Contaminant Pathway Evaluation and Control for

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Waterways Experiment Station

The High Points

- **CDFs are containment options**
- **Pathway evaluations are critical**
- **Tiered approach to testing and evaluations**
- **Testing/ evaluation procedures are available for all pathways**
- **Pathway controls are available**

Confined Disposal Facilities

- CDFs used for navigation because:
  - More economical for some projects
  - Most common option for material unsuitable for open water
- CDFs used for cleanup projects because:
  - Needed for pretreatment
  - Option for disposal

CDF Design Objectives

- Retain solids during placement
- Provide adequate volume storage for the project
- Contain contaminants

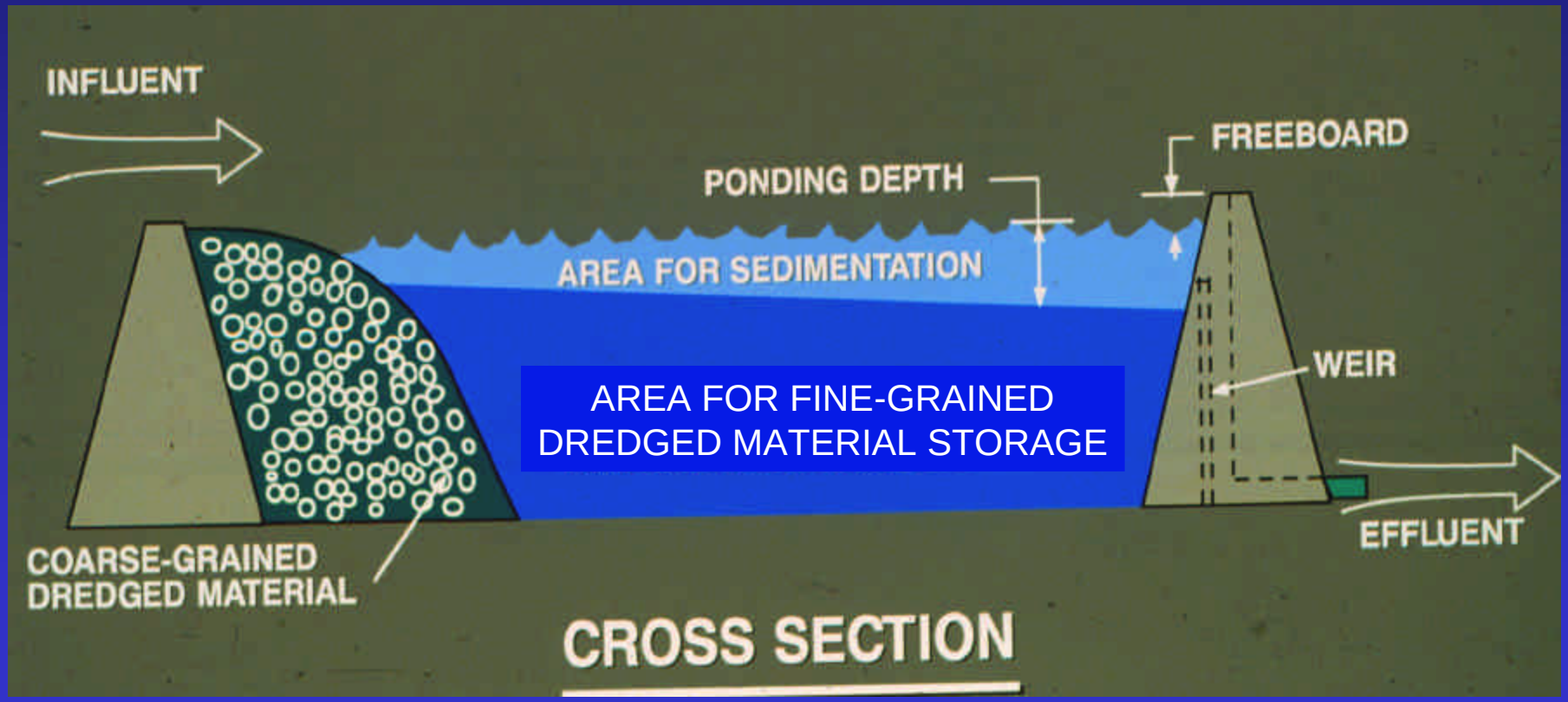
CDF Dikes

- Planning
  - Design life / Total volume
  - Staged construction vs one-time construction
- Design
  - Geotechnical - static and seismic
  - Coastal - waves
- Construction
  - Conventional earthwork
  - Special methods

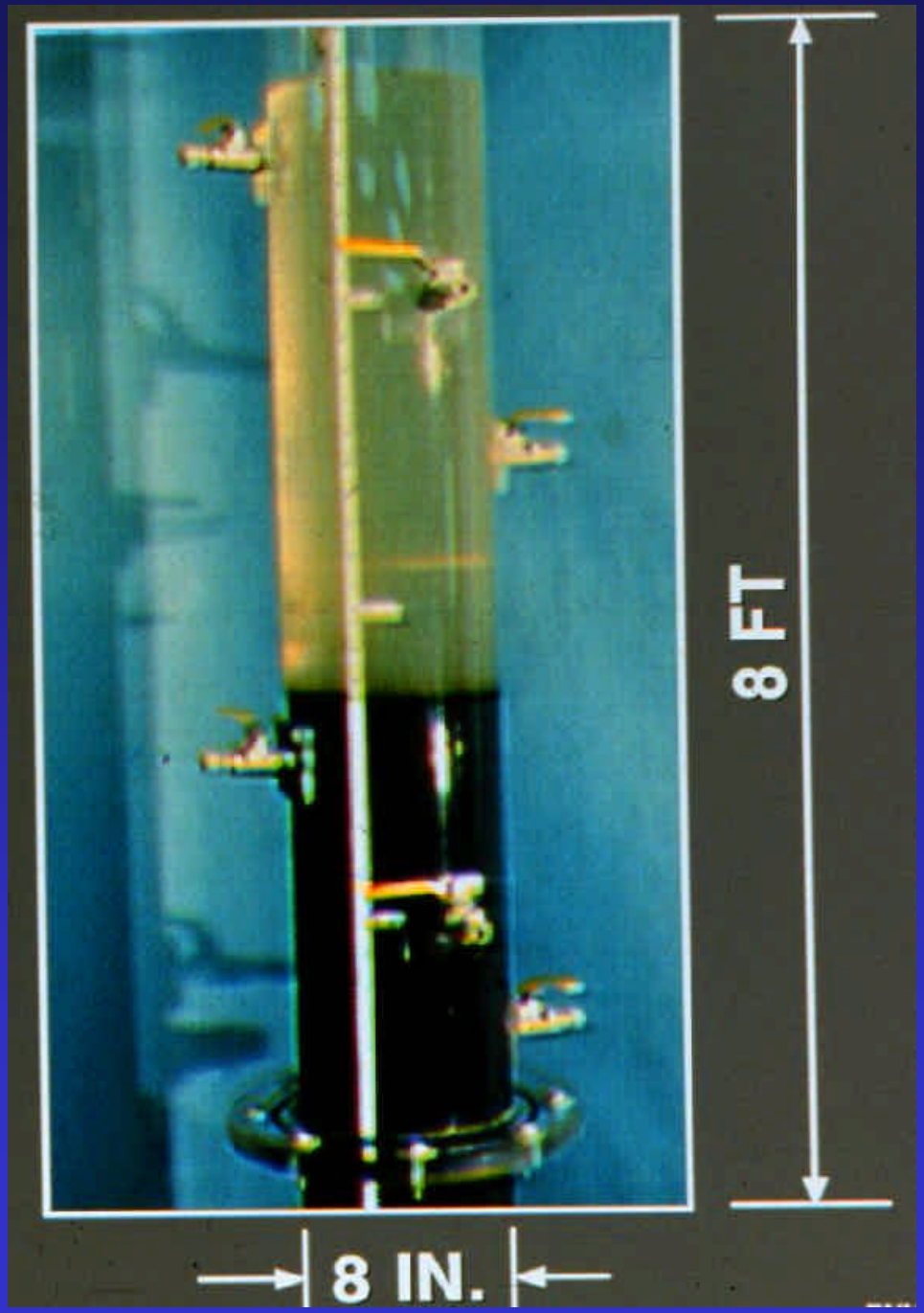
Initial Storage and Solids Retention (Hydraulic Filling)

- Volume required for initial storage during filling
- Ponded surface area required for effective settling
- Ponded volume required for solids retention

Basin


INFLUENT
FREEBOARD
PONDING DEPTH
AREA FOR SEDIMENTATION
WEIR
AREA FOR FINE-GRAINED
DREDGED MATERIAL STORAGE
EFFLUENT
COARSE-GRAINED
DREDGED MATERIAL
CROSS SECTION

Standard 8-Inch Settling Column

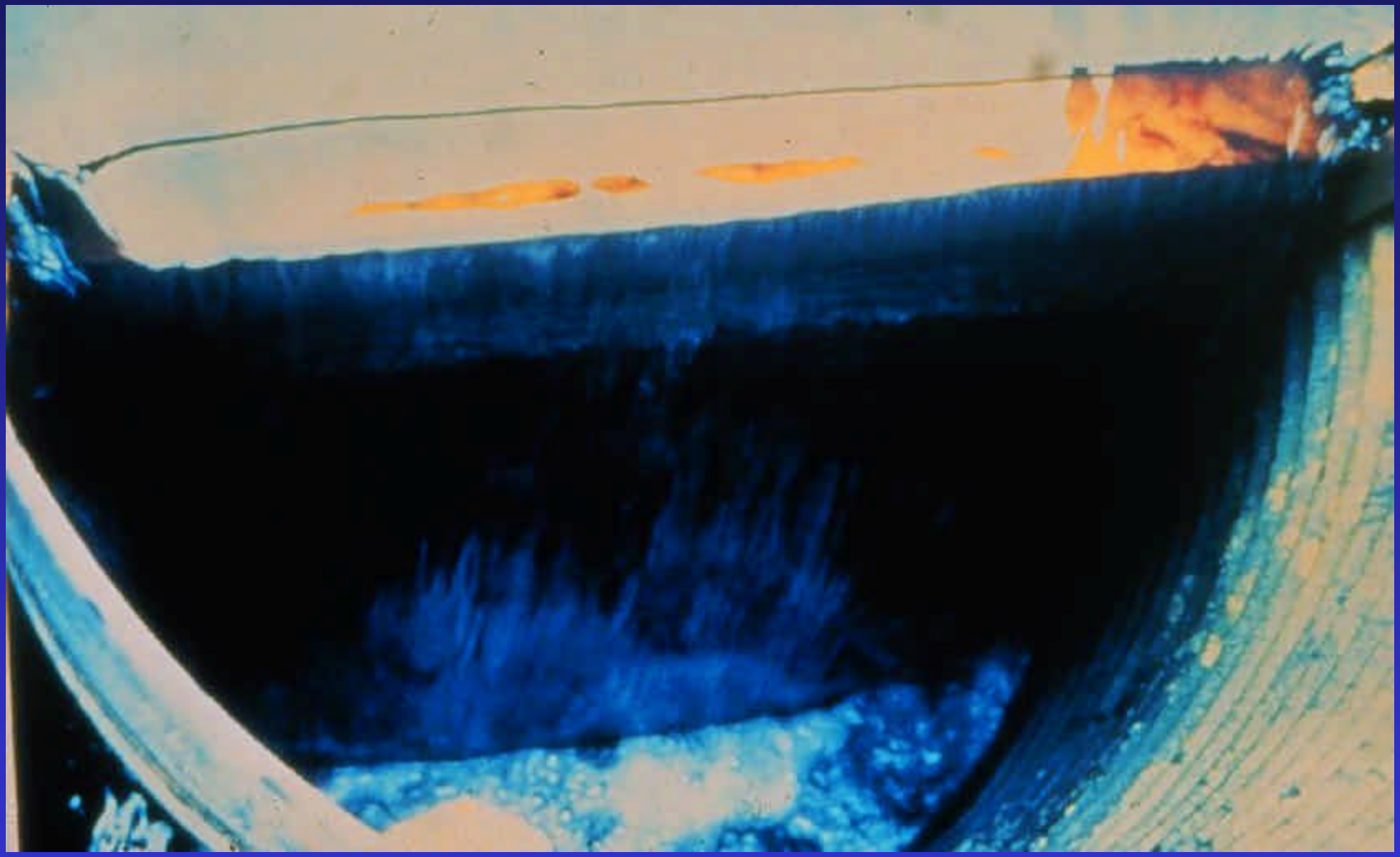


Design and Management of CDFs
ADDAMS Programs

- SETTLE - Initial Storage and Solids Retention
- PSDDF - Long-term Storage and Dewatering

EM 1110-2-5027
Confined Disposal of Dredged Material

- Field investigations and sampling
- Site selection to avoid groundwater impacts
- Settling tests for evaluation of solids retention
- Consolidation tests for evaluation of long-term storage
- Design for solids retention
- Design for storage during filling
- Weir design
- Design of chemical clarification systems
- Prediction of dredged material consolidation
- Dredged material dewatering operations
- Design and construction of dikes
- Operation and management activities
- Long-term management plans



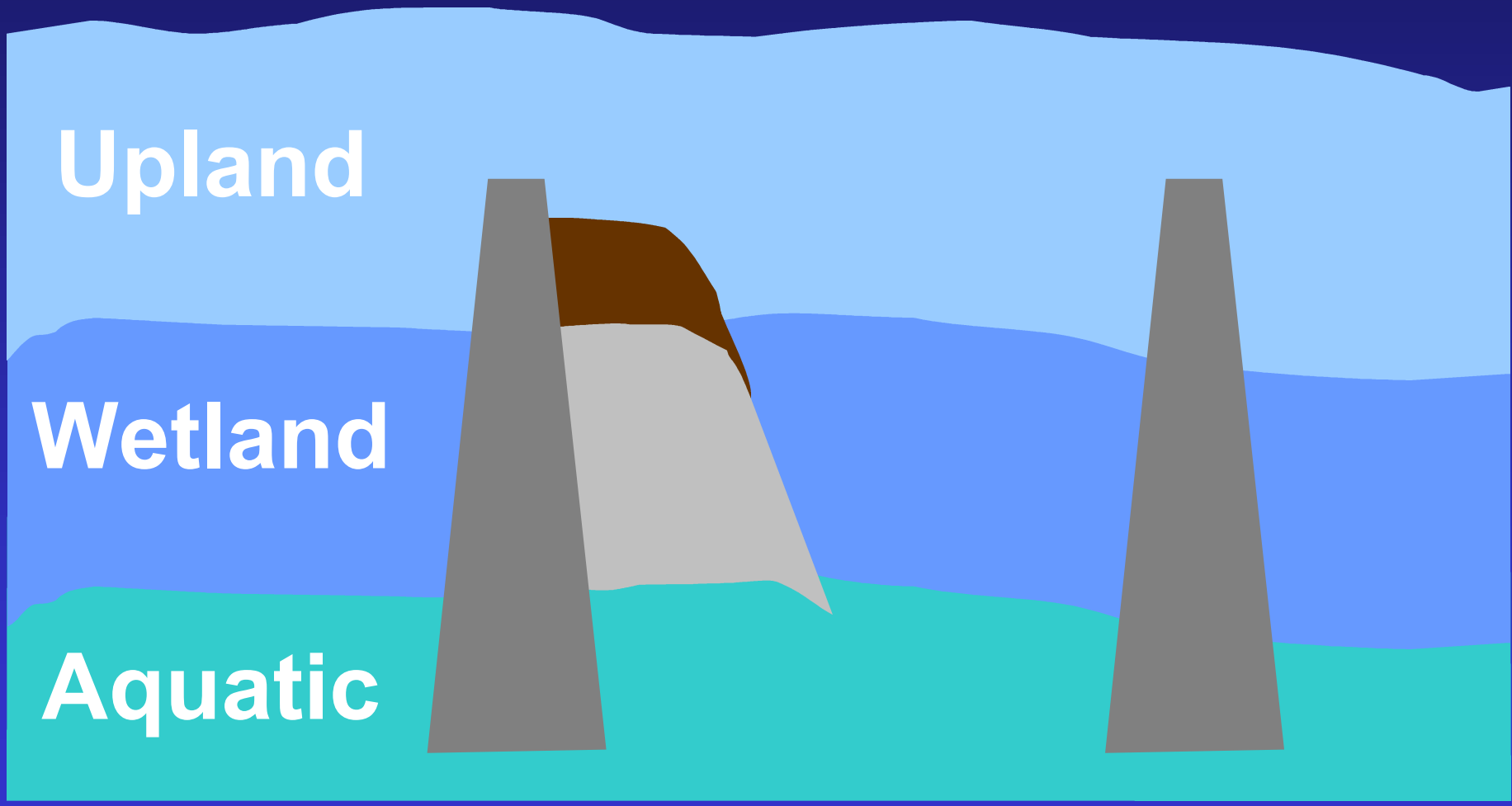
Long-Term Storage and Dewatering

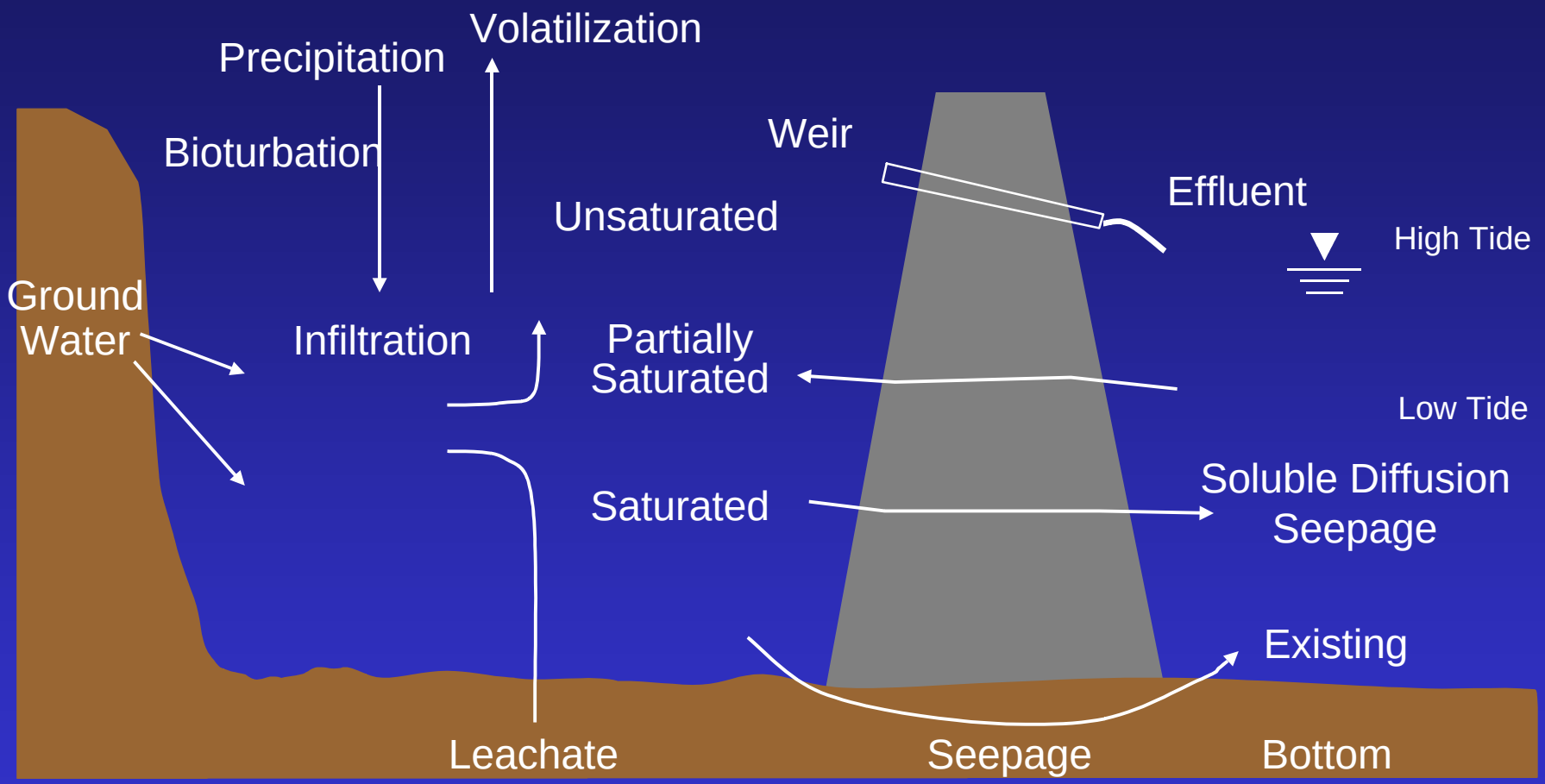
- Prediction of consolidation / desiccation rates
- Site management for dewatering
- Dewatering equipment and operations

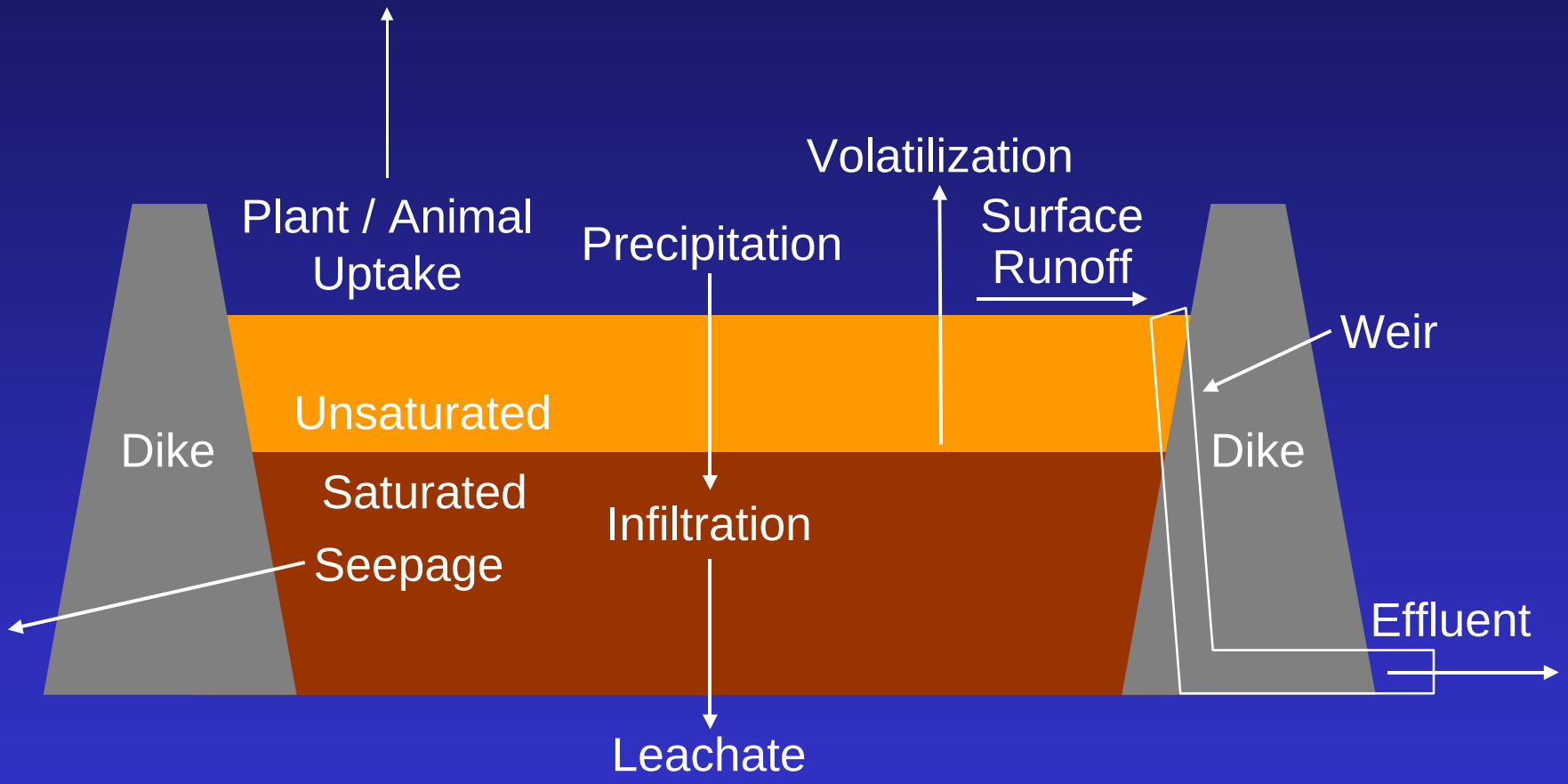
CDF Contaminant Pathways

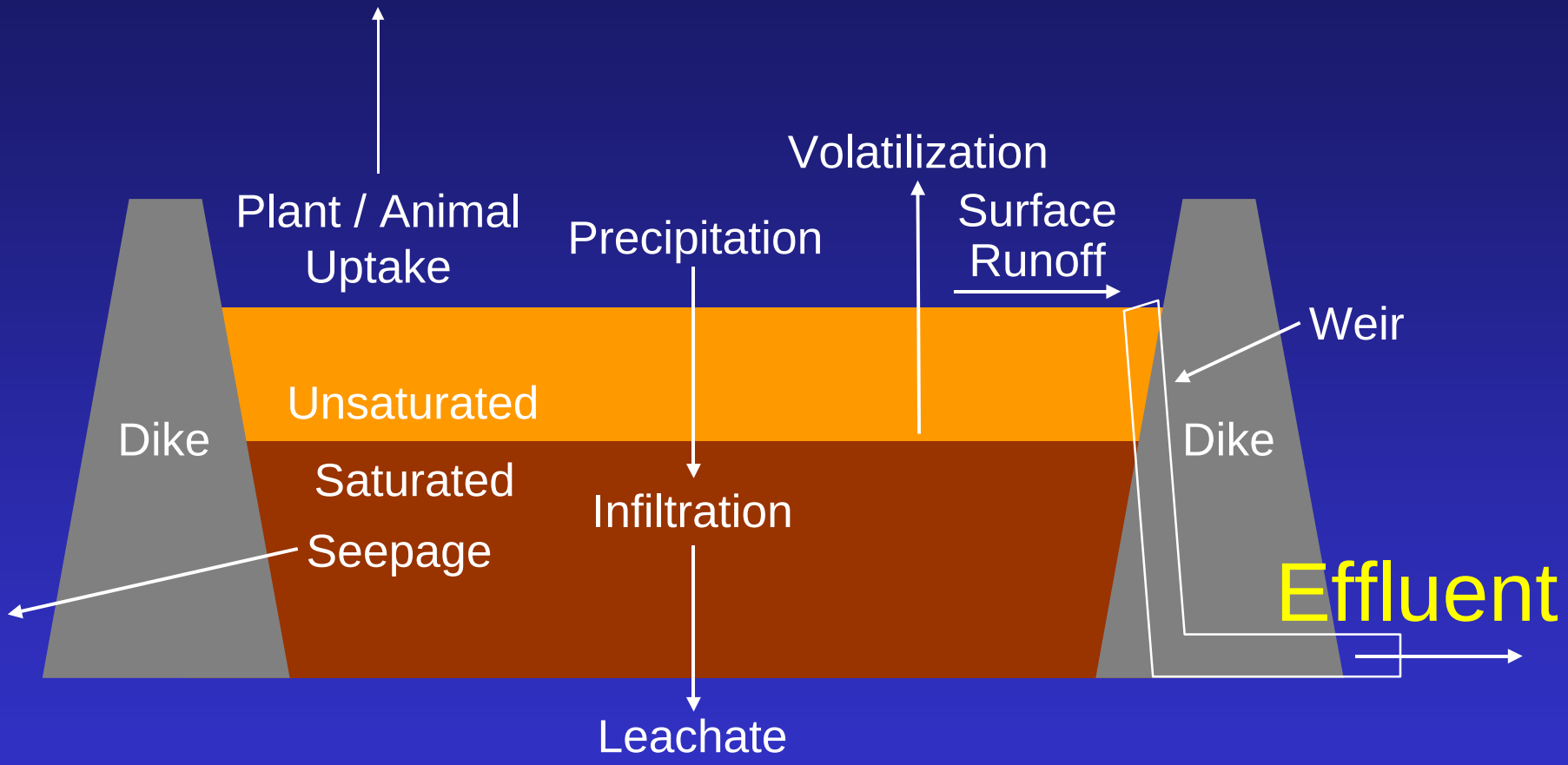
Confined (Diked) Disposal Contaminant Pathways

- Effluent During Filling
- Surface Runoff
- Leachate to Groundwater
- Direct Uptake by Plants/ Animals
- Volatilization to Air

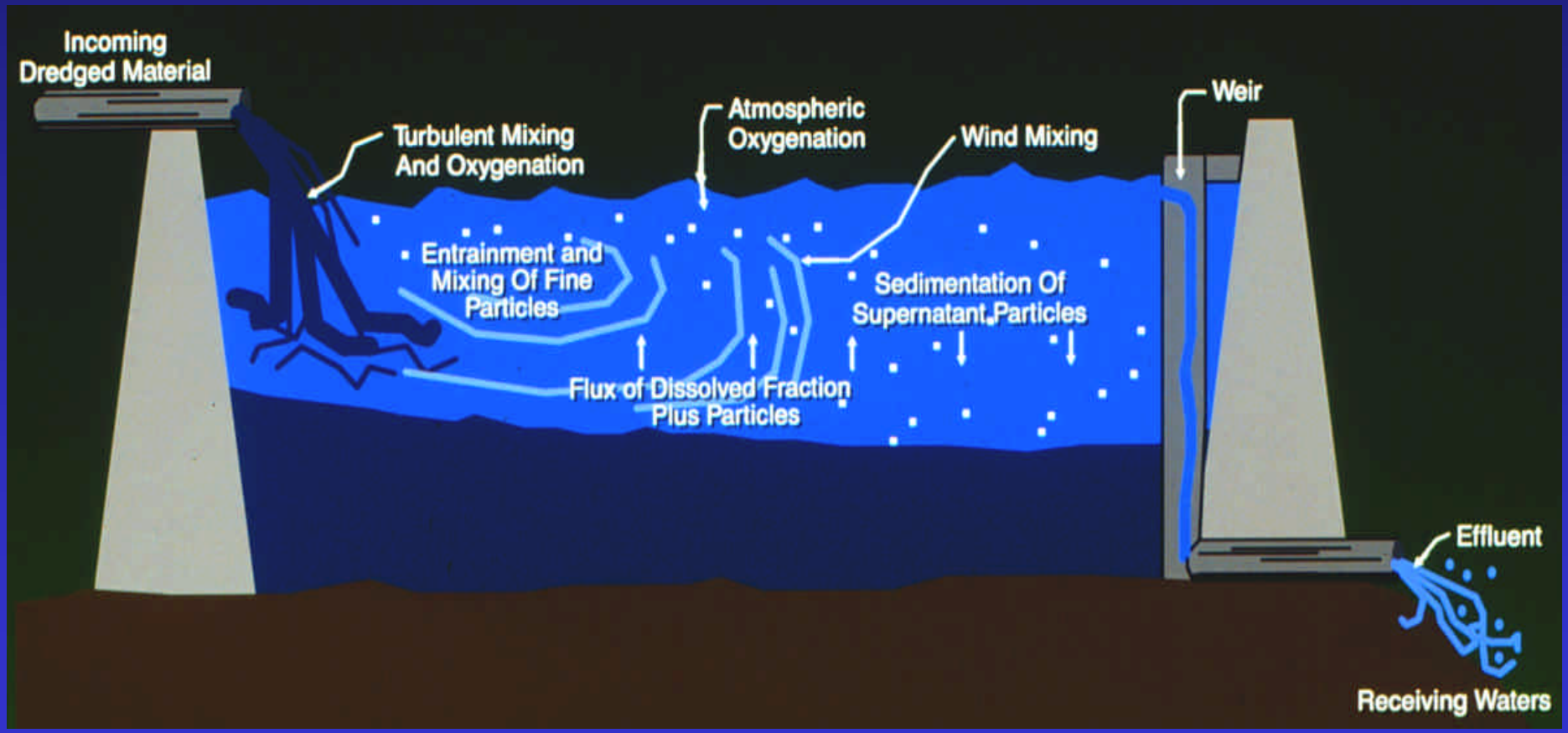

Upland
Wetland
Aquatic

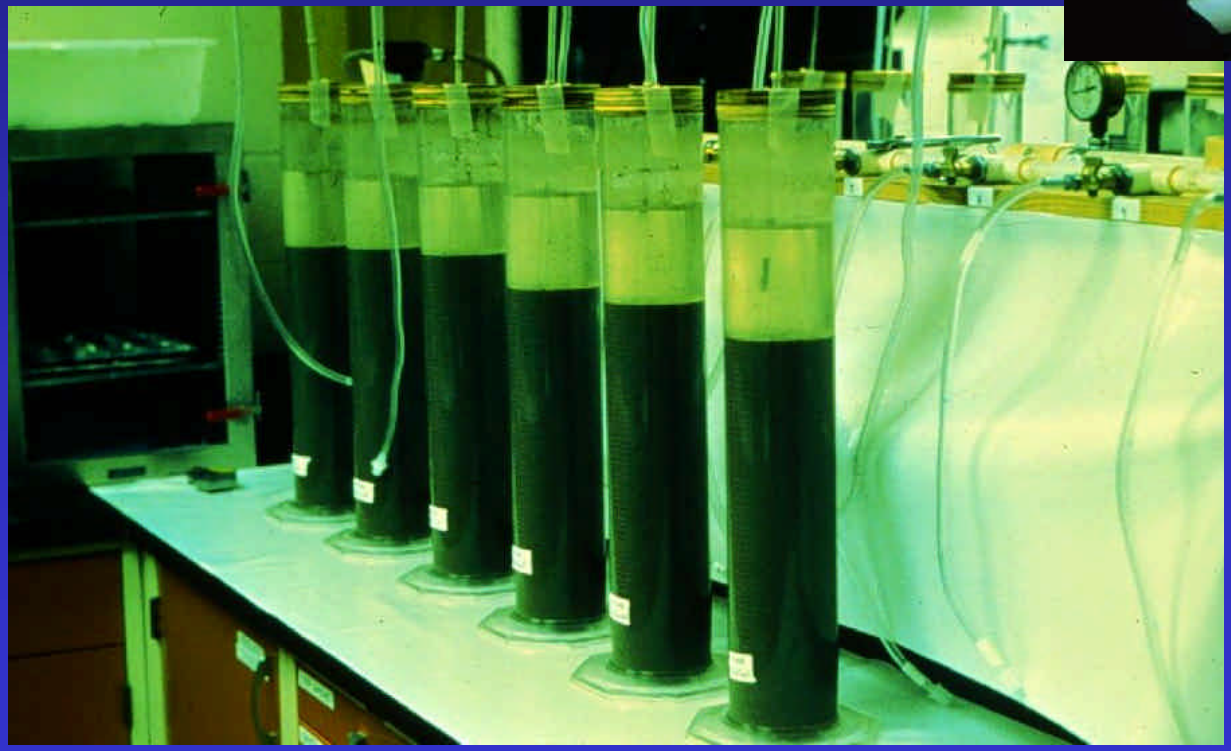

Precipitation
Volatilization
Bioturbation
Weir
Effluent
Unsaturated
High Tide
Ground Water
Infiltration
Partially Saturated
Low Tide
Saturated
Soluble Diffusion Seepage
Existing
Leachate
Seepage
Bottom


Plant / Animal
Uptake
Precipitation
Volatilization
Surface
Runoff
Weir
Dike
Unsaturated
Saturated
Seepage
Infiltration
Dike
Effluent
Leachate


Plant / Animal Uptake
Precipitation
Volatilization
Surface Runoff
Weir
Dike
Unsaturated
Saturated
Dike
Infiltration
Seepage
Effluent
Leachate

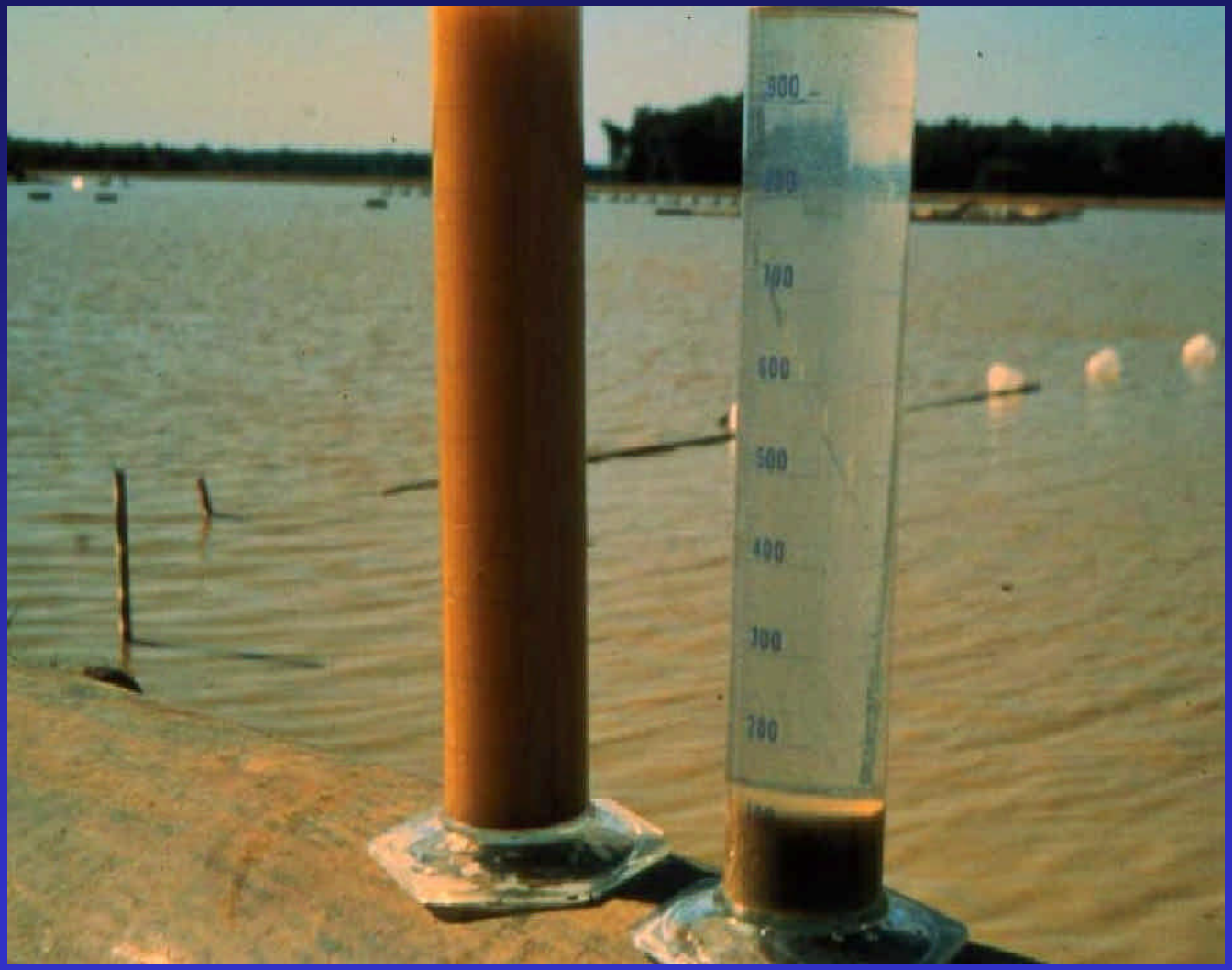
CDF Supernatant Water Interactions

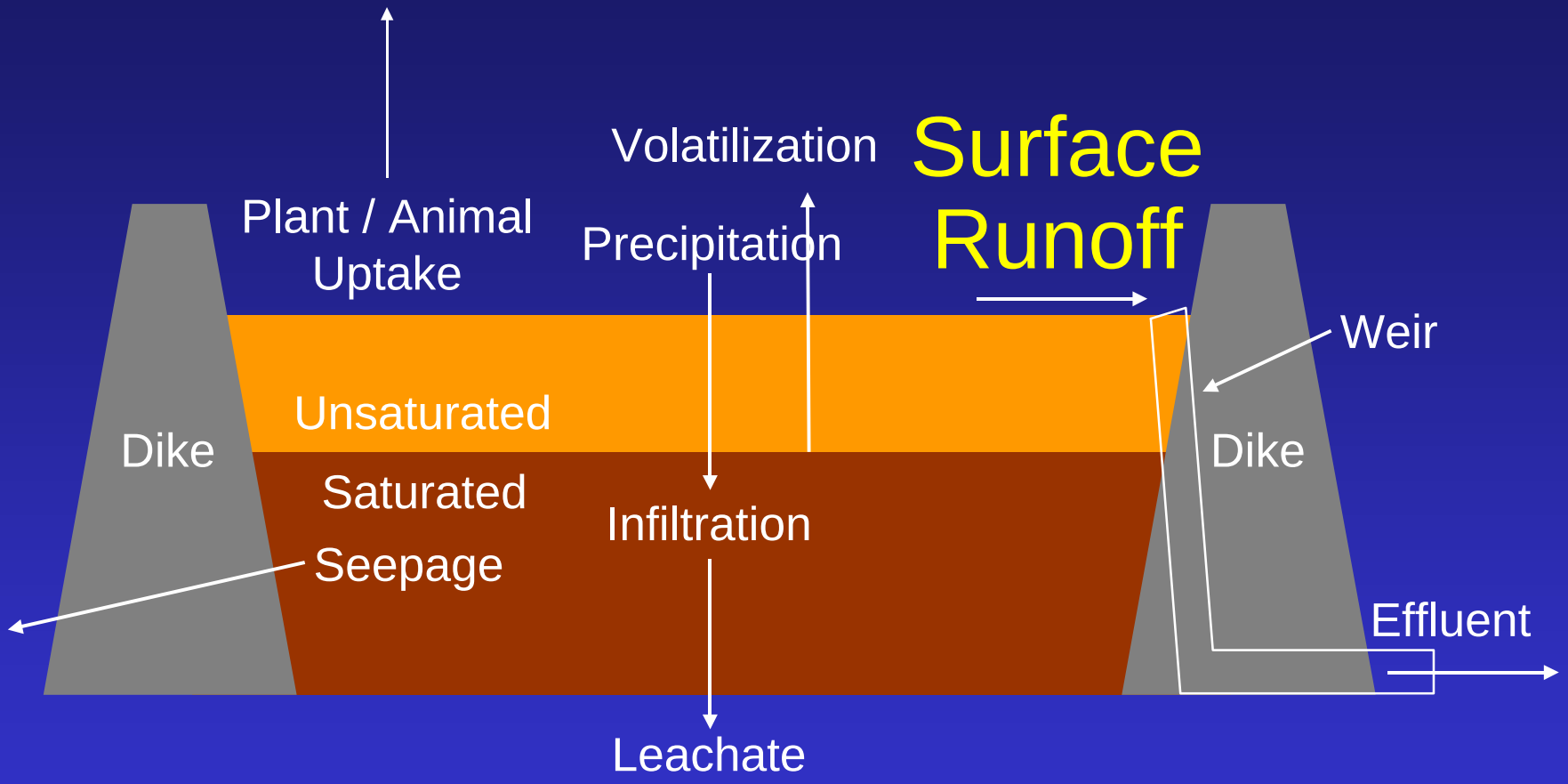




Effluent Quality Controls for TSS

- Operational modification
  - Reduce inflow rate
  - Increase ponding
- Filtration
- Chemical flocculants


800
700
600
500
400
300
200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Volatilization
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Weir
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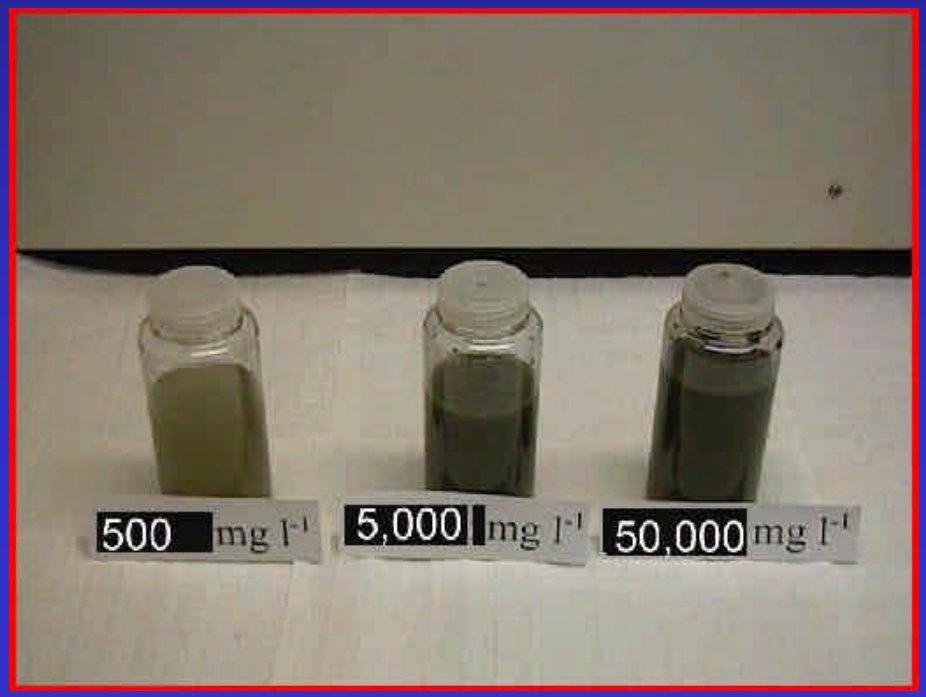
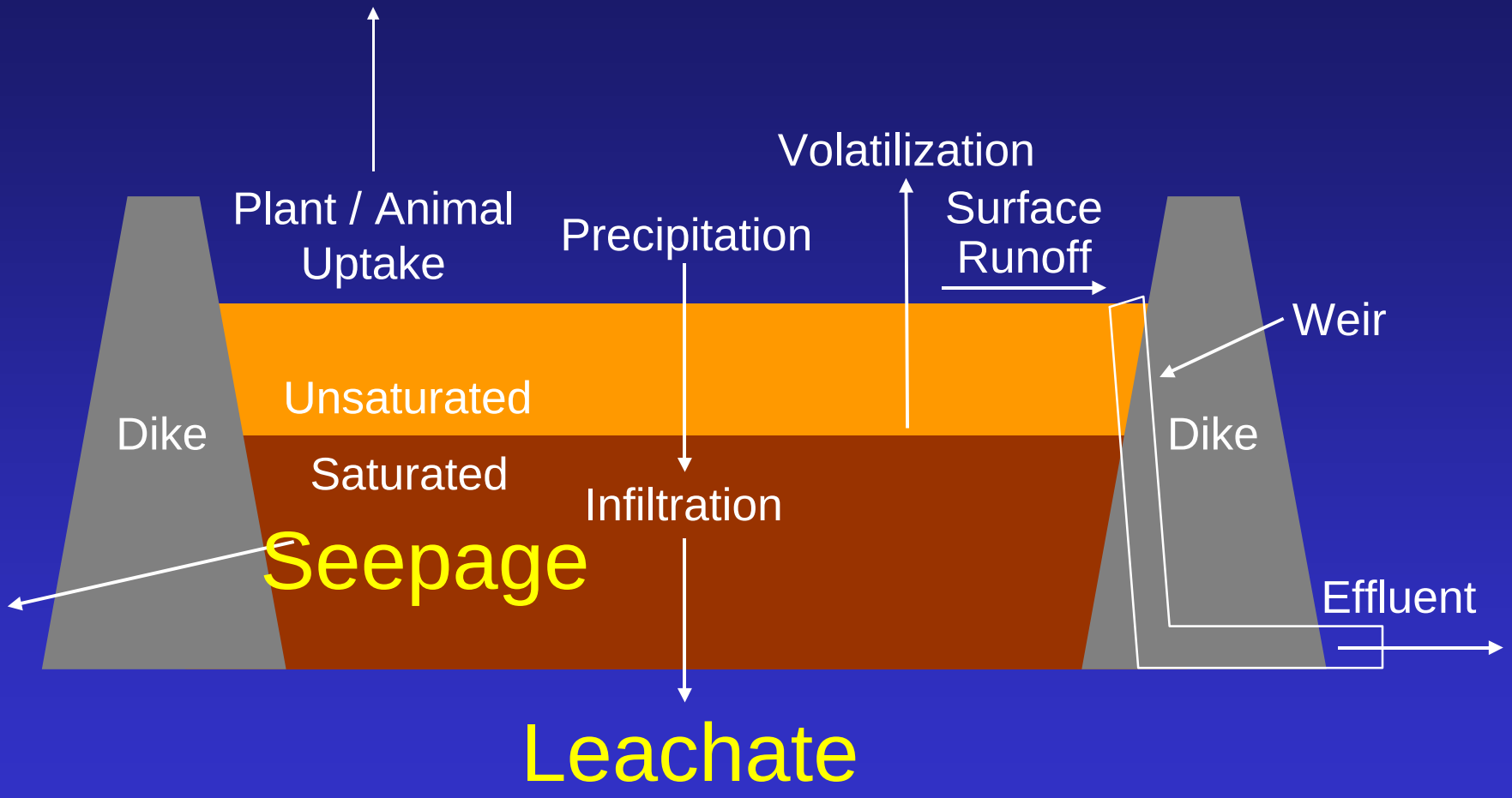
Saturated
Dike
Seepage
Infiltration
Effluent
Leachate

Surface Runoff Tests

- Simplified Laboratory Runoff Procedure (SLRP)
- Field-portable lysimeter system for runoff prediction




Plant / Animal Uptake
Precipitation
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Weir
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Unsaturated
Saturated
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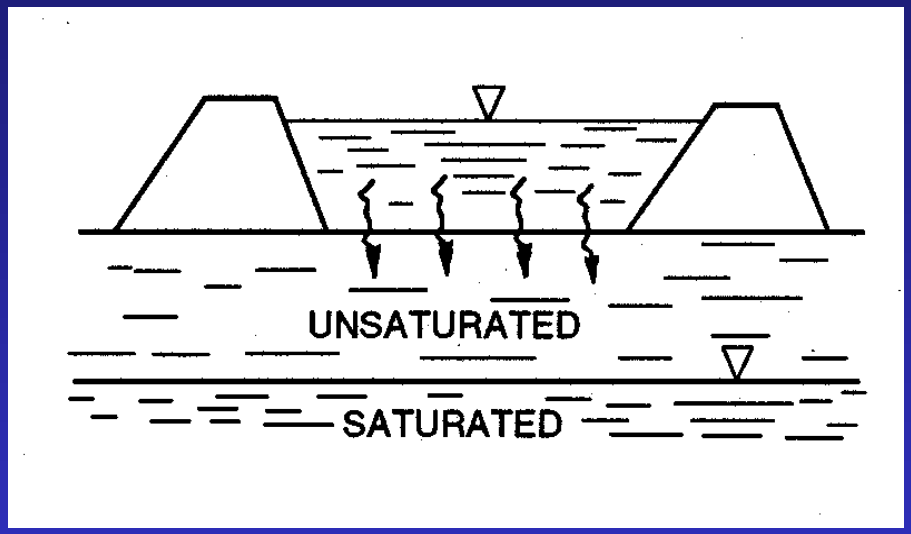
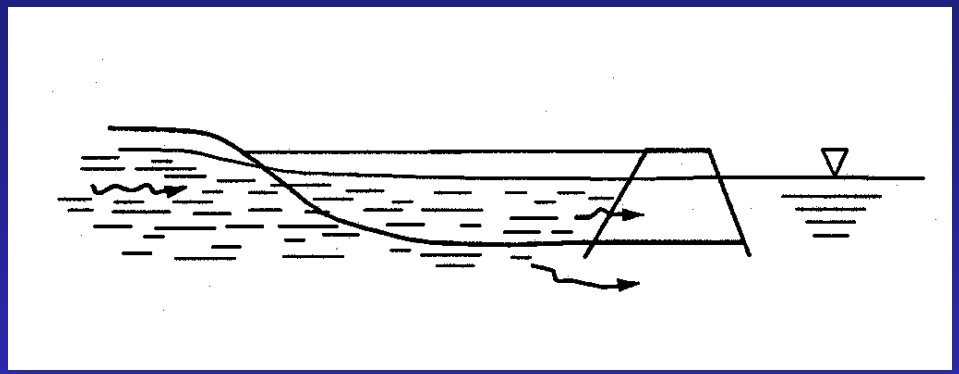
Seepage
Effluent
Leachate

Upland CDF



The CDF is separated from groundwater by the vadose zone; flow is into foundation soils and toward groundwater. Hydraulic gradient is approximately one.

Nearshore CDF



The CDF is partially sited in the saturated zone; water table is seasonally dependent and flow is through site. Hydraulic gradient is near zero.

Selection of Test Procedure

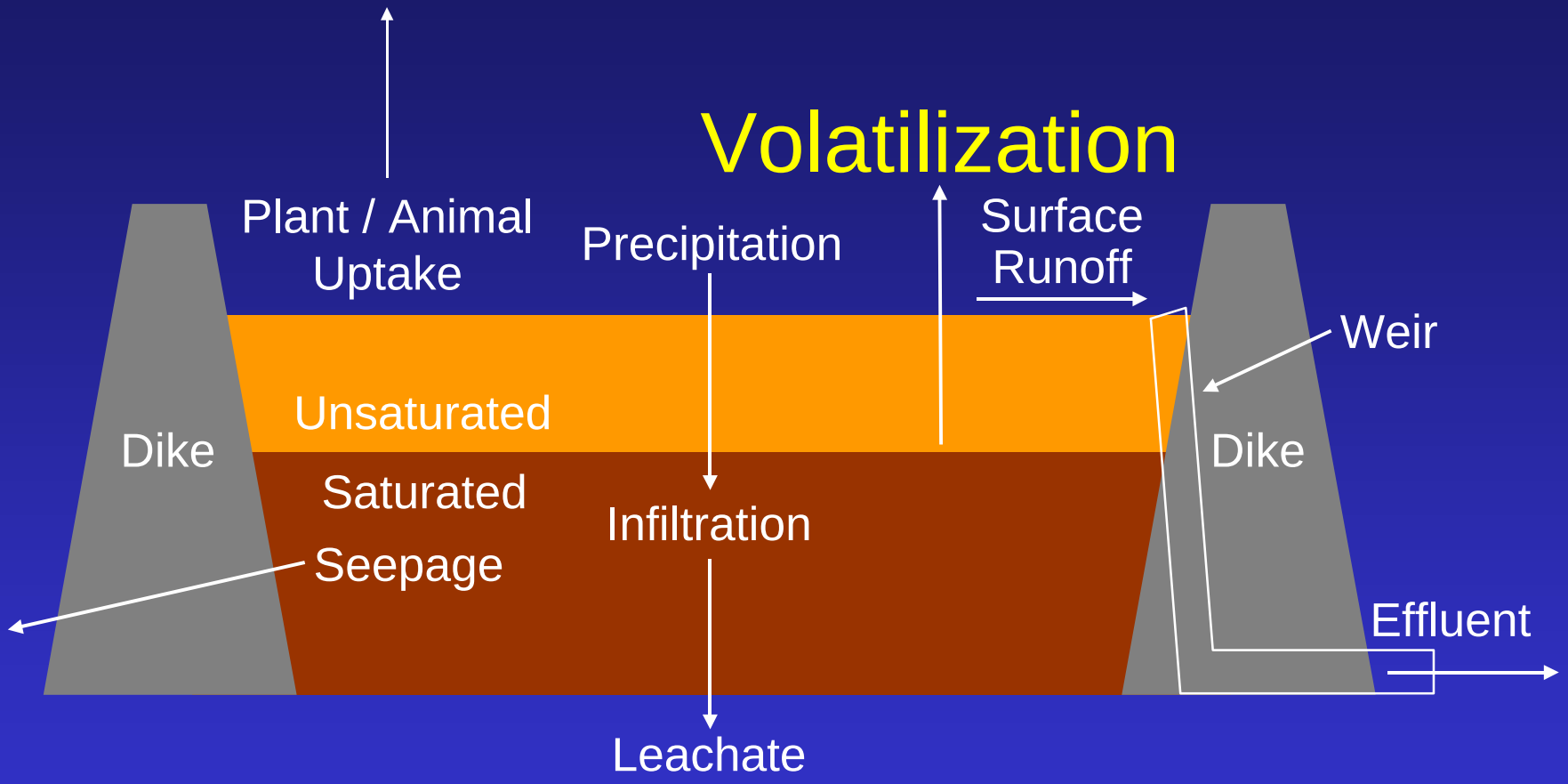
- Freshwater Dredged Material: Batch testing

  Generally yields well-behaved contaminant desorption isotherm or single point K_D if clustered concentration data result

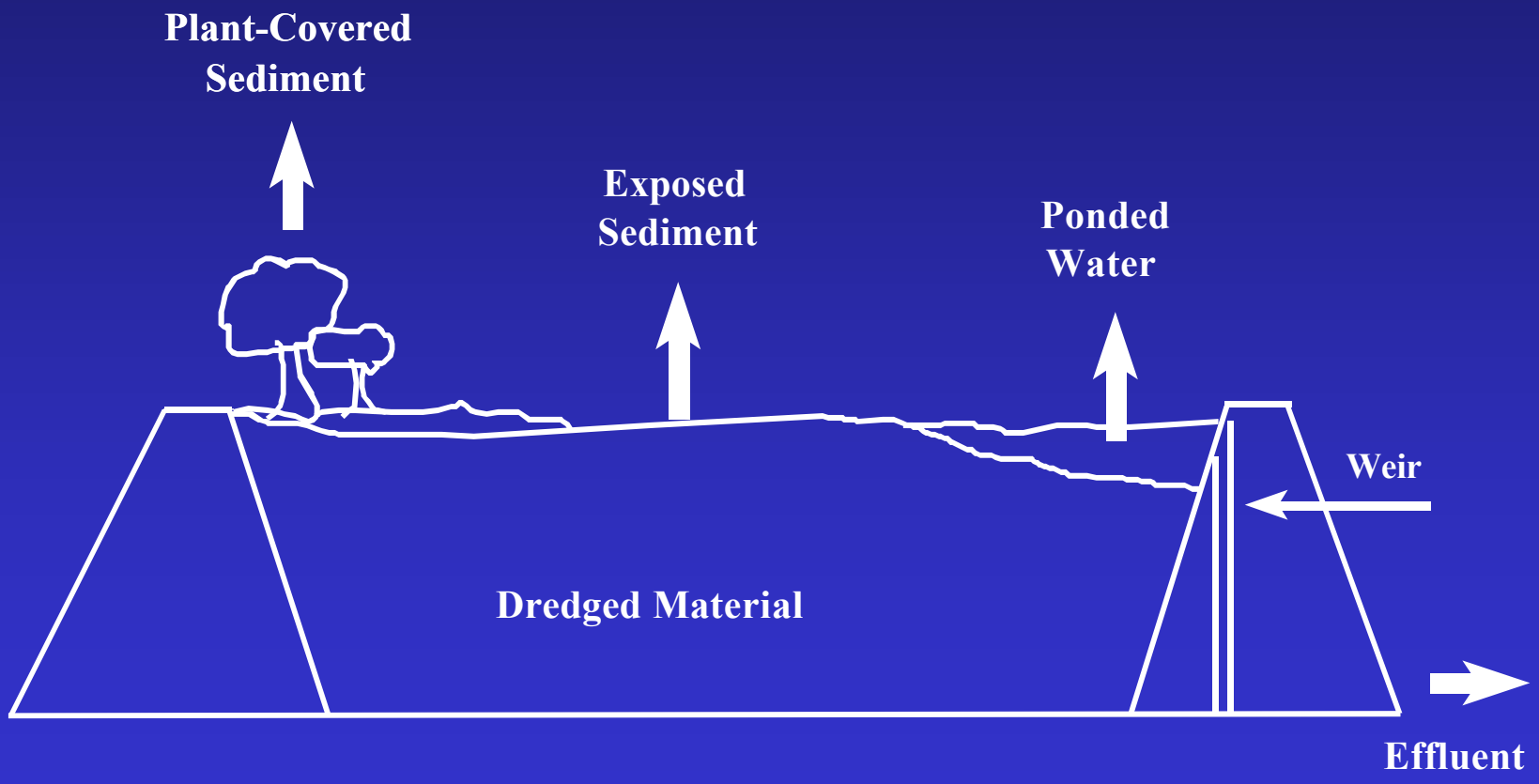
- Saline Dredged Material: Column Testing

  Salt elution from saline dredged materials results in colloid release to leachate that cannot be quantitatively described by batch test results because of the effects of leachate shear velocity

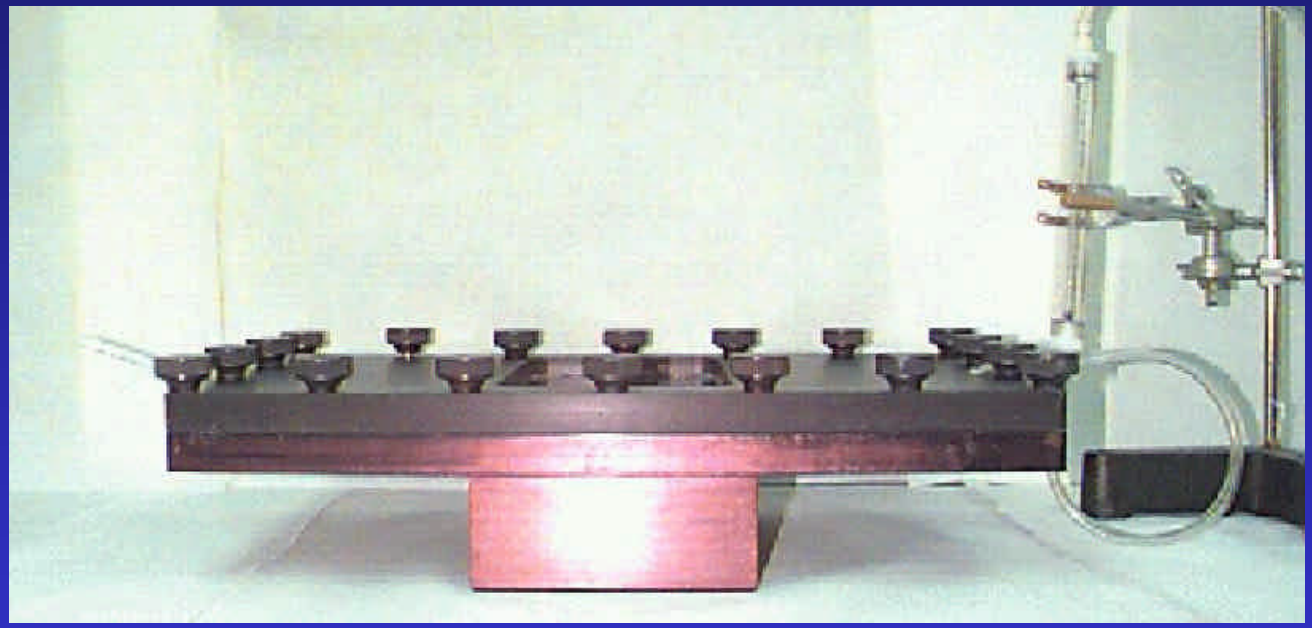
“Pancake” column leach test


Volatilization
Plant / Animal Uptake
Precipitation
Surface Runoff
Weir
Unsaturated
Dike
Dike
Saturated
Infiltration
Seepage
Effluent
Leachate

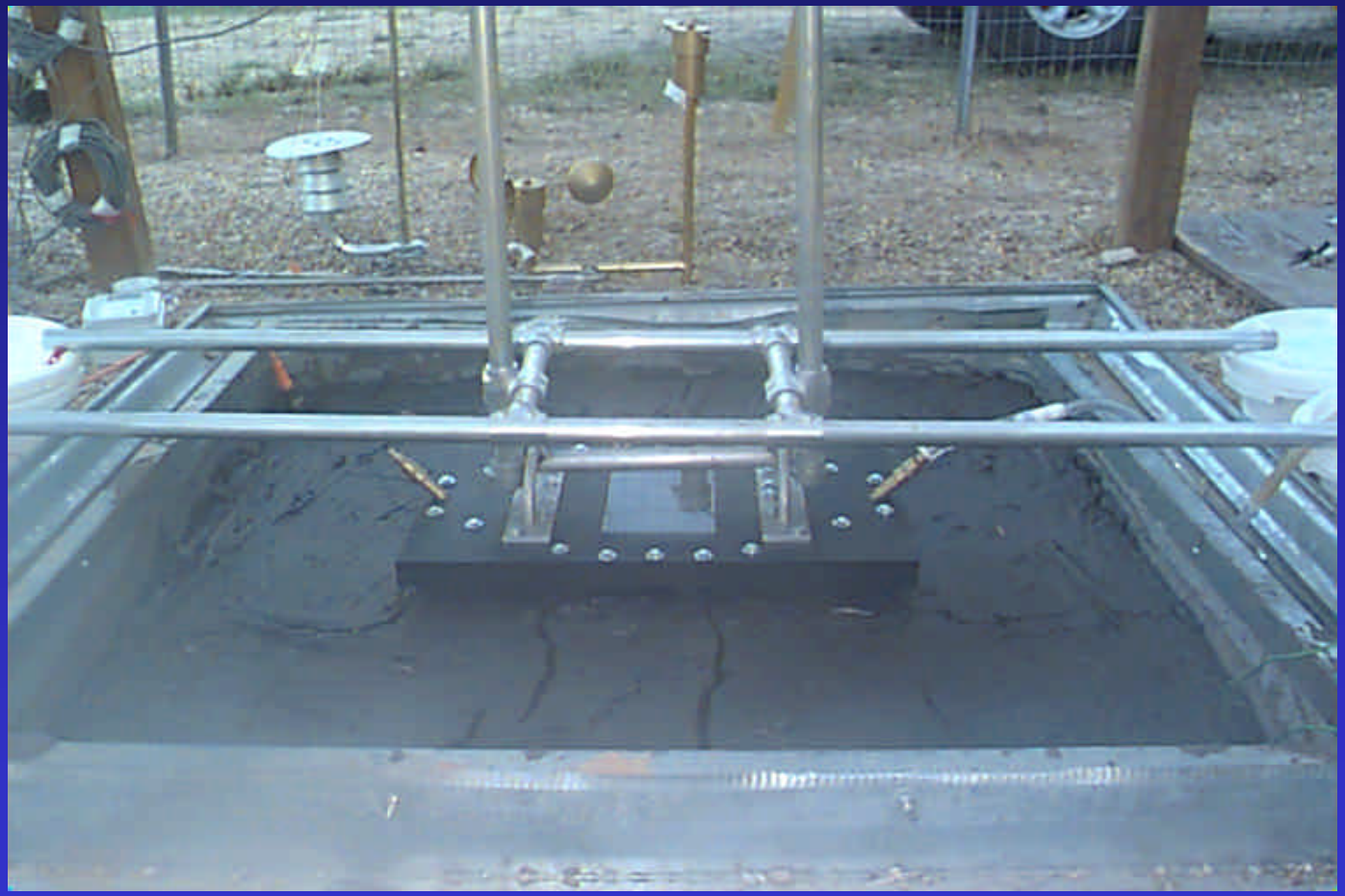
Volatile Emissions from Dredged Material

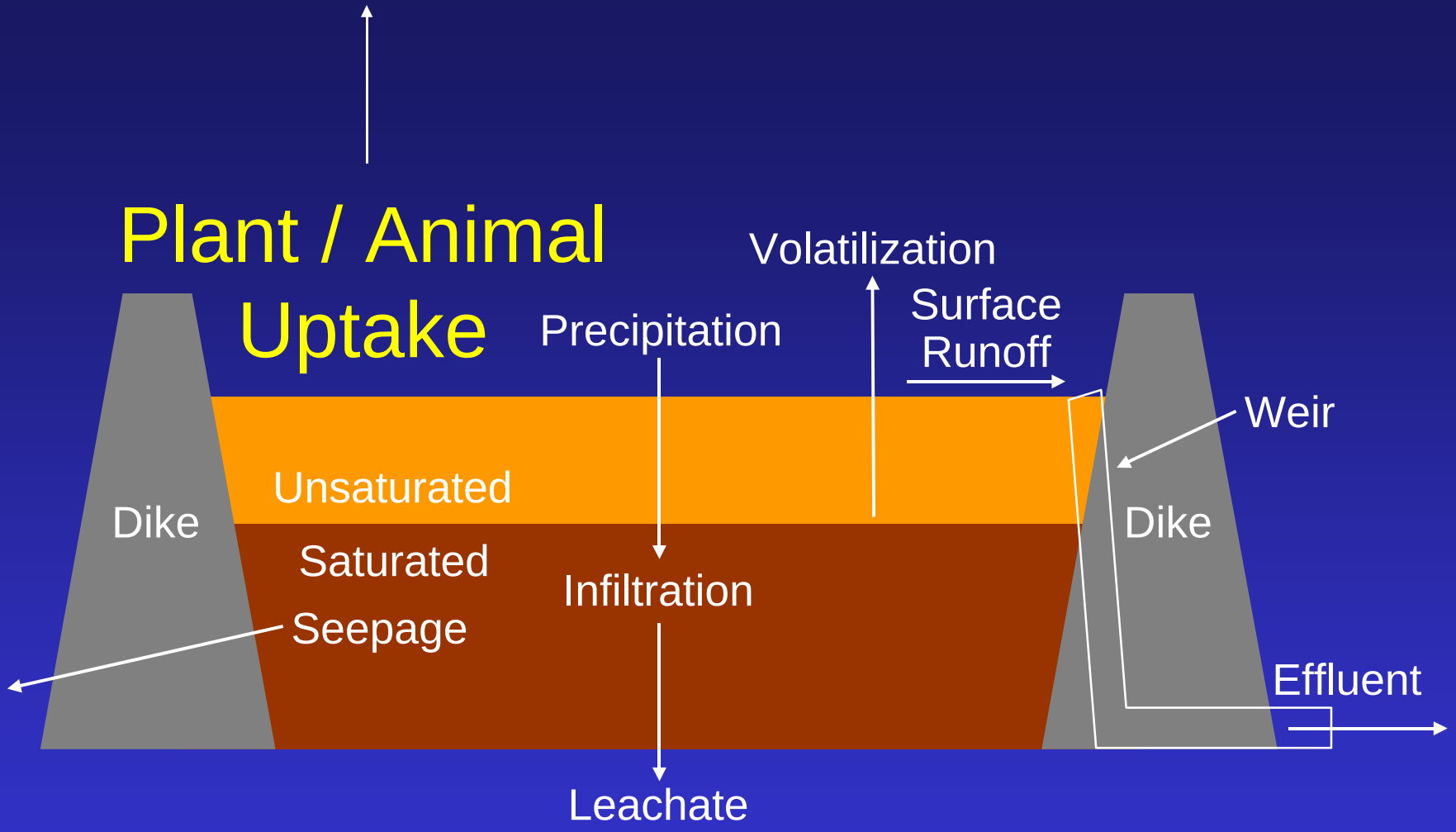


Volatile Test Apparatus



Field Apparatus

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Volatilization
Precipitation
Surface Runoff
Weir
Unsaturated
Dike
Dike
Saturated
Infiltration
Seepage
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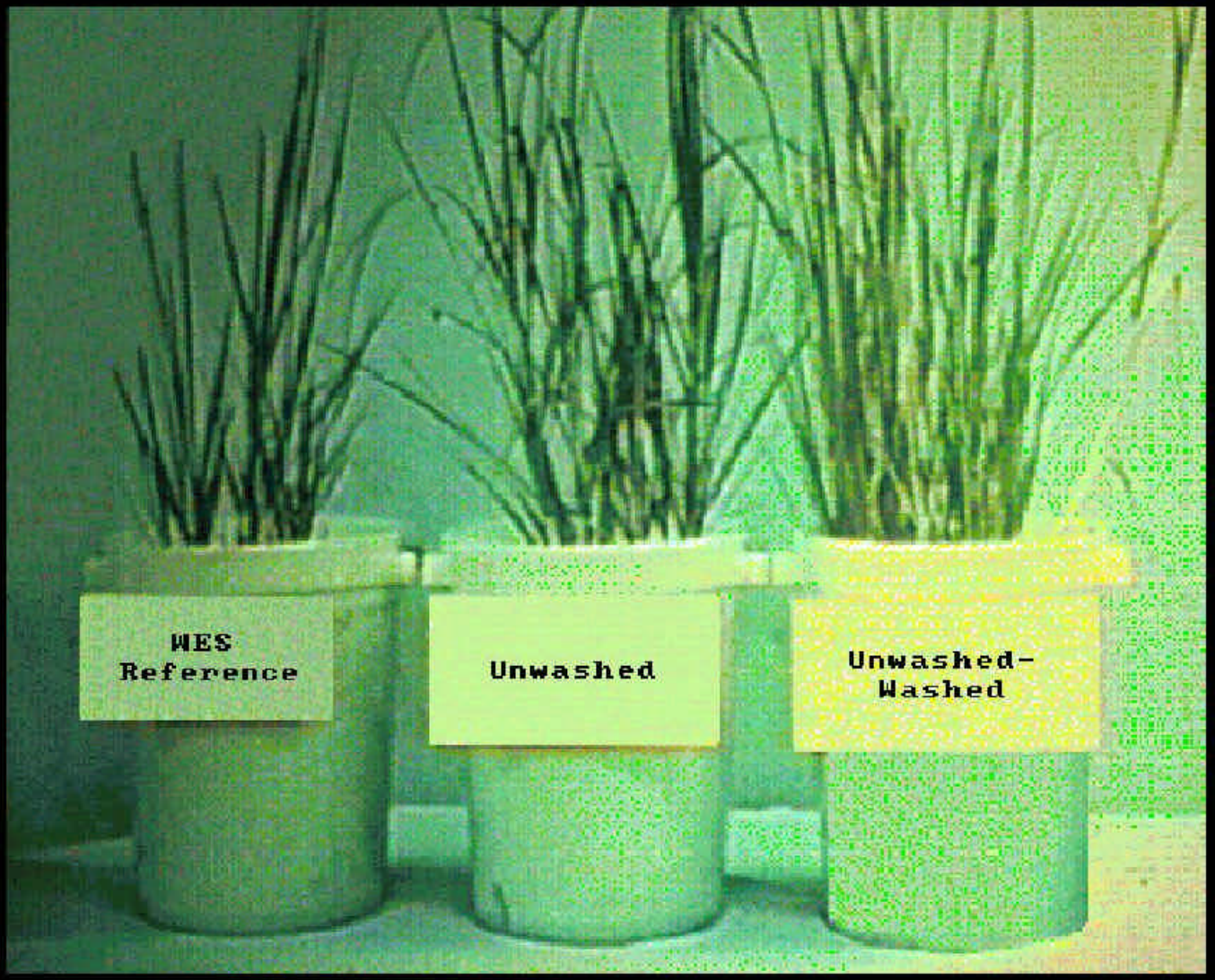
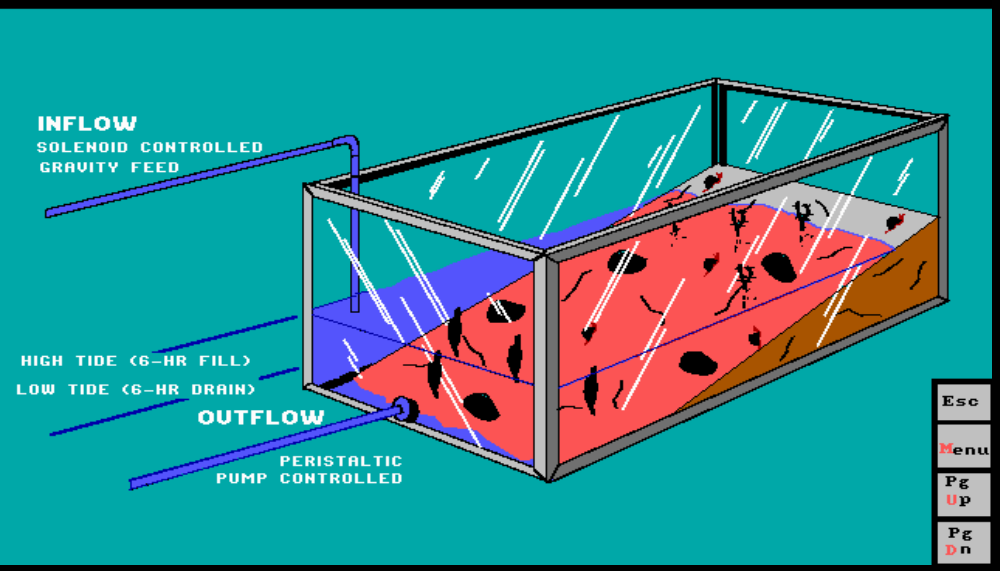
Leachate

FLOODED - BLACK ROCK HARBOR



- Salinity of dredged material (<10 ppt)
- Earthworm bioassay for toxicity (7 days)
- Bioaccumulation (28 days)
- Analyze for metals, PAHs, PCBs, etc.
- Compare to reference controls

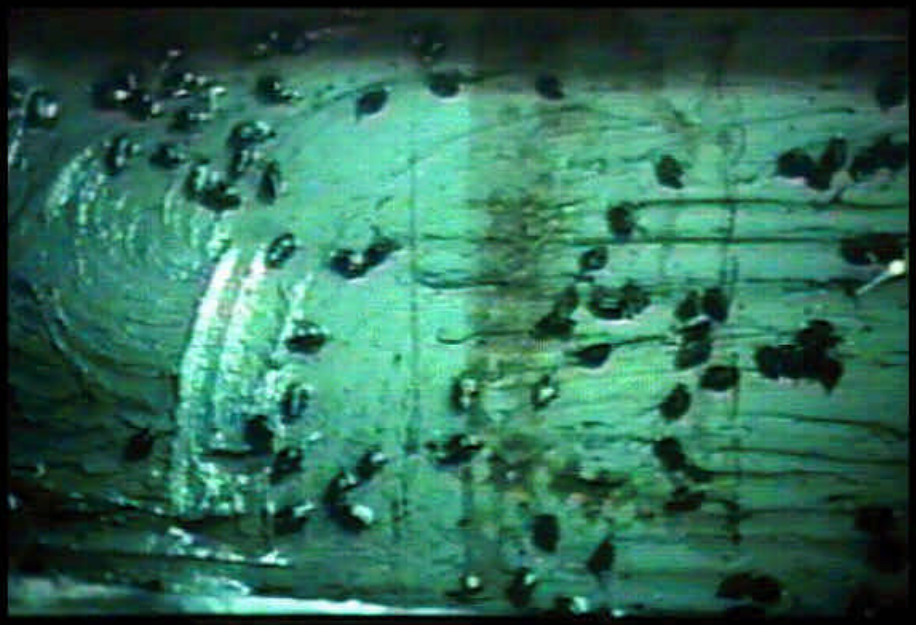
WETLAND BIOASSAY APPARATUS



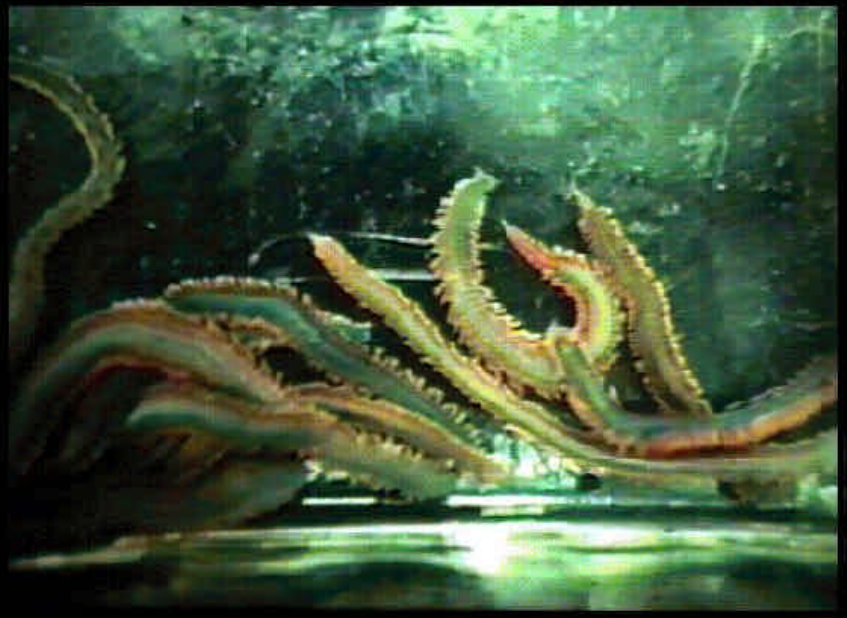
Esc
Menu
Pg Up
Pg Dn

RIBBED MUSSELS (Modiolus demissus)

MUD SNAIL (Nassarius obsoletus)



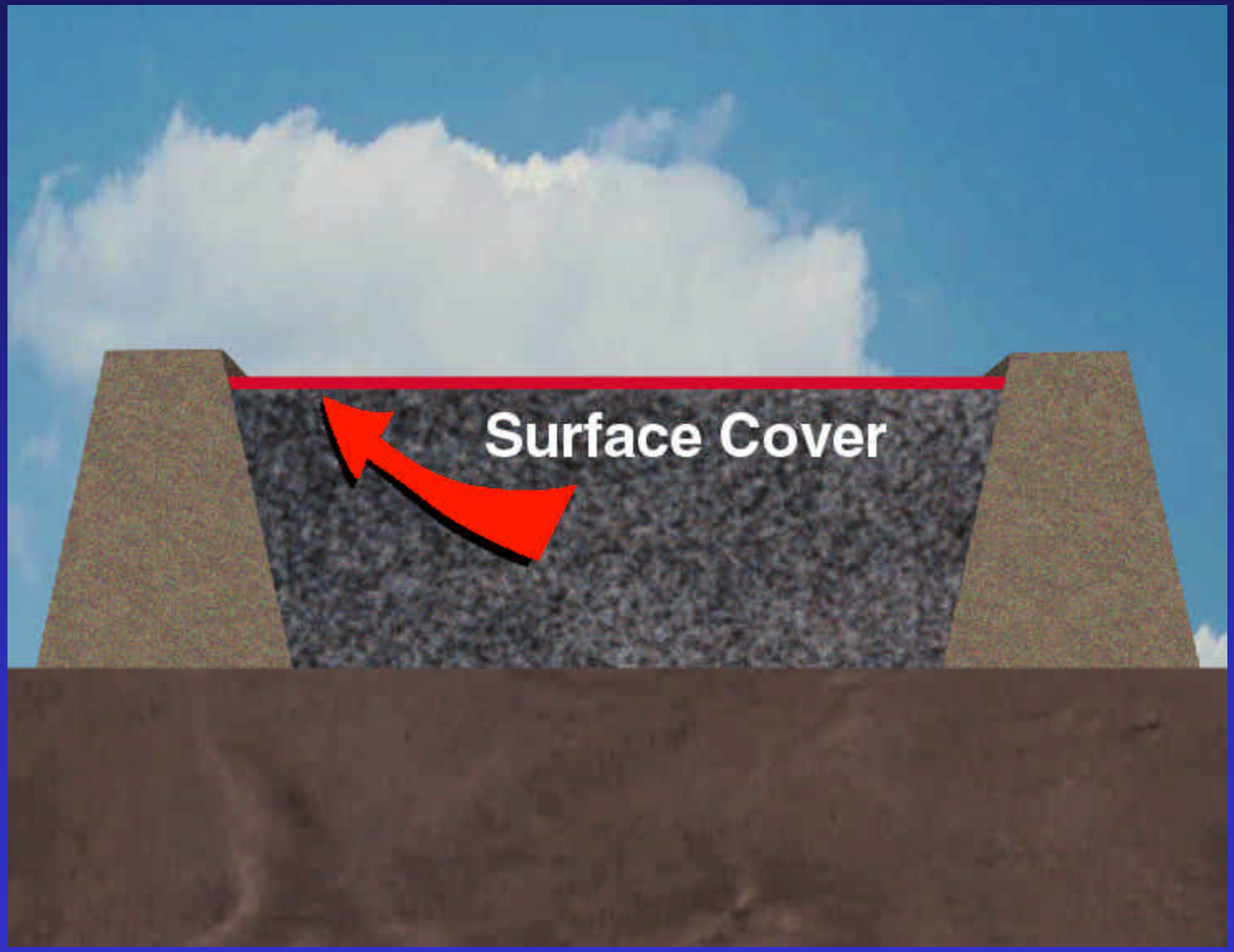
SANDWORMS (Nereis virens)

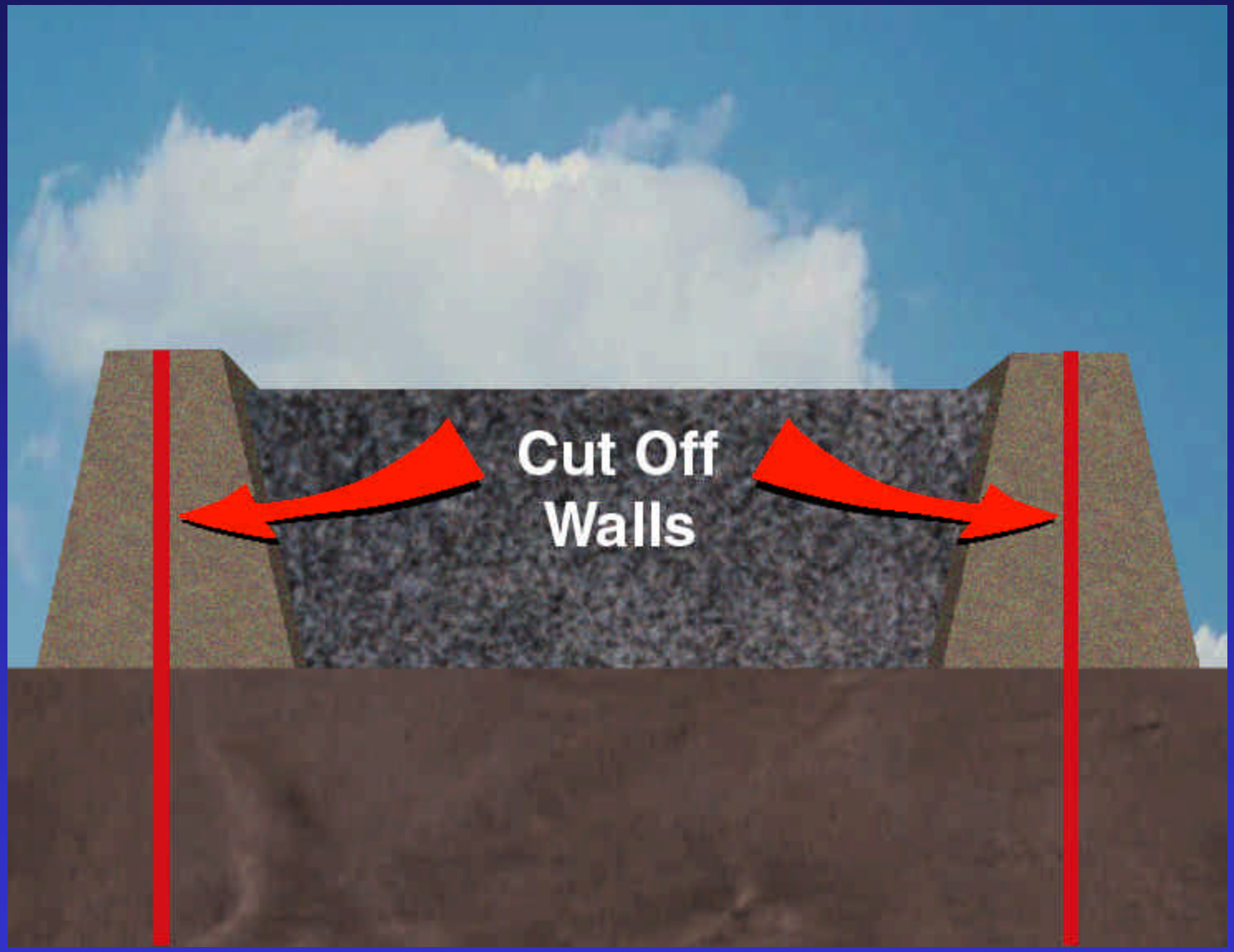


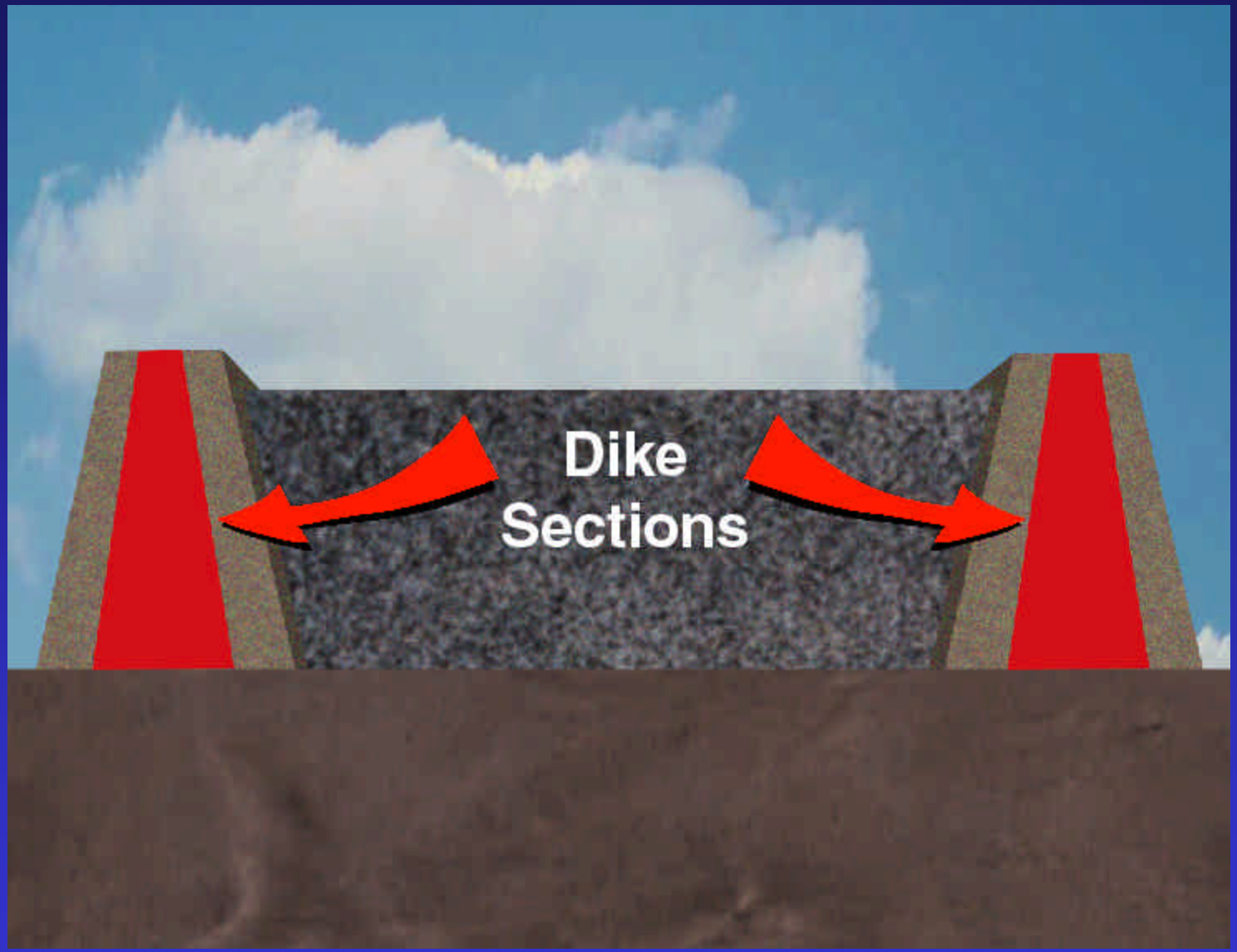
CDF
Containment Features

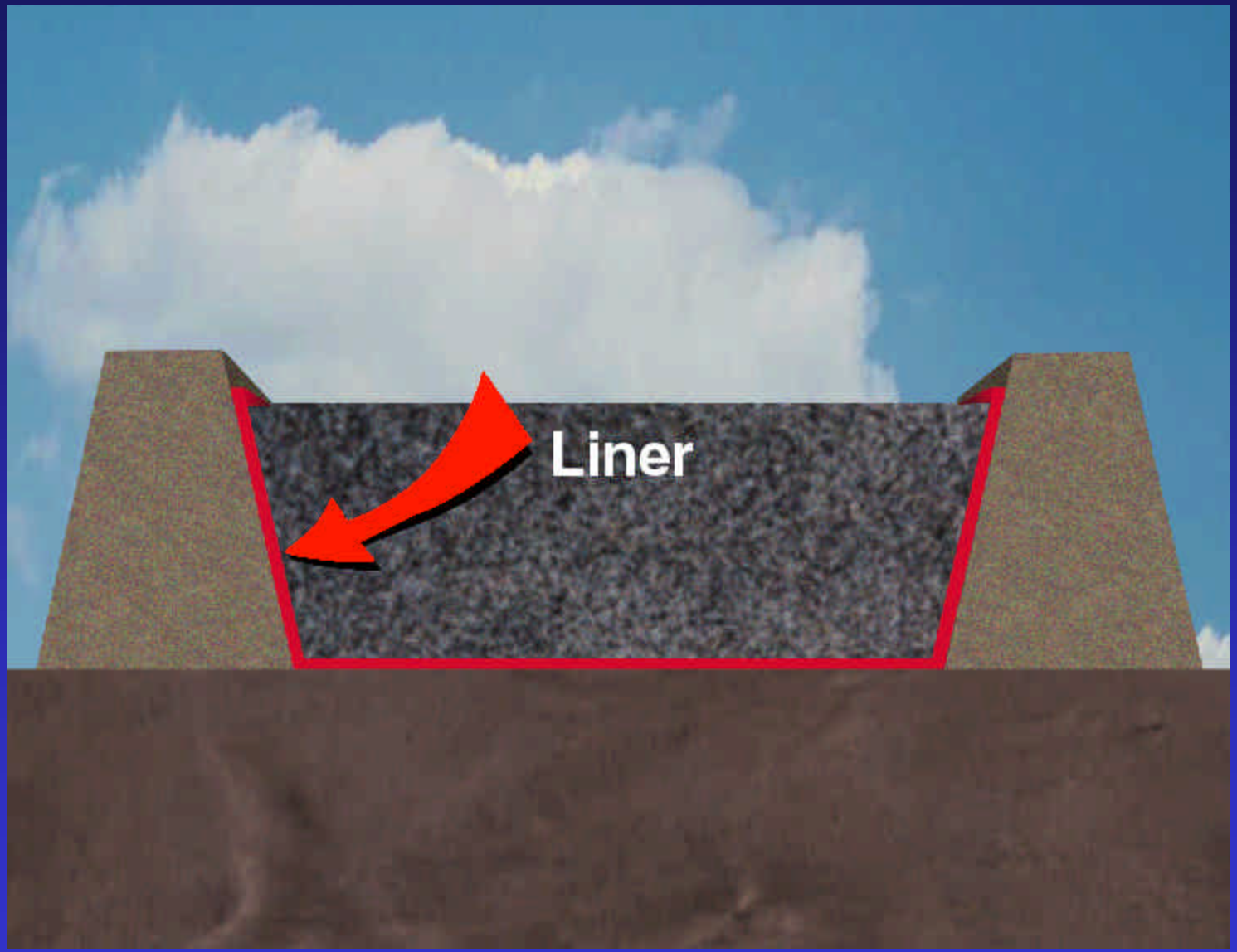
CDF Pathway Controls

- Operational
  - Selective placement
  - Self sealing
- Engineered Controls
  - Surface Covers
  - Liners
  - Lateral Containment


Surface Cover

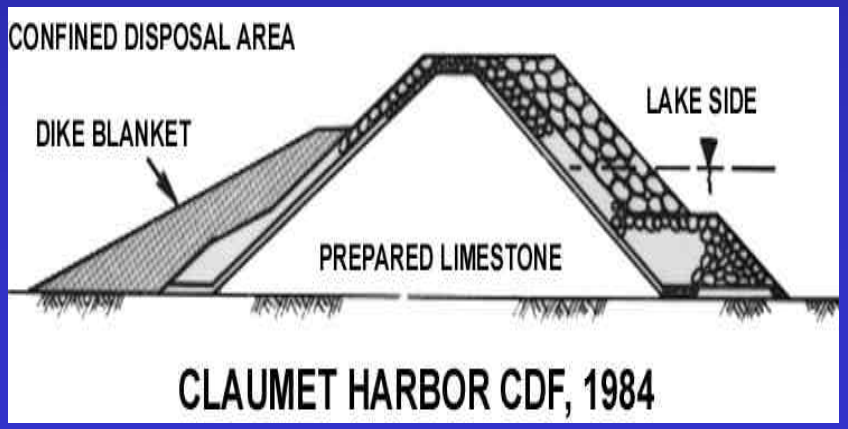

Cut Off
Walls


Dike
Sections


Liner

Calumet Harbor,

Chicago, Illinois



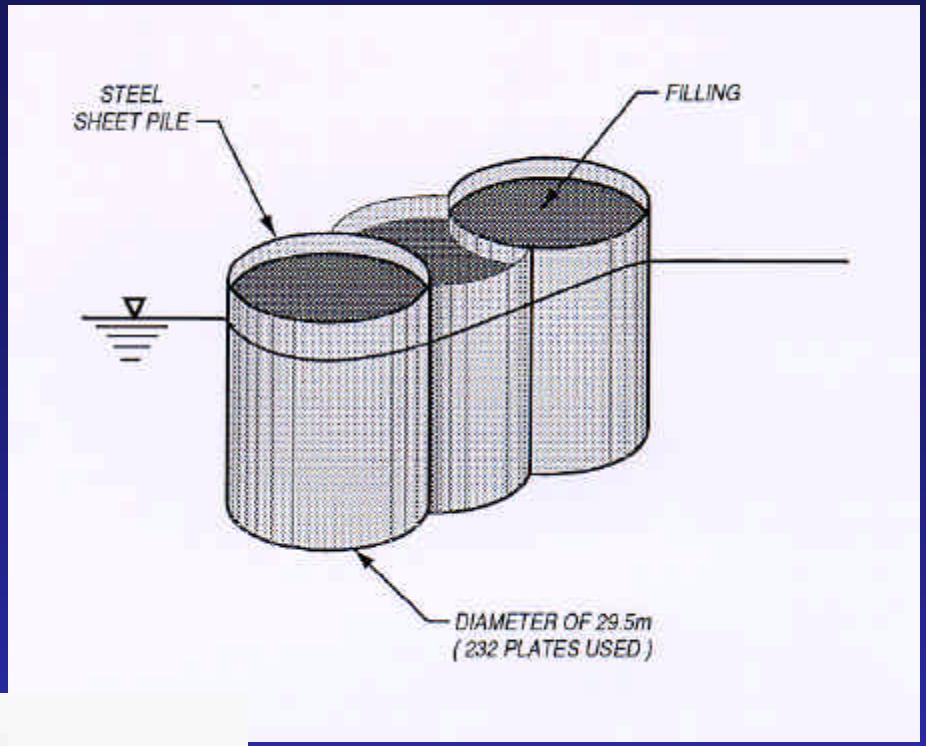
Michigan City, MI

Guezenhoeck - Ghent, Belgium

Terminal 3

Tacoma, WA

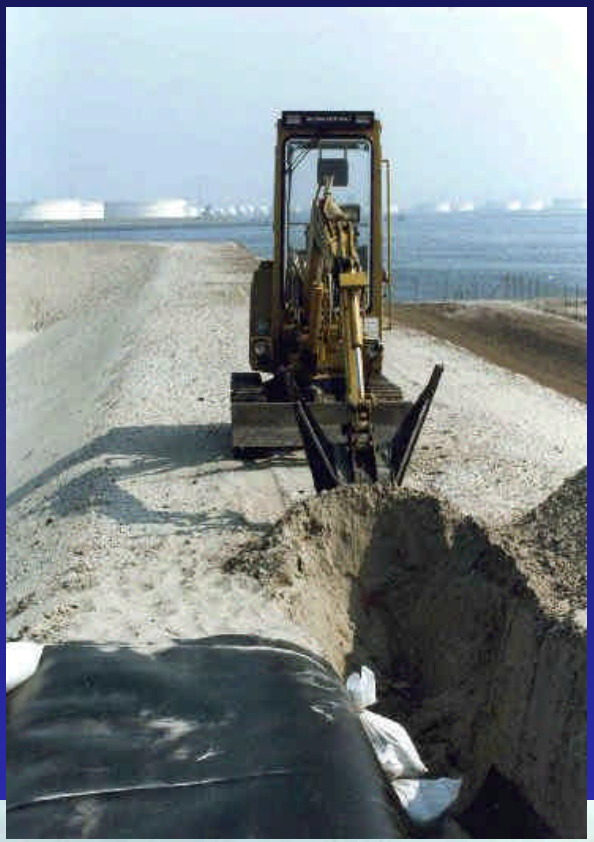
Minamata Bay, Japan



Waukegan Harbor, Illinois

Parrot Beak,

Rotterdam, The Netherlands



Hamburg, Germany

- Number of sites with containment features is limited
- Need for controls established primarily by mandate
- Designs have been case by case
- Effectiveness poorly documented
- No CDF-specific guidance for design or construction

Guidance Documents for CDFs

- Engineer Manual 1110-2-5027 Confined Disposal of Dredged Material
  - http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-5027/toc.htm
- USACE/EPA Technical Framework
  - http://www.epa.gov/OWOW/oceans/framework/
- DOTS Website
  - http://www.wes.army.mil/el/dots

Take Home Message

- CDFs must be properly engineered
- CDFs can be effective containment options
- Solutions must be project specific
- Solutions must be site specific
- Solutions must be material specific

ERDC
Center for Contaminated Sediments

CCS Website:

http://www.wes.army.mil/el/dots/ccs/index.html

Email:

schroep@wes.army.mil

palermm@wes.army.mil