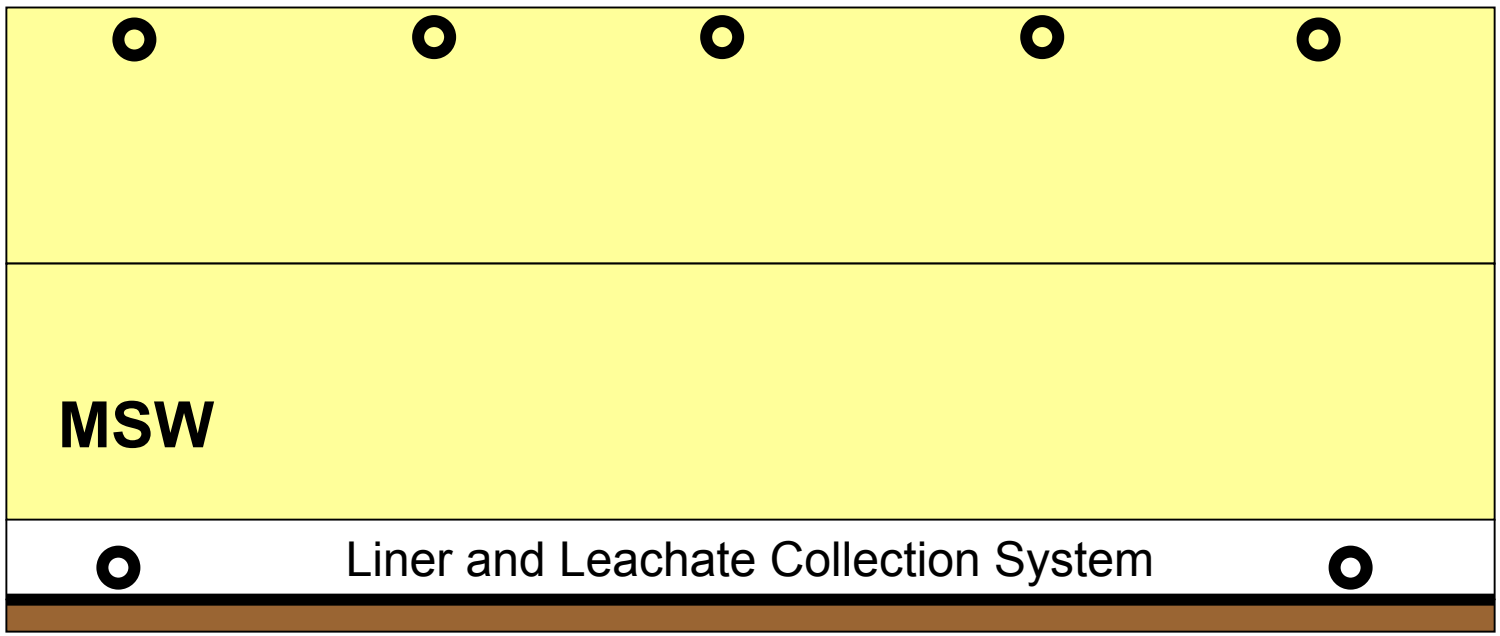
Deep Horizontal Trenches

1. Install Horizontal Trenches on Lower Lifts



Deep Horizontal Trenches

2. Continue Installing



Deep Horizontal Trenches

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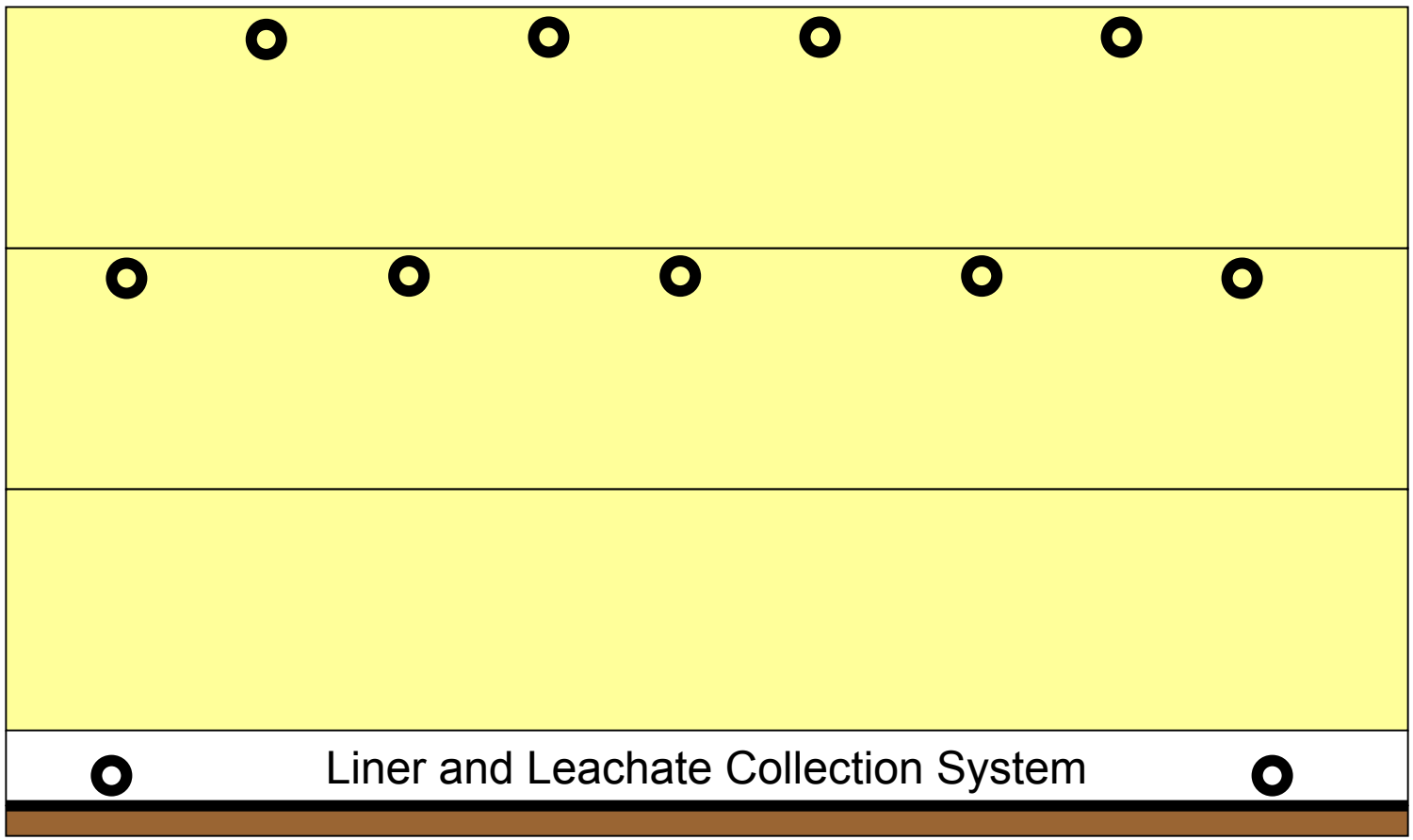
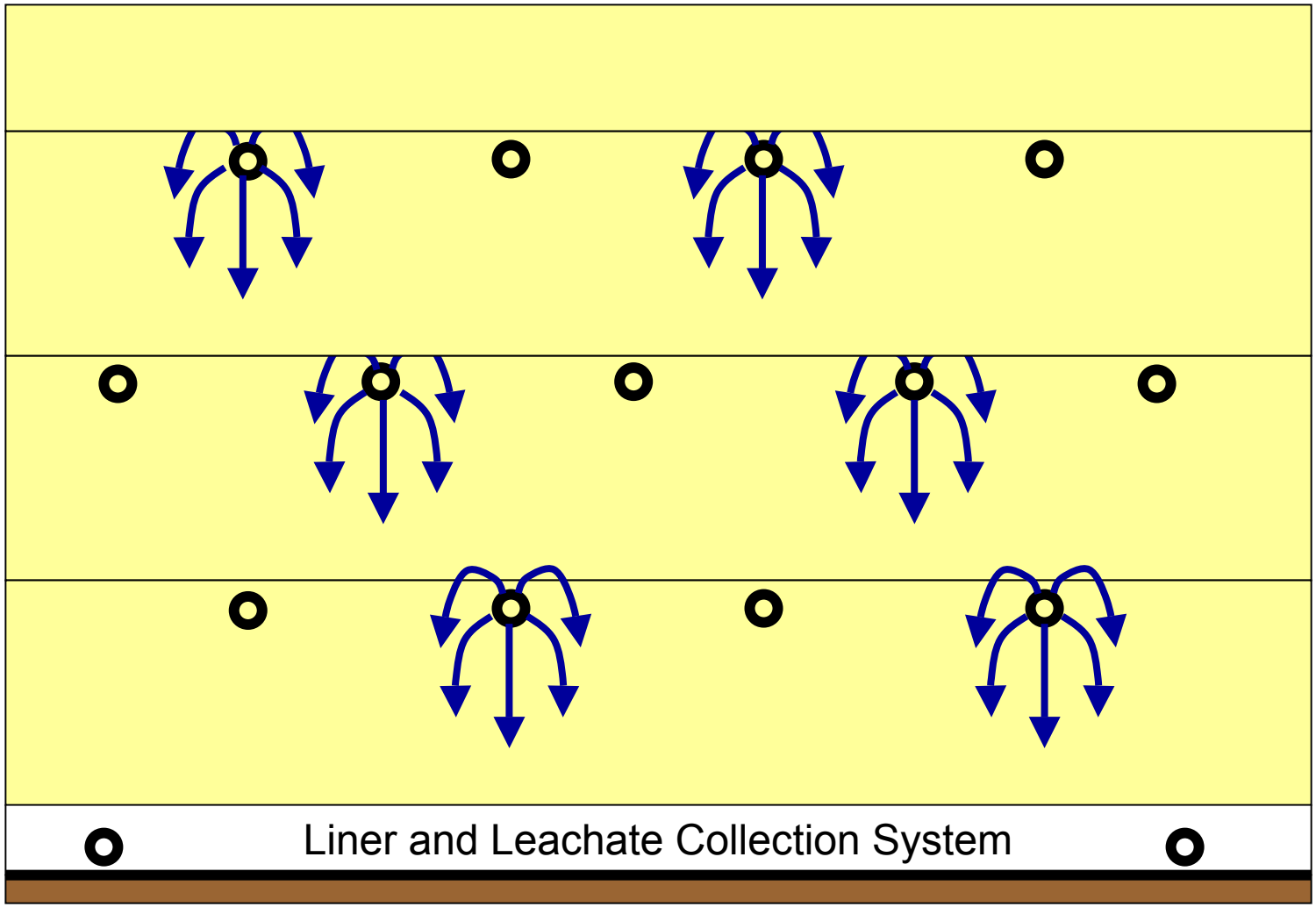


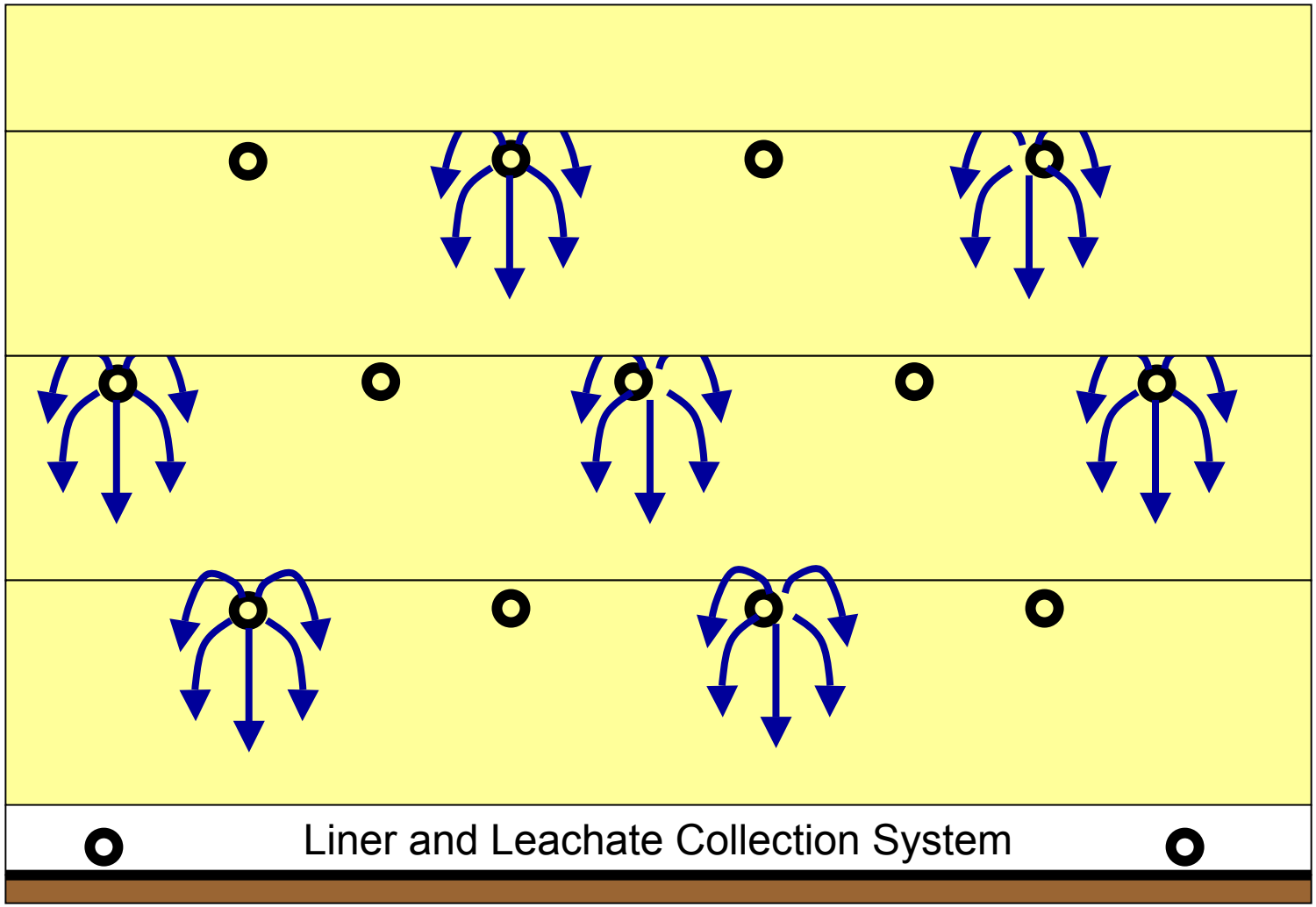
Deep Horizontal Trenches

4. Recirculate Leachate



Deep Horizontal Trenches

4. Recirculate Leachate



Horizontal Trench Installation Photos: Alachua County SW LF


CAT

Horizontal Trench Installation Photos: Polk County NC LF


CAT
CAT

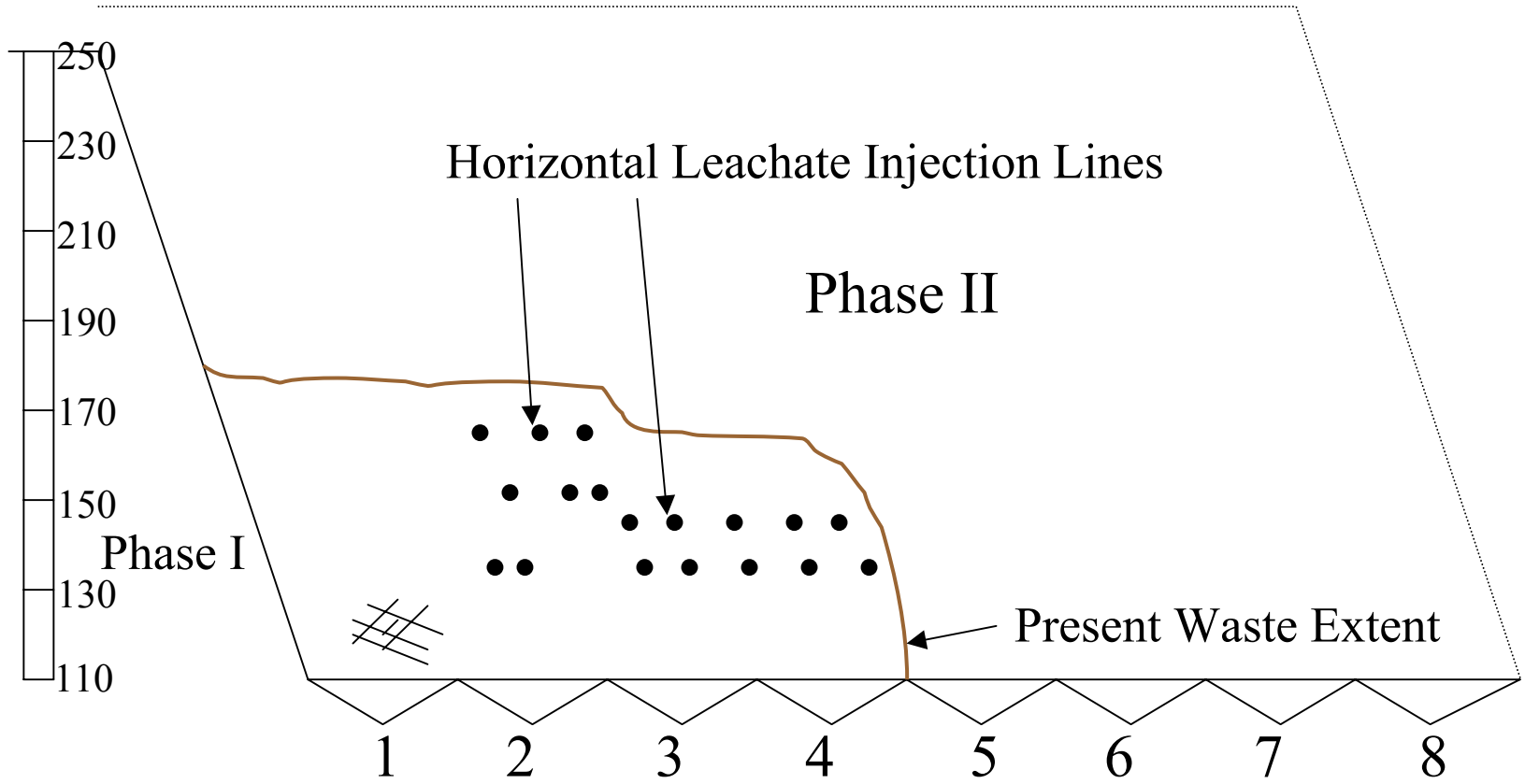

Bull

Clay plug.

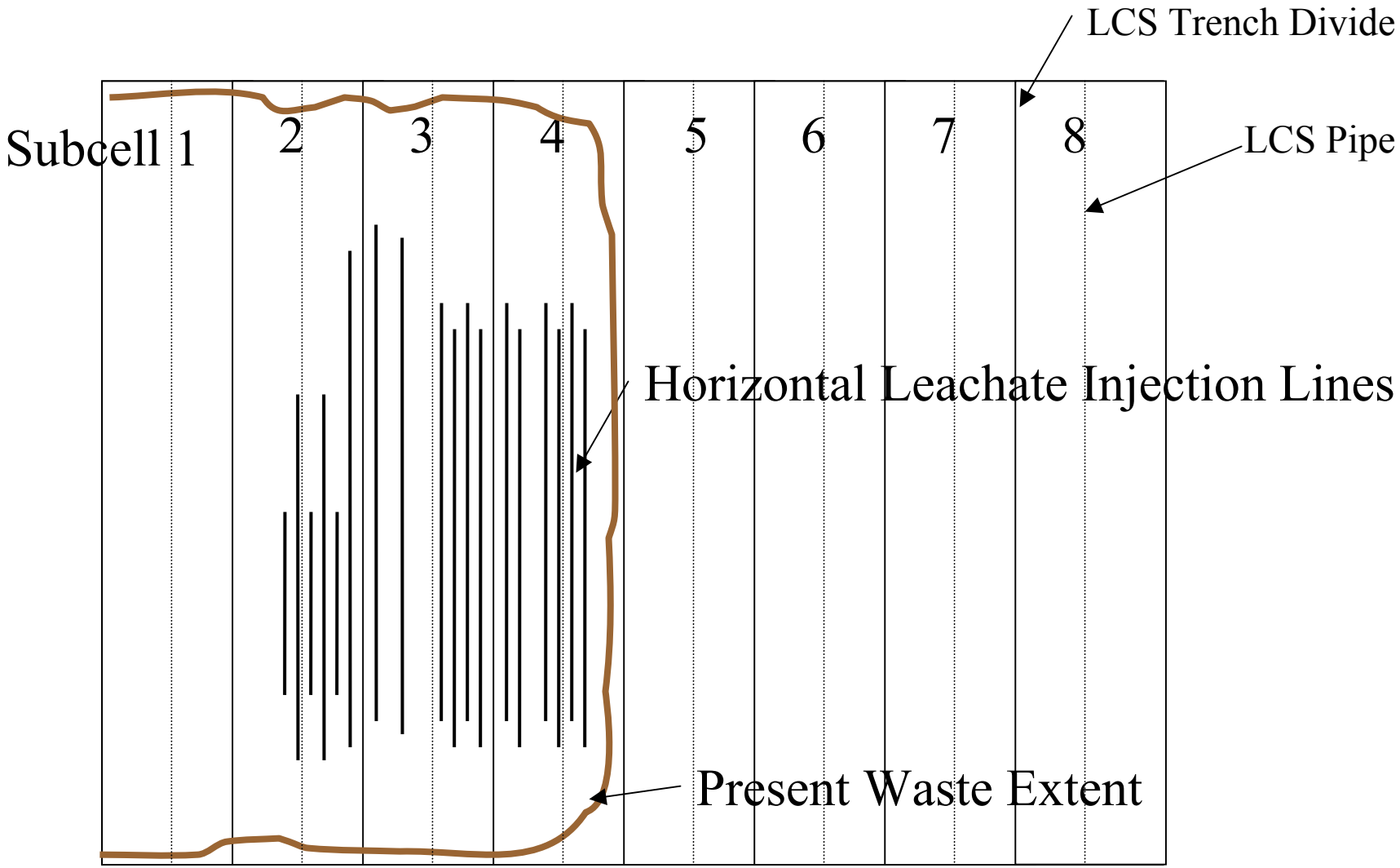
Filling in the trench.


Filling in Trench

Cross Section of Horizontal Injection Trenches at Polk County NCLF



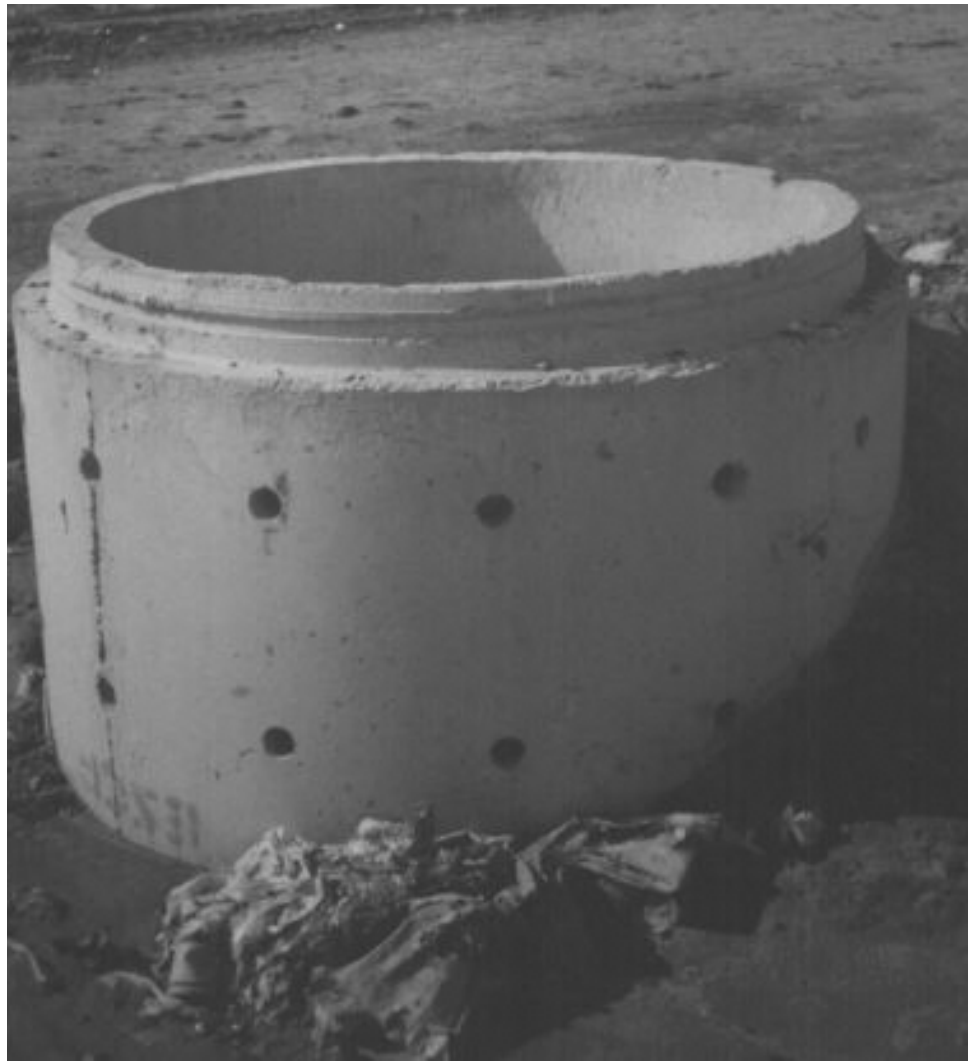
Plan View of Horizontal Injection Trenches at Polk County NCLF



Vertical Injection Wells

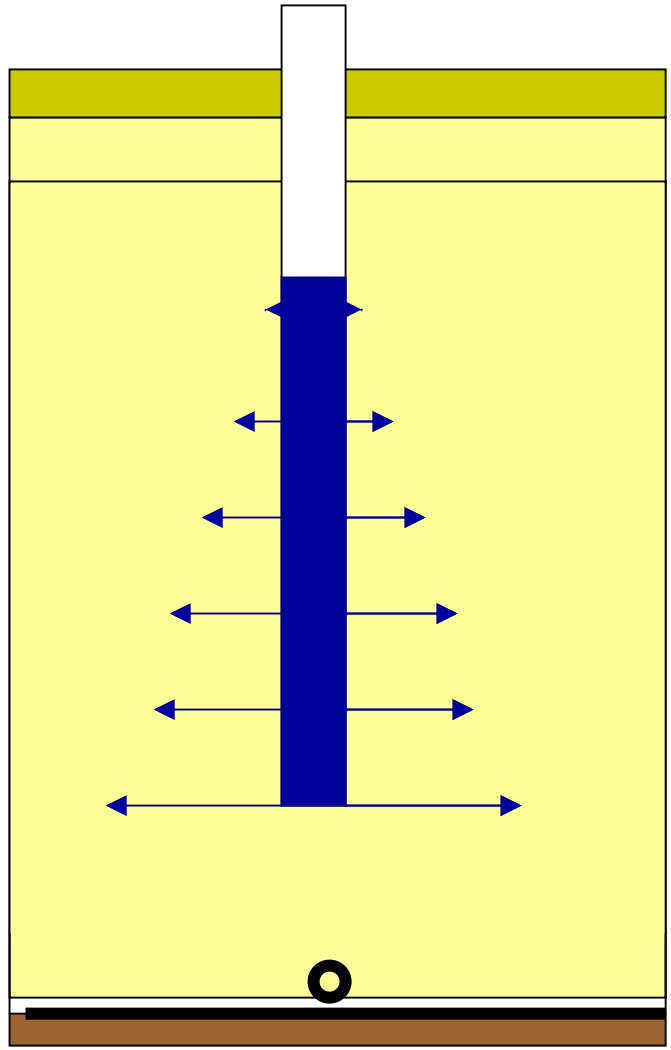
- Two major types
  - Large diameter wells
  - Small diameter wells
- Many of the early leachate recirculation attempts used large diameter wells
- Most new designs use small diameter wells

Large Diameter Vertical Leachate Injection Well



Potential Disadvantage of Vertical Wells

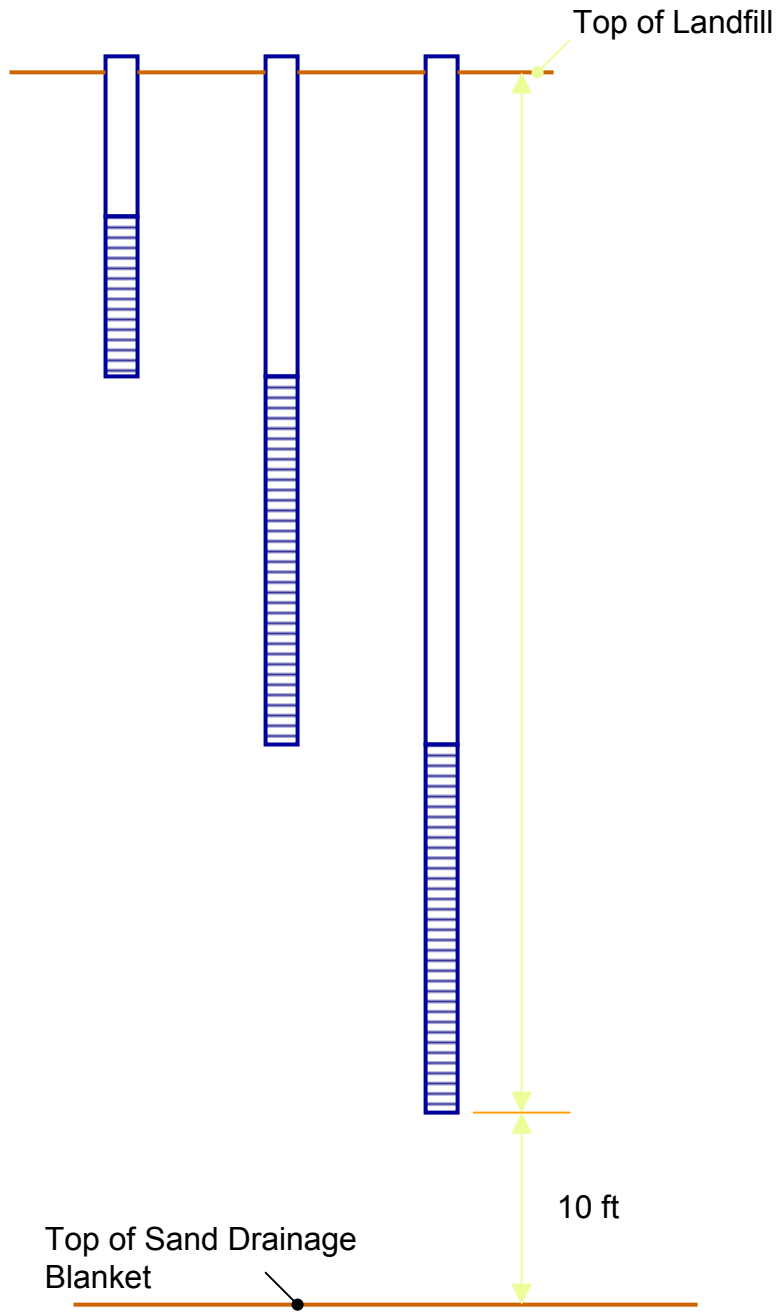
- The greatest hydraulic pressure will be at the bottom of the well.
- This might result in more leachate distribution on the bottom of the landfill.



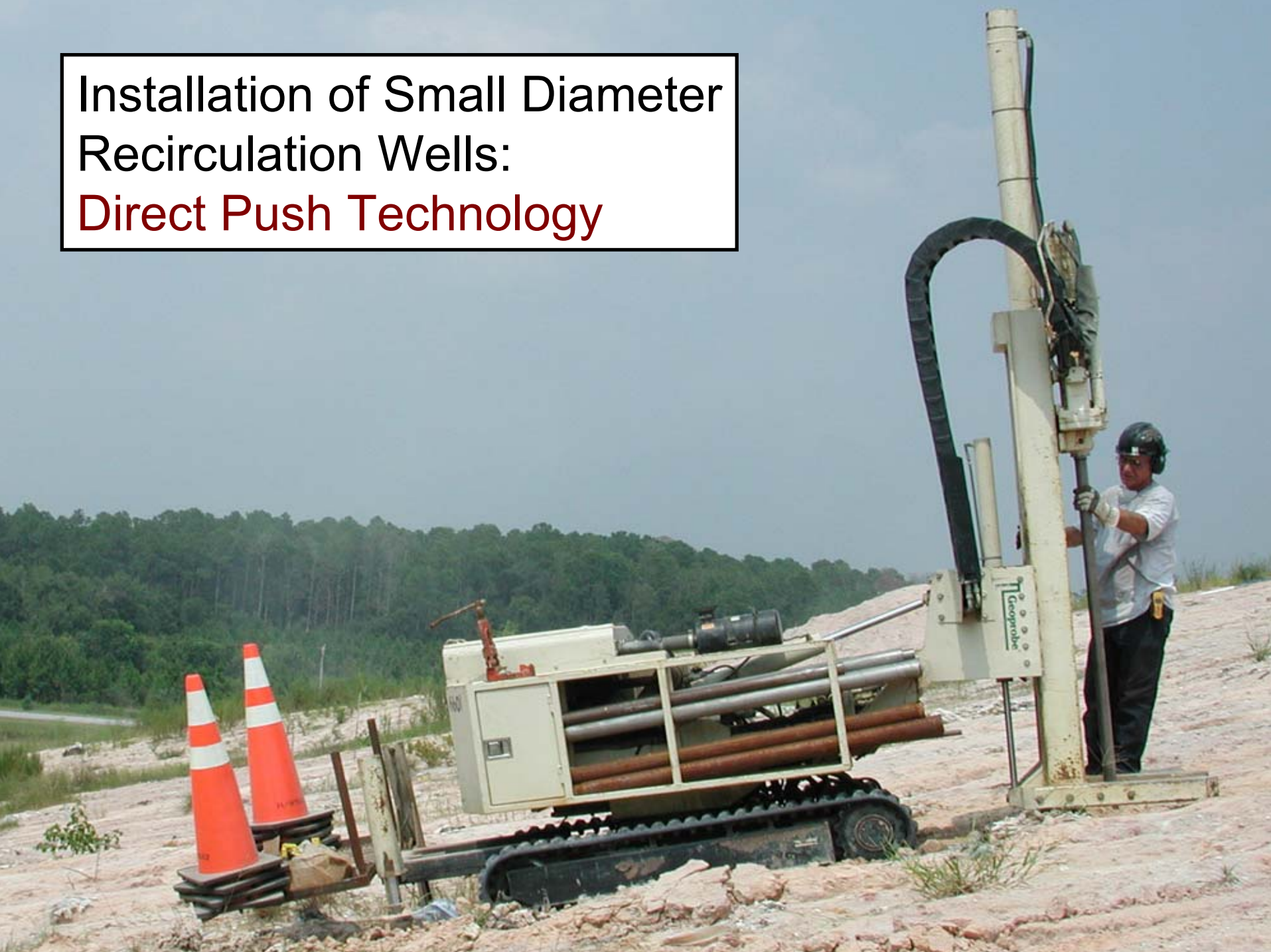
Vertical Injection Cluster Wells

Use multiple small diameter wells.

Since more wells are needed, installation must not be cost prohibitive.



Installation of Small Diameter Recirculation Wells:
Direct Push Technology



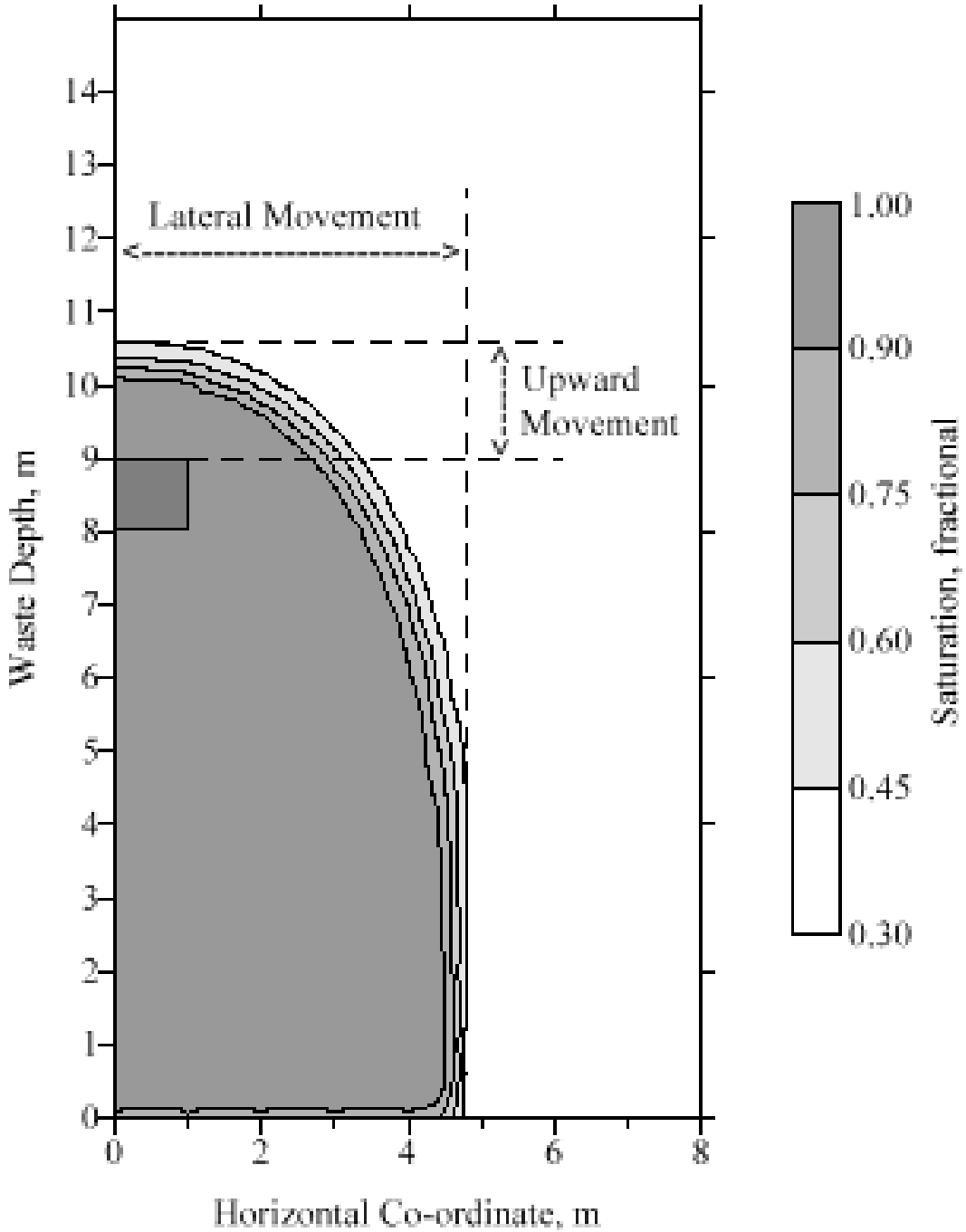

Installation of
Small Diameter
Recirculation Wells:
Open Flight Auger


CECS

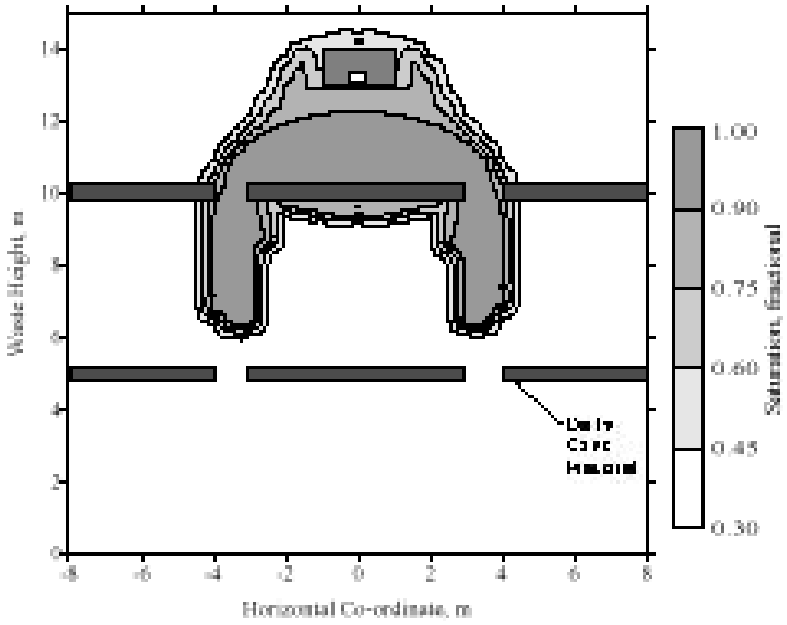

COARSE GRADE
BENTONIT
CONTROLLED
TURAL BENT
FOR:
UGGING AND ABAND ONING
ILLED HOLES TO PRE-VENT
UIFER CONTAMINATION
ING SHOT-HOLE EX
EVENT BLOW-
IRFACE
SIZE
NITE
UG

Comments on Moisture Distribution

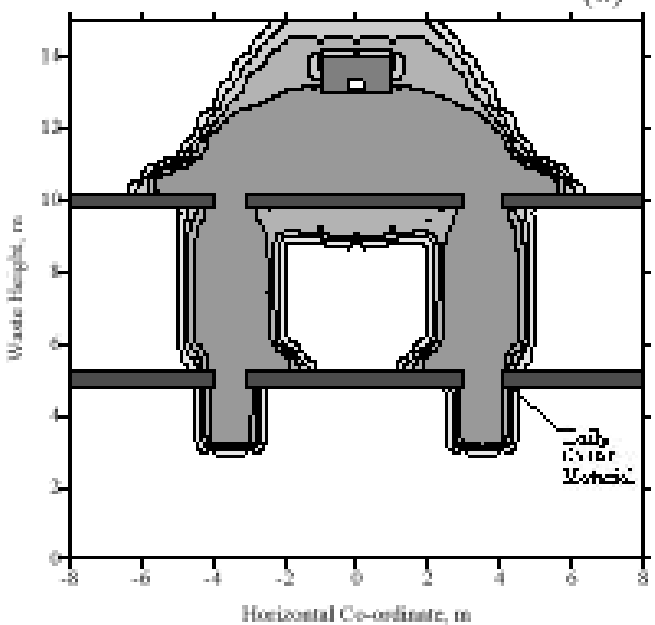
- Hydraulic conductivity of compacted is MSW is relatively low (especially in the vertical direction).
- Compacted MSW is anisotropic with respect to hydraulic conductivity.
- Channeling will occur.
- For subsurface applications, some of the waste will be at or near saturation for part of the time. Conditions will be above field capacity.



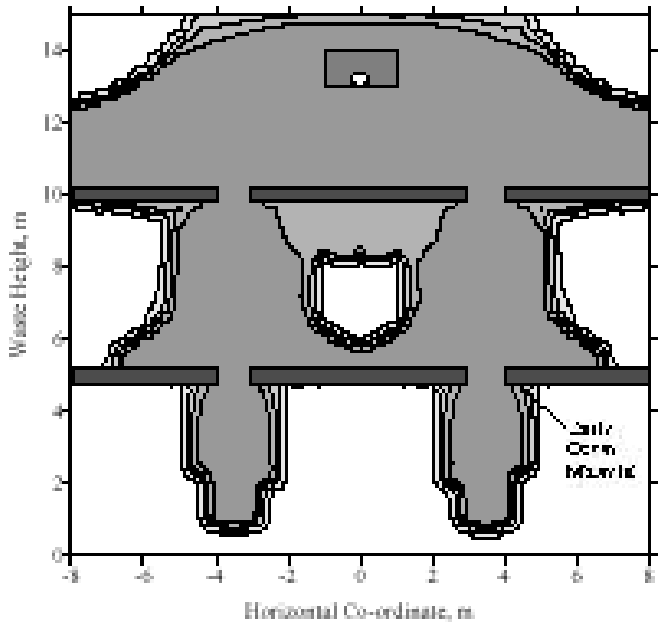
McCreanor and Reinhart


Waste Height, m
Horizontal Co-ordinate, m
Saturation, fractional
1.00
0.90
0.75
0.60
0.45
0.30

(a)


Waste Height, m
Horizontal Co-ordinate, m

(b)


Waste Height, m
Horizontal Co-ordinate, m

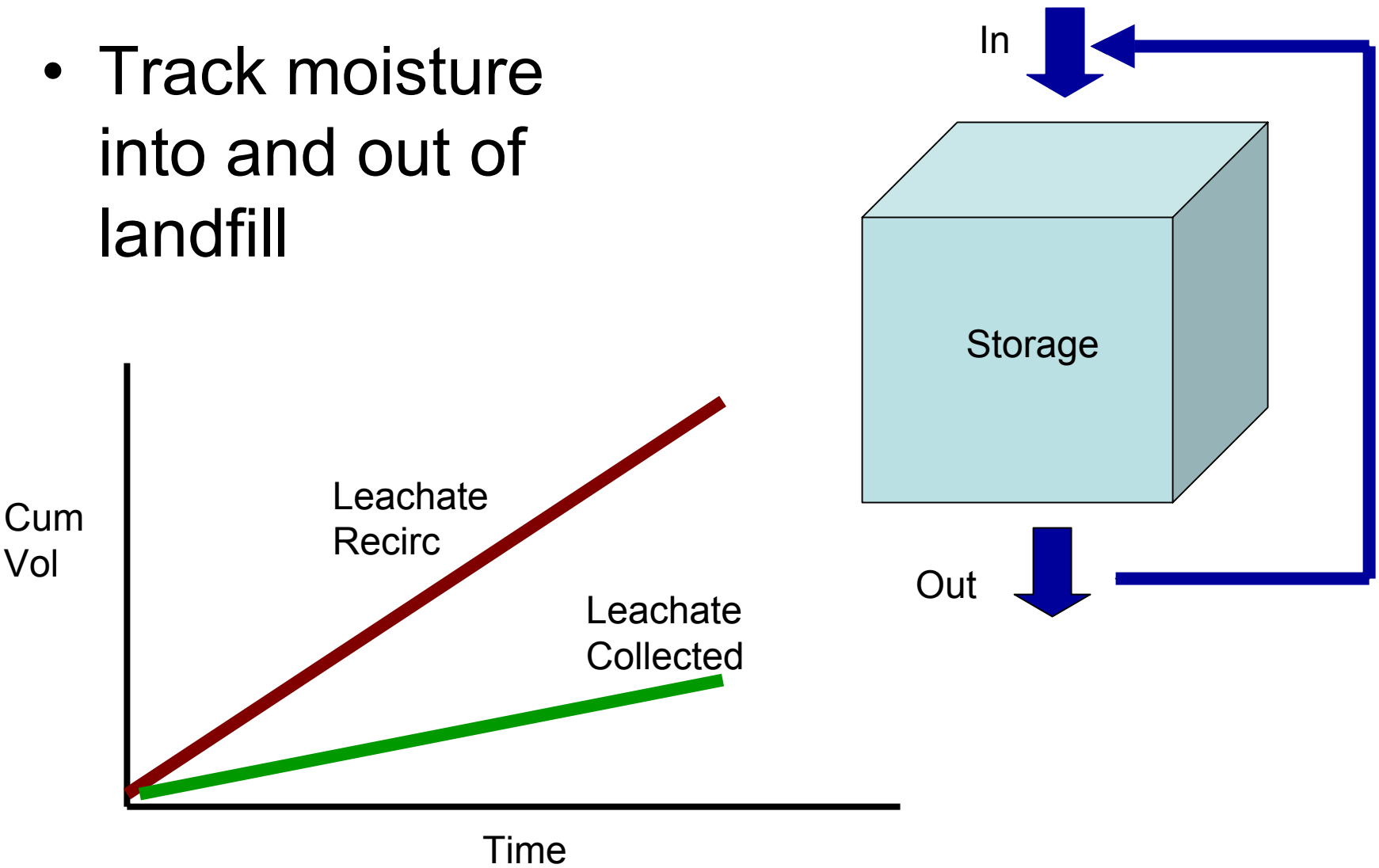
(c)

Measurement of Moisture

- Water balance
- Collect waste samples and measure gravimetrically
- *In situ* methods

Water Balance

- Track moisture into and out of landfill



Collection of Waste Samples

- Great data
- Expensive
- Infrequent

In Situ Devices

- Adapted from devices used for soil irrigation purposes
- Examples:
  - Neutron probes
  - Time domain reflectometry (TDR)
  - Resistance devices

Neutron Probes

- Neutrons emitted by the probe travel through adjacent medium; neutrons get thermalized by other atoms, especially hydrogen (H_20).
- Can measure thermalized neutrons using a device like a Geiger counter.
- Relate this measurement to moisture content.
- Probe lowered into pipes in landfill.

TDR Devices

- An electromagnetic pulse is emitted.
- The propagation time of the pulse is a function of the dielectric constant of the surrounding medium.
- The dielectric constant is also a function of the moisture content.

Resistivity Devices

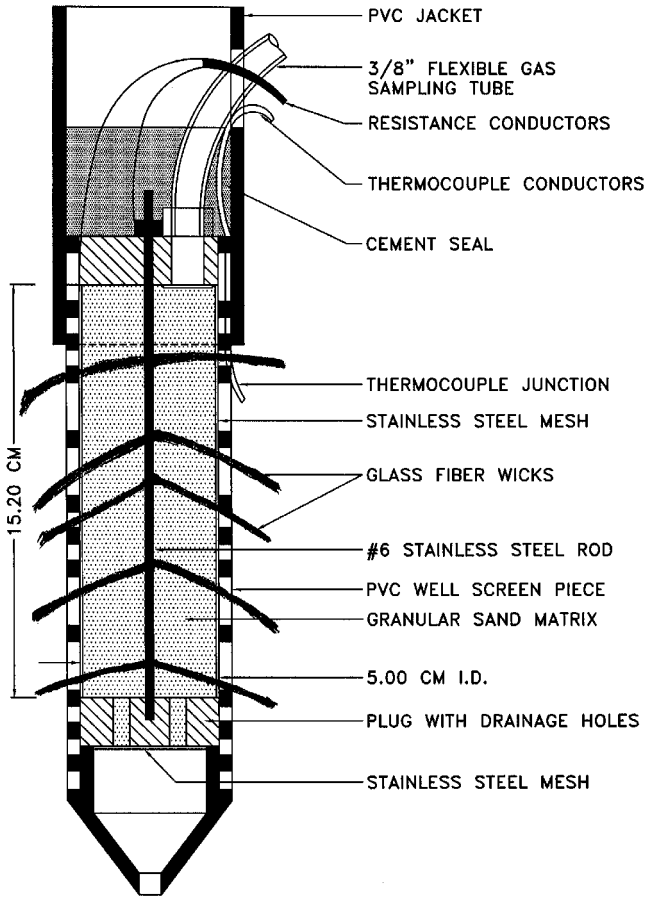
- Measures the electrical resistance of between two electrodes inserted into a medium.
- The greater the moisture content, the lower the resistance.
- A function of liquid specific conductance.
- Example: Gypsum block

Challenges

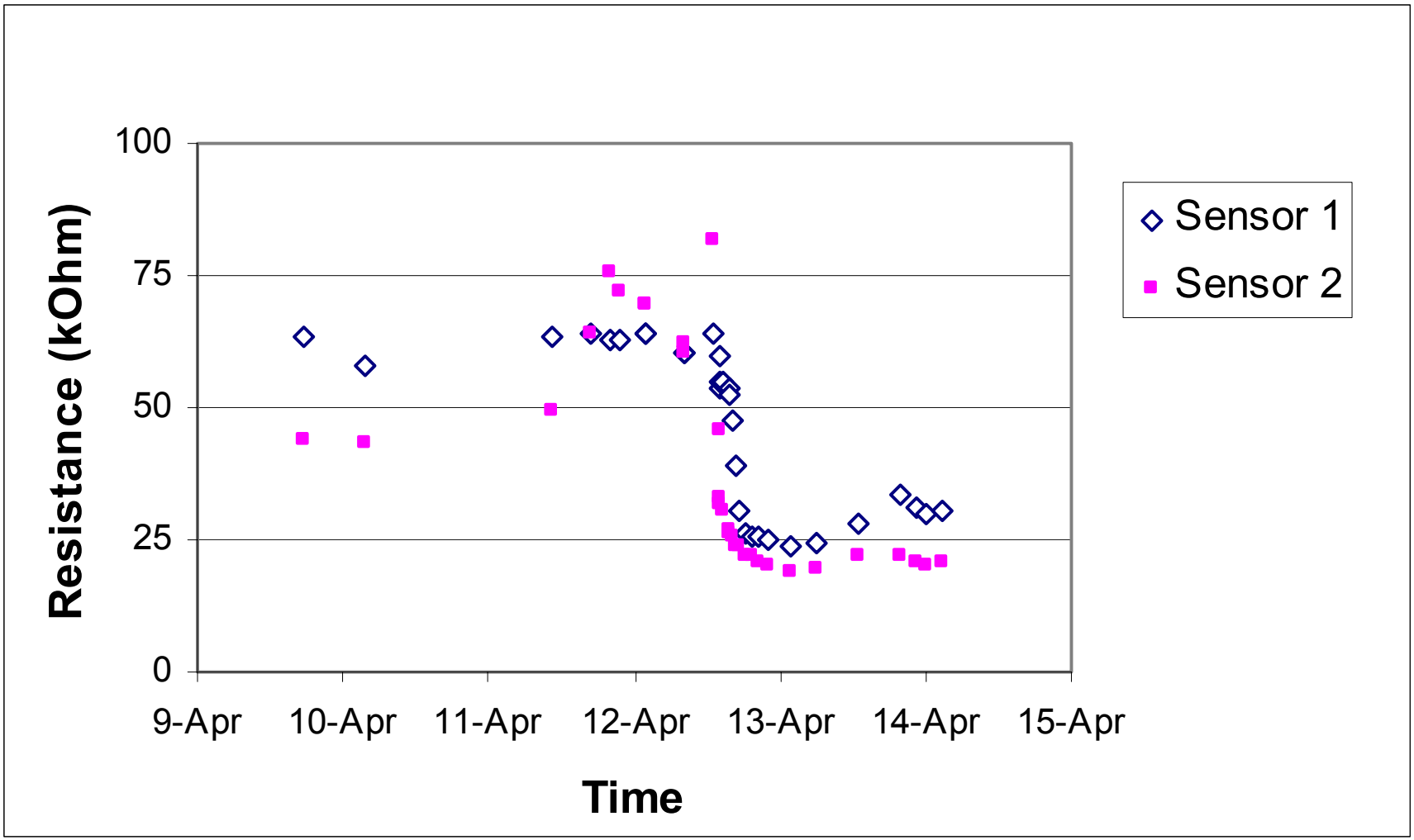
- How to install: TDR and resistivity are permanant; Neutron probe requires borehole
- Direct contact with the waste: Desired for TDR and resistivity.
- Calibration (what is actual moisture content?)
- Neutron probe required radioactive source

TDR Device Used in Florida

Resistivity Probe Used in Florida

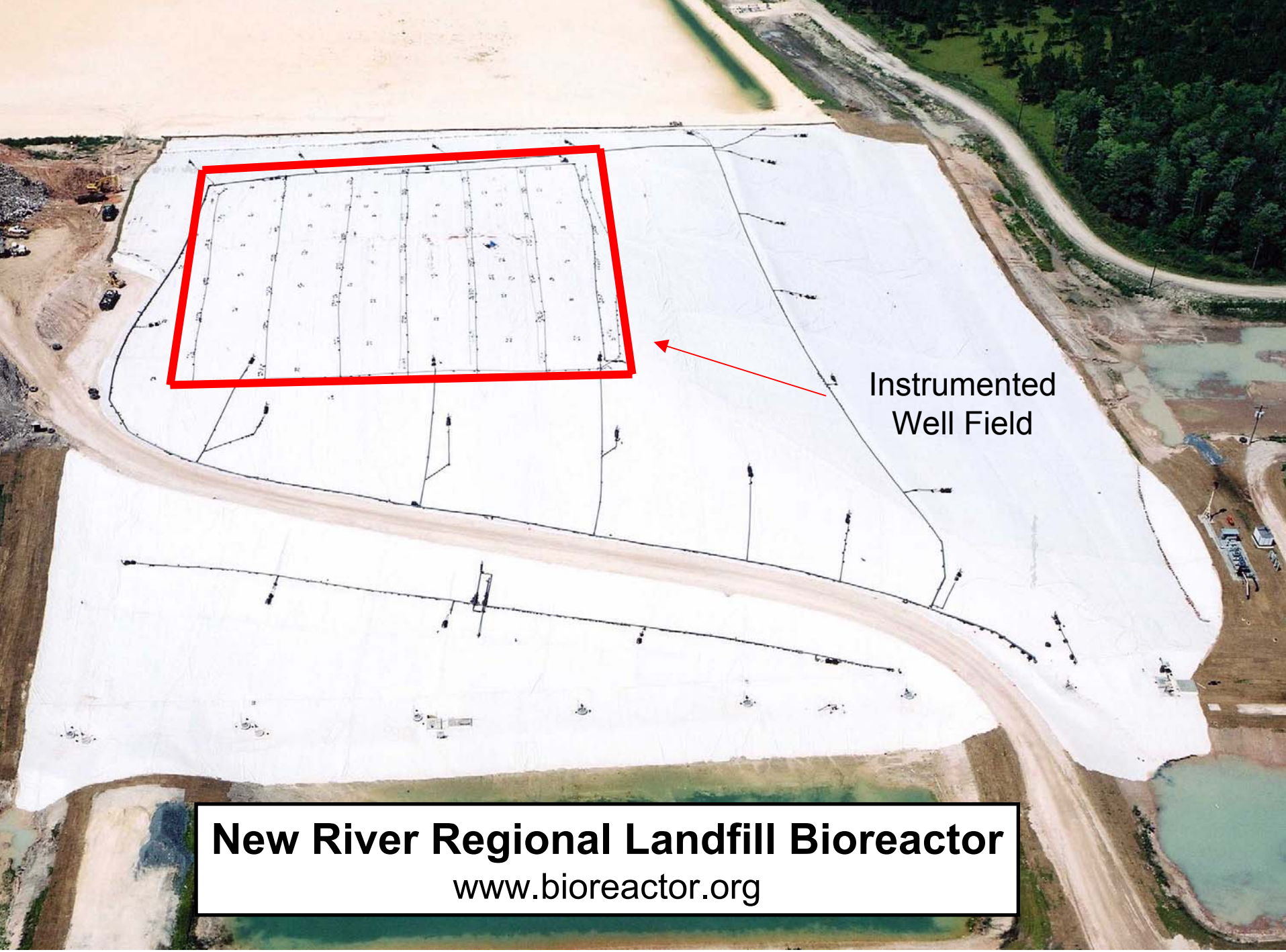


Results of Field Trial



New River Regional Landfill Bioreactor

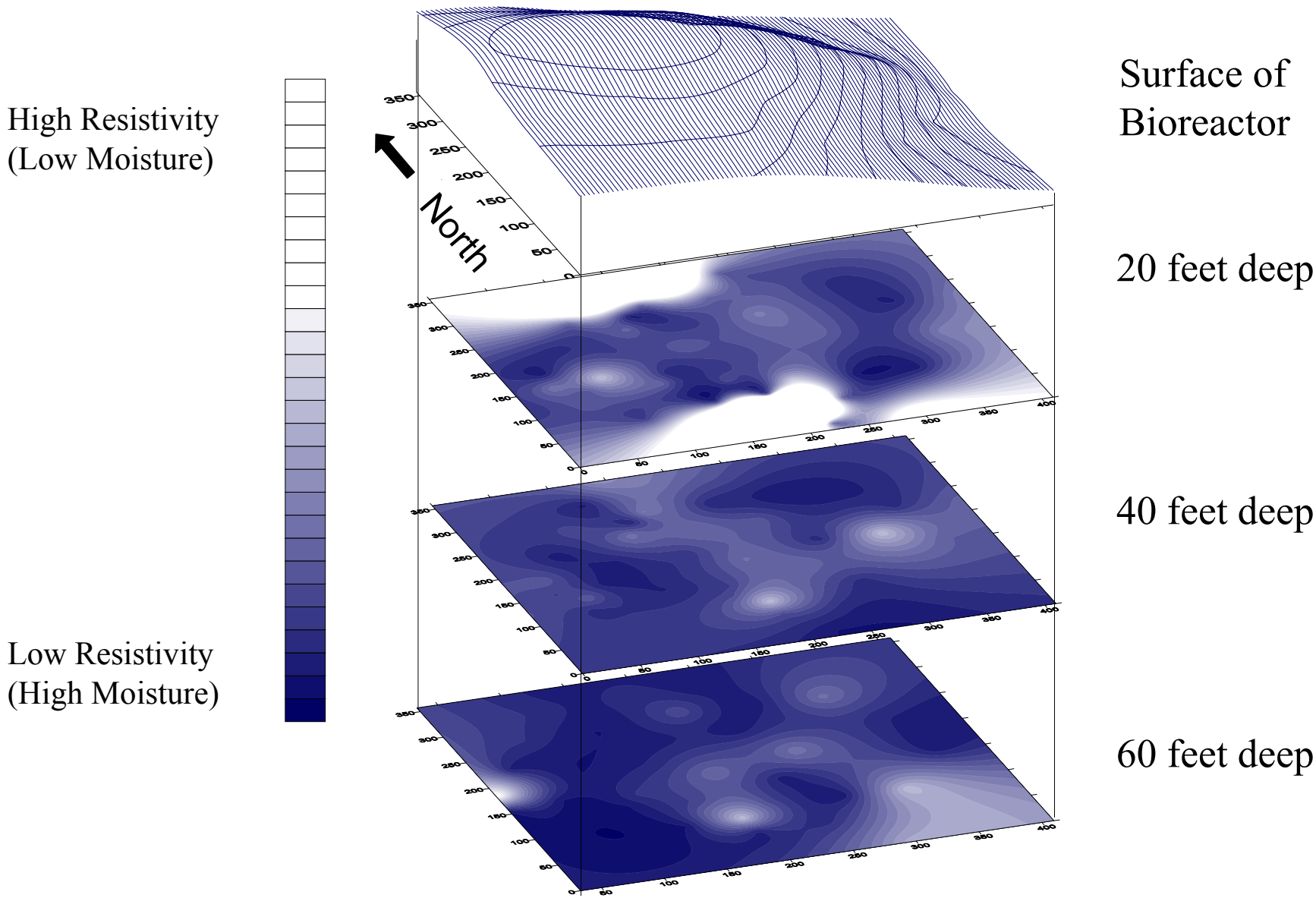
www.bioreactor.org



New River Regional Landfill Bioreactor

www.bioreactor.org

Resistivity distribution inside NRRL Bioreactor, 12/18/02



Remaining Questions

- How long will they work?
- Once wetted, do they stay wet?
- Does installation create preferential flow paths?
- Can true moisture content be measured, or only relative moisture content?
- Are they economical?
- Can wireless measurement be implemented?