



# Florida Department of Environmental Protection

## Petroleum Restoration Program

# Remediation Overview Technologies and Equipment

2017 PRP Workshop





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# How do we clean it up?

- Types of Soil Clean-up
- Types of Ground Water Clean-up
- There are multiple technologies available to remediate a contaminated site.

In-situ – in place

Ex-situ – out of place/on site or off site



# Remediation

## Soil

- Stabilization
  - Encapsulation/Fixation
  - Vitrification
- Excavation
  - Conventional
  - LDA
- Vapor Extraction
- Bioremediation
  - Landfarm
  - Biopiles
  - Blending
- Chemical Oxidation
  - Direct Injection
  - Blending

## Ground Water

- Air Sparge
- Pump and Treat
- Dual Phase
- Multi Phase
- Bioremediation
- Chemical Oxidation
- Thermal





# Stabilization

- Encapsulation/Fixation
  - Slurry Wall
    - Trenched
    - Cast
  - Polymer/Cement
    - Blending
    - Direct Injection
- Vitrification
  - High Heat and Energy

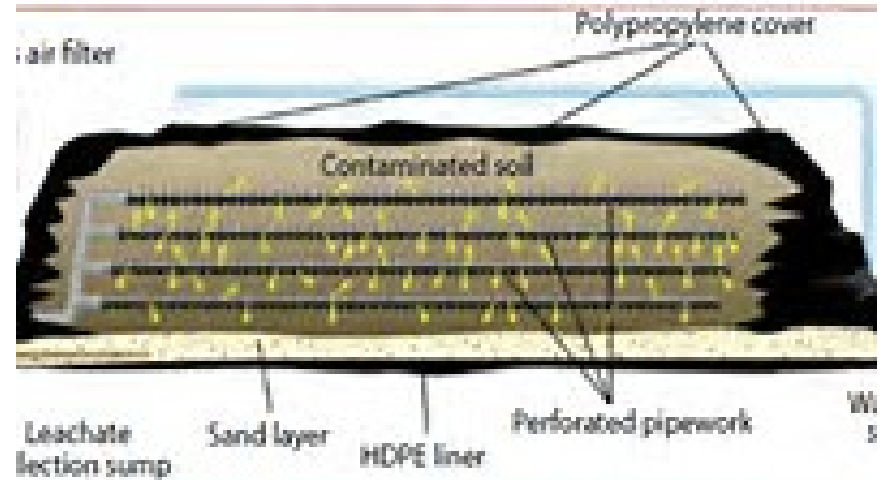


# Encapsulation





# Blending/Biopile/Landfarming







# Vitrification



Photo provided by Georgia Tech Research Institute.

Cross section of a vitrified monolith from the Savannah River Site demonstration.





# Excavation

- Conventional
  - With Shoring
    - Sheet Pile
      - Unbraced
      - Braced
    - LDA
  - Without Shoring
    - Side Slopes (OSHA)
      - Soil Type
- LDA
  - Overlap
  - With Chambers
- With Dewatering
  - Ingress/Egress





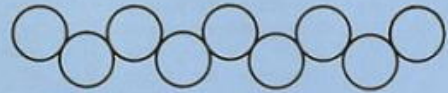
# Large Diameter Auger (LDA)



a) Contact style



b) Overlapping style



c) Zigzag style



d) Water interrupt wall, grouting water-proof-chemicals







# Dewatering





# Air Sparge/Soil Vapor Extraction

- Most Commonly Used Technology
- Best In Sandy Lithology
- Key Design Parameters:
  - Well Depth/Screen Interval
  - Well Spacing
  - Radius of Influence (ROI)
  - Overlap
  - Air Flow: Volume and Pressure





# What's the Air Flow?

There are multiple ways to obtain flow readings

Anemometer

Direct Read

Rotameter

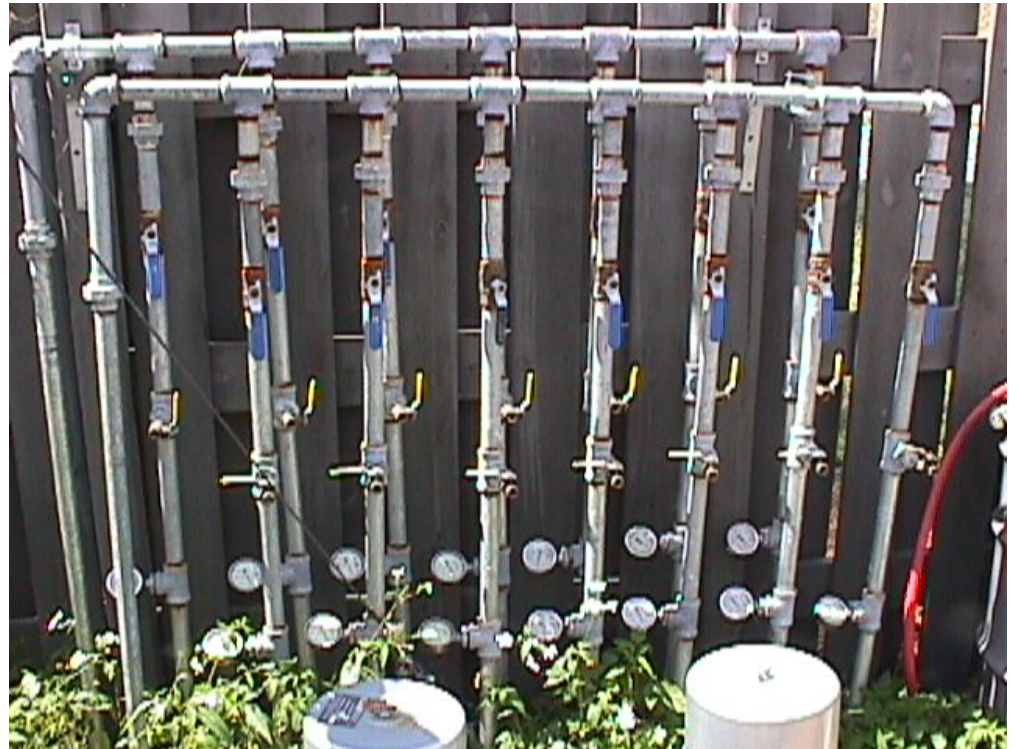
Differential

Pressure





# Anemometer





# Direct Read







# Rotameter







# Differential Pressure



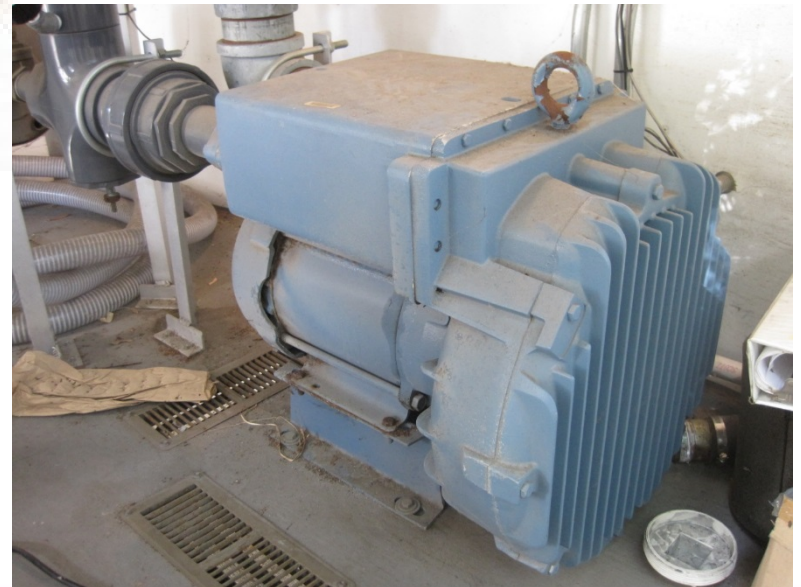
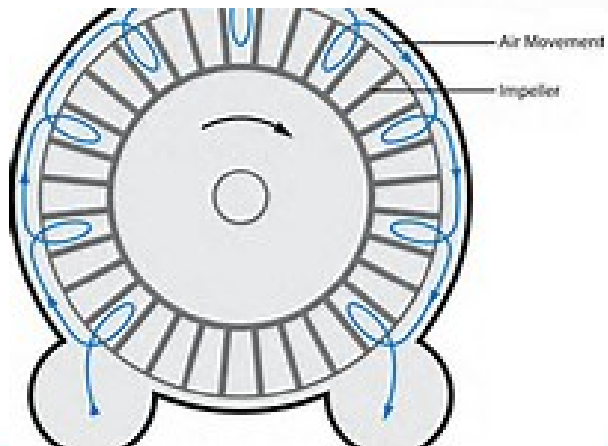


# Types Blowers and Compressors

- Regenerative
- Centrifugal/Multistage
- Rotary Lobe
- Rotary Claw
- Rotary Screw



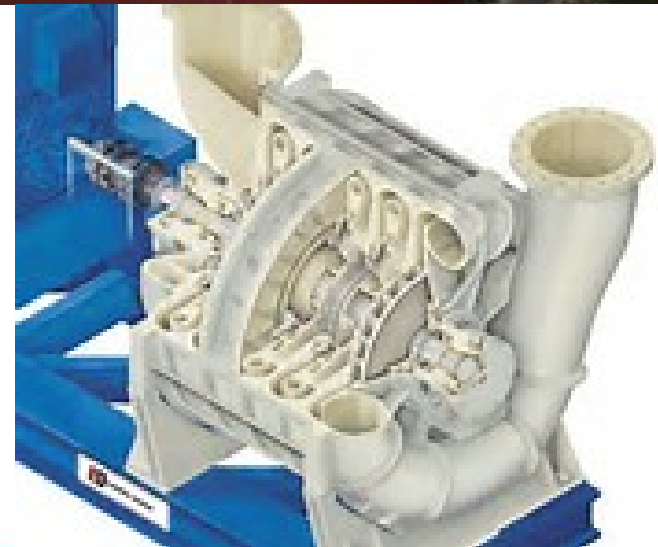
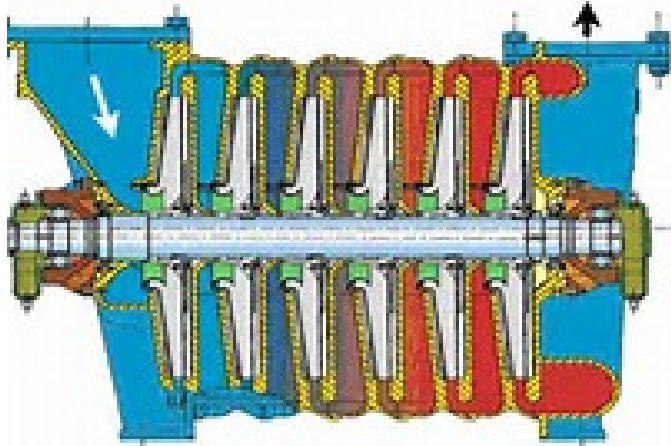
# Regenerative







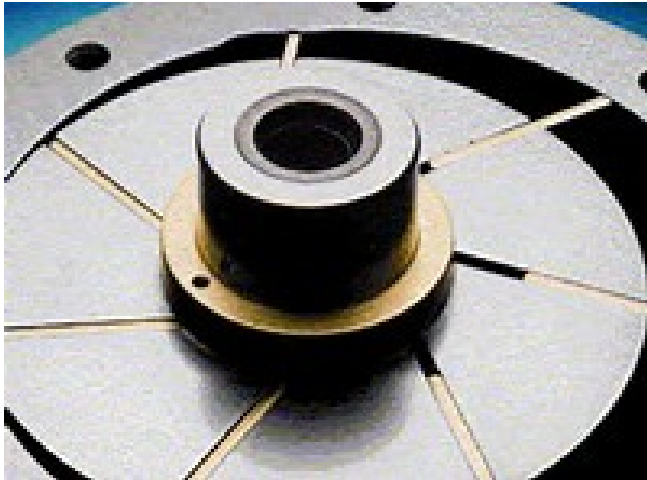
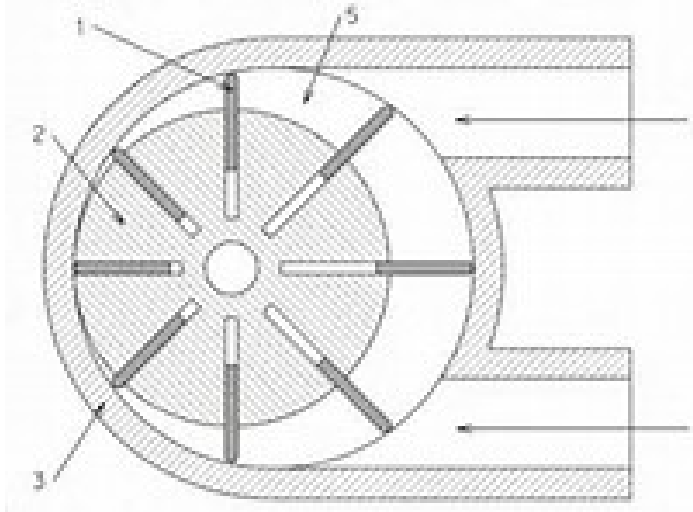
# Centrifugal Multistage





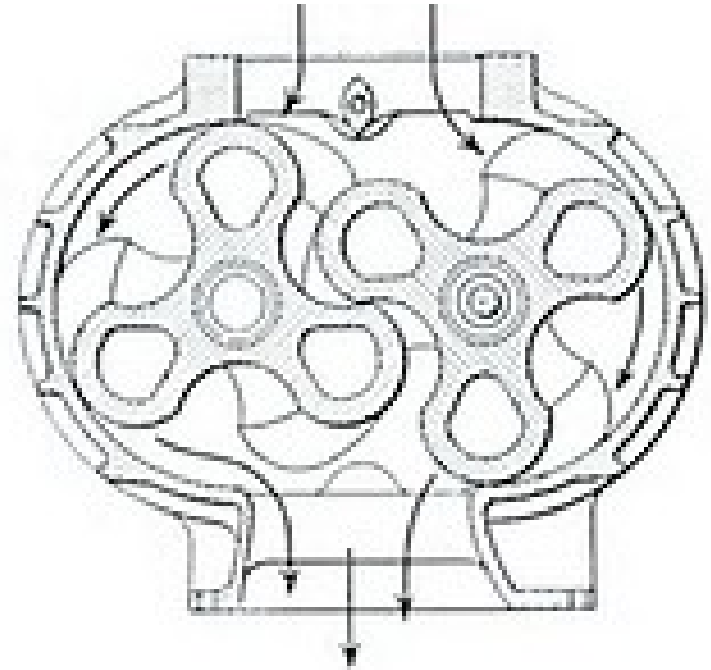
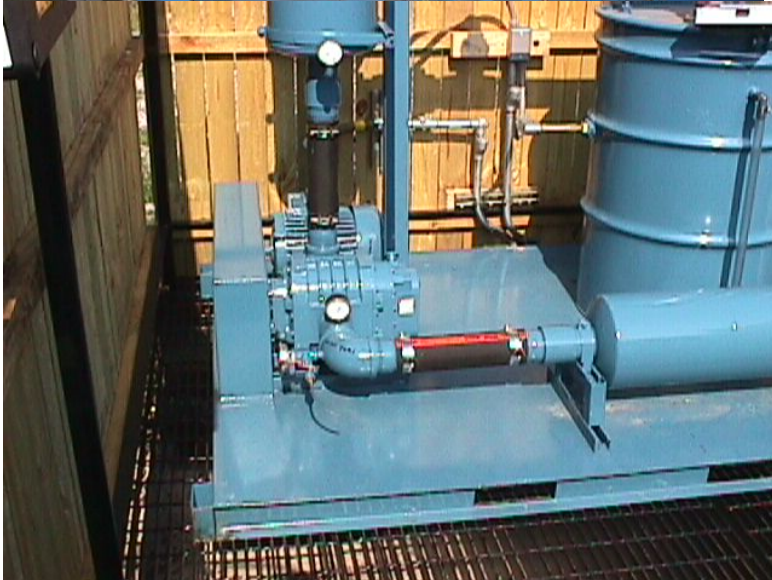


# Rotary Vane





# Rotary Lobe





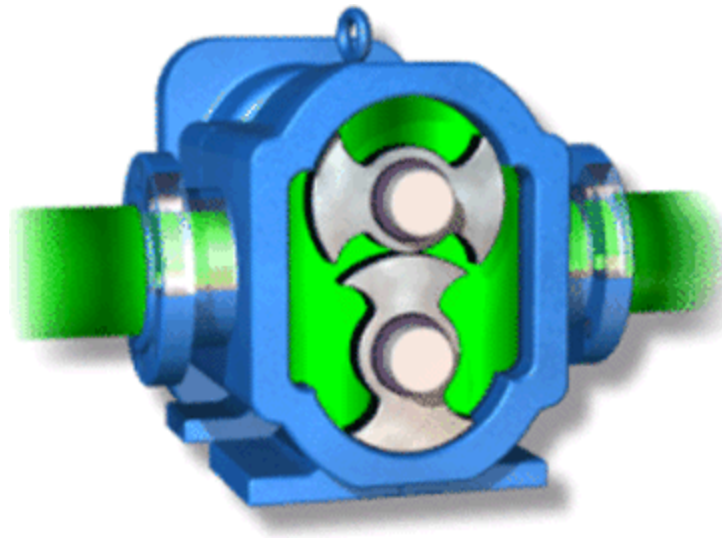


# Rotary Lobe





# Rotary Claw





# Rotary Claw





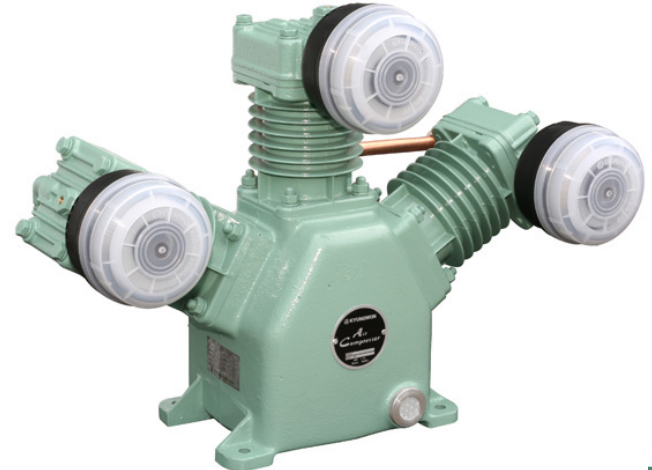
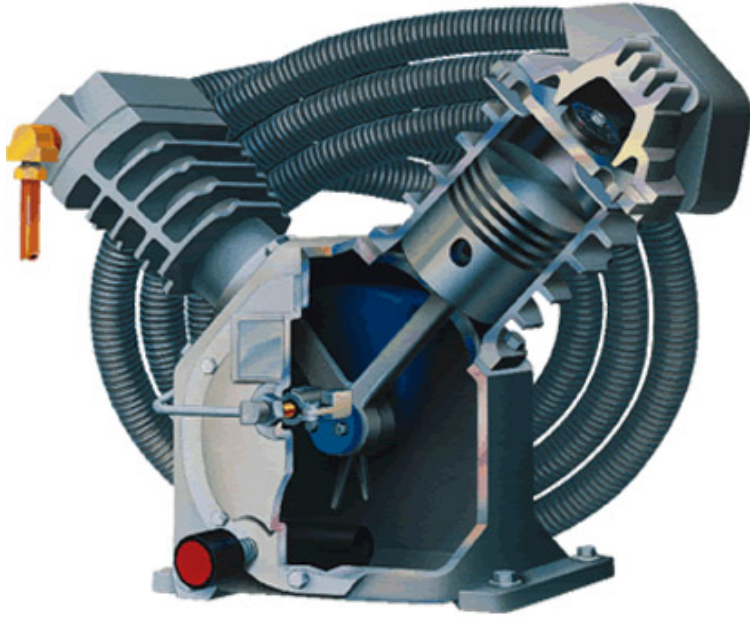
# Rotary Screw







# Reciprocating





# Groundwater Remediation

- Pump and Treat
- Dual Phase
- Multi Phase
- Air Sparge
- Chemical Oxidation
- Bioremediation





# Pump and Treat

- Old Technology
- Good for Hydraulic Control
- Mass Removal/Cleanup Typically Very Slow

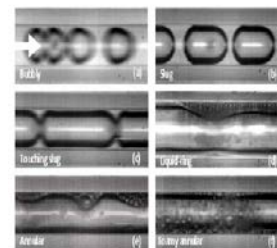
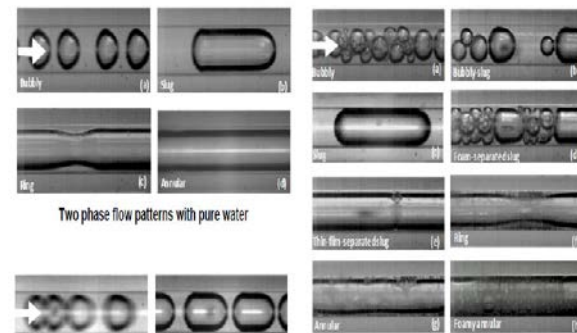
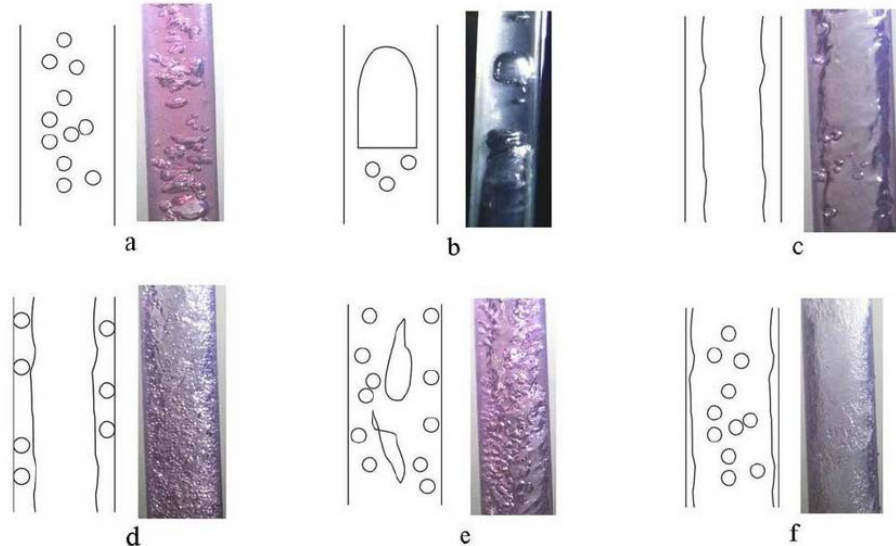
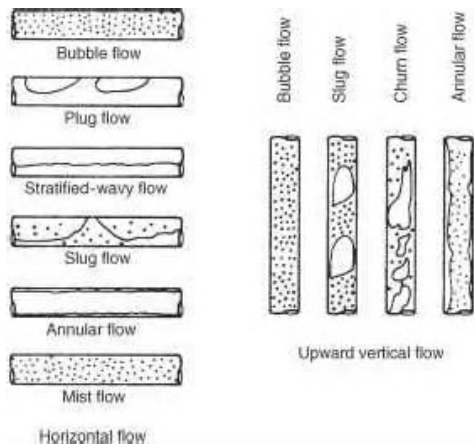
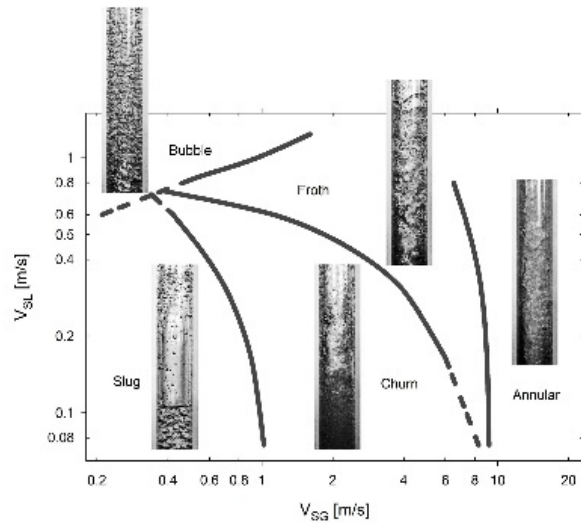
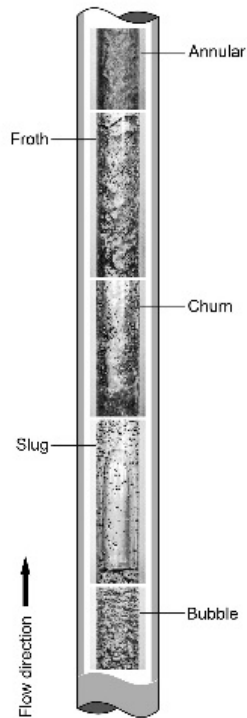


# Pump and Treat

- Submersible Pump
- Surface Pump
  - Head
  - Flow Rate
  - Well Spacing
  - Drawdown



# Dual Phase/Multi Phase



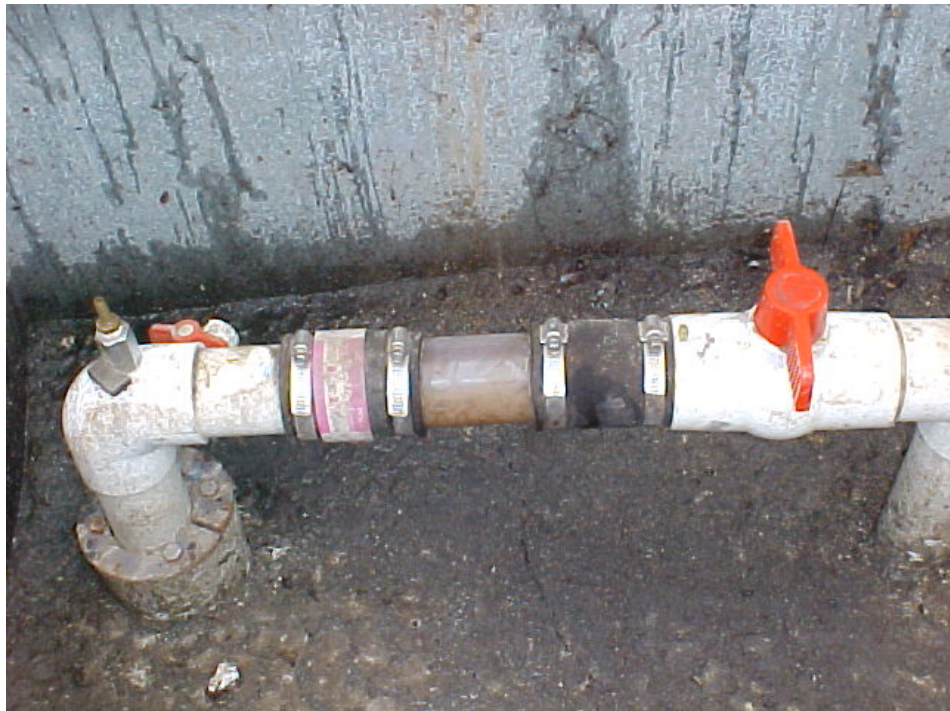
Two phase flow patterns with 1000 wppm

Two phase flow patterns with 400 wppm





# Well Head Configurations







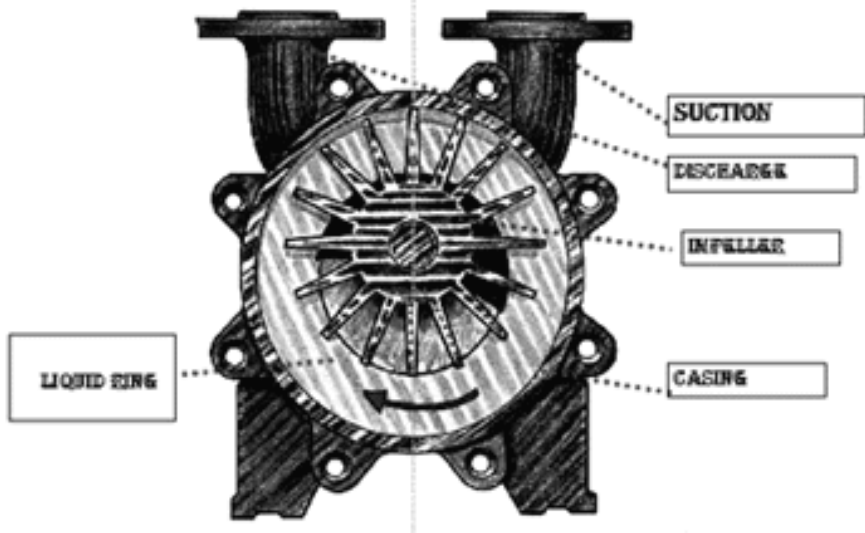
# Rotary Lobe/Claw







# Liquid Ring Pump





# Direct Observation







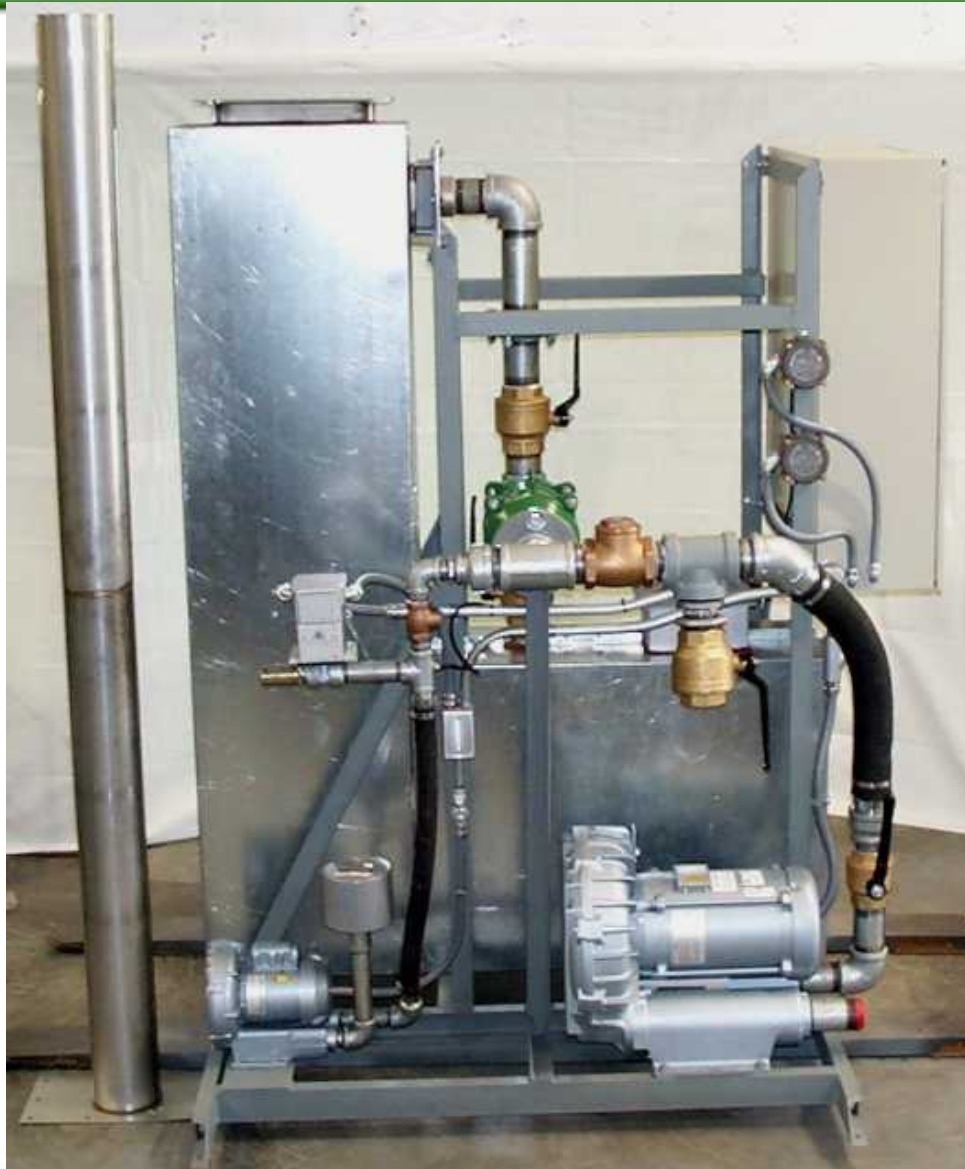
# Off Gas Treatment - Granular Activated Carbon (GAC)







# Off Gas Treatment Catalytic Oxidizer





# Off Gas Treatment Thermal Oxidizer





# Water Treatment







# Air Stripping Tower





# Tray Strippers







# Diffused Aerators







# Level Controls







# Chemical Oxidation







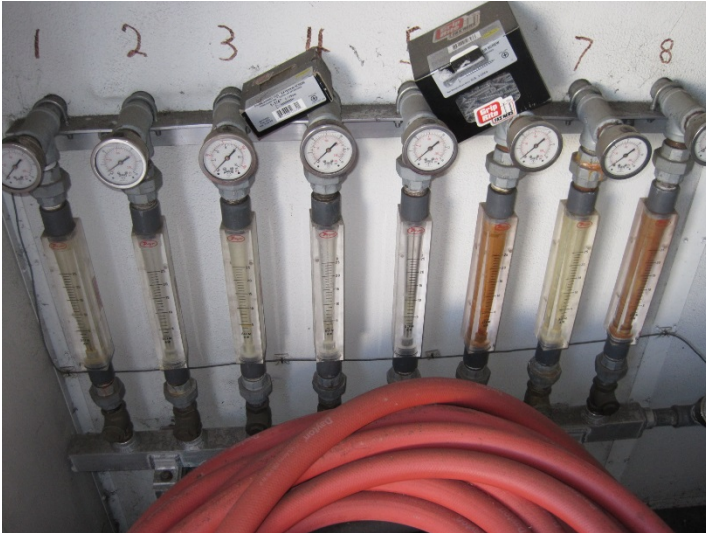
# Totalizing Flow Meters







# Typical Fouling





# Dual Phase Water Fouling







# Submersible Pump Fouling







# AS/SVE Performance Issues

- Treatment Wells Screened Inappropriately:
  - AS Wells Too Far Below Contamination
  - SVE Wells Recovering Too Much Water
- Undersized Equipment Used
- Technology Used At A Site with Too Much Clay

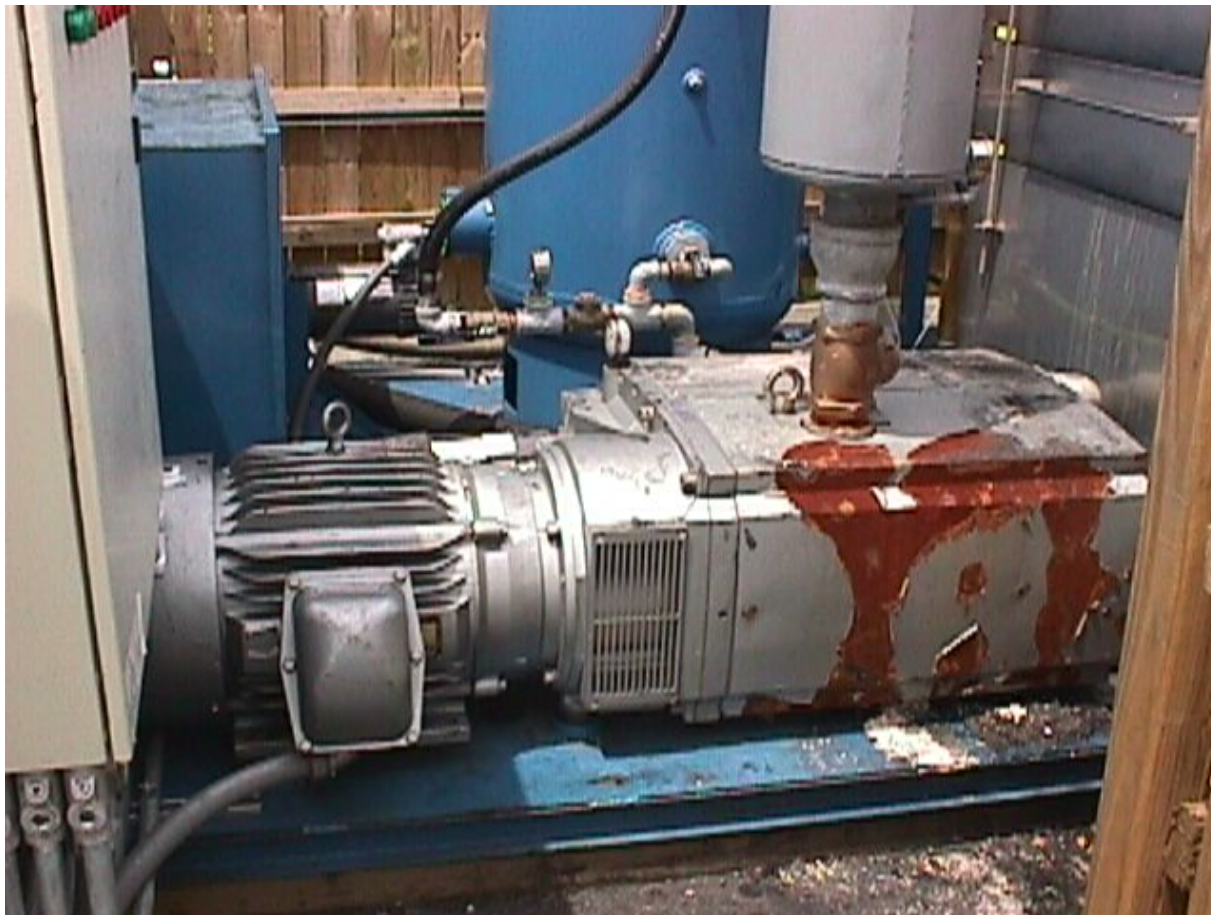


# MPX Fouling





# Not The Correct Application







# Details are Critical



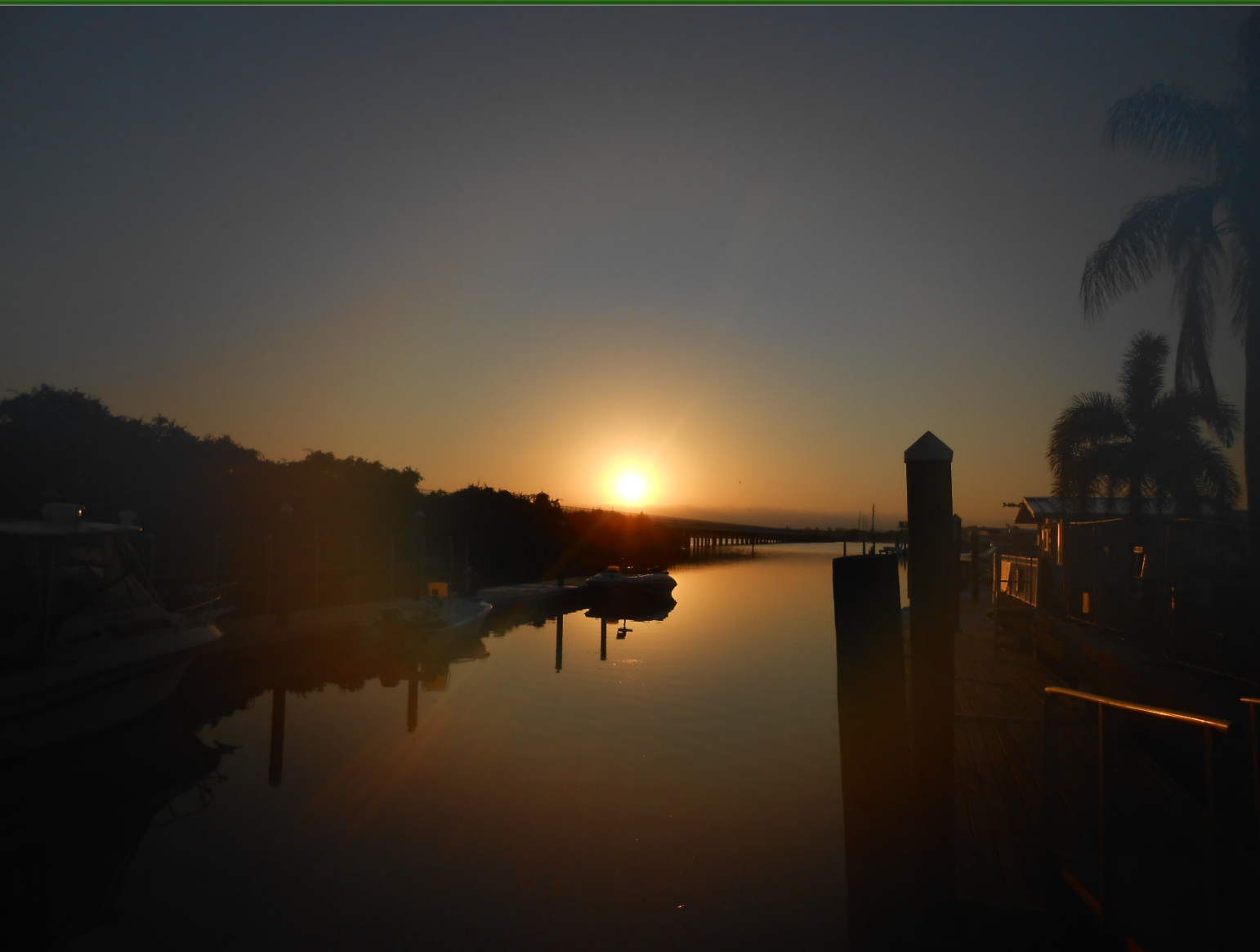


# What we are getting into





# It's a New Dawn







# Shinning Bright





# Questions?