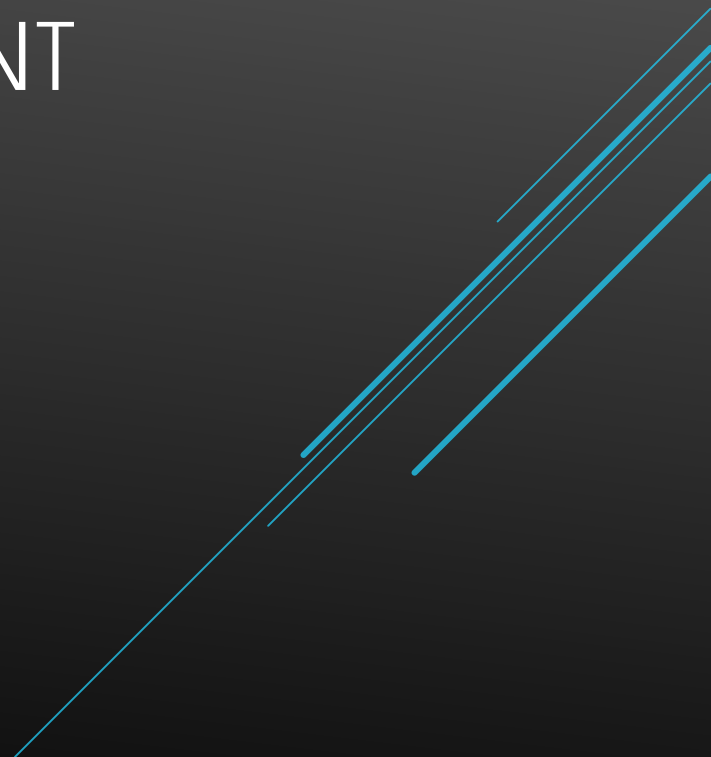


# WASTEWATER TREATMENT PONDS: ASSETS OR LIABILITIES?

Steve Worrell, P.E.  
Summit Engineering

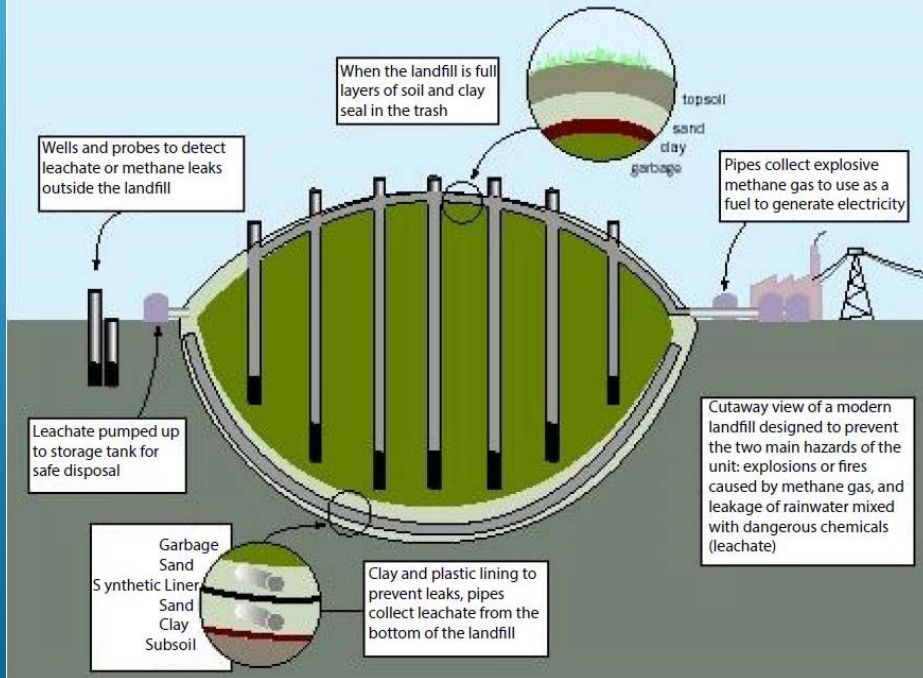


# INTRODUCTION

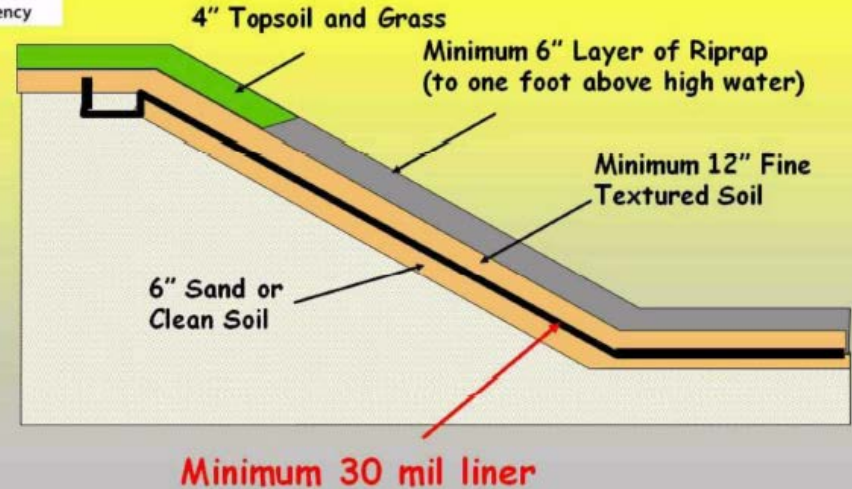


# PONDS AND LANDFILLS??

DIAGRAM OF A PROPERLY CLOSED LANDFILL



## Pond Sealed With Synthetic Liner



18

# POND COMPONENTS





# POND COMPONENTS



# POND COMPONENTS





# POND COMPONENTS



# POND COMPONENTS





# WHY PONDS?

- ↓ Historical Use in Farming
- ↓ Inherent equalization storage
- ↓ Resistant to shock loading
- ↓ Ease of Management
- ↓ Seasonal Loading



<http://napamosquito.org/about-us/history/#prettyPhoto>

# LINING SYSTEM

- ↓ Compacted Clay Liner
  - ➔ 12" thick min
  - ➔  $1 \times 10^{-6}$  cm/s
  - ➔ Resistant to UV
  - ➔ Shrink/swell degradation

- ↓ Geosynthetic Liner
  - ➔ 40 and 60 mil thickness common
  - ➔ Impermeable\*
  - ➔ Textured or smooth
  - ➔ Chemical resistance

*\*Not impermeable*

A series of four parallel white diagonal lines extending from the bottom right towards the center of the slide.


# POND DESIGN 101 - LINER SELECTION

got ~~milk~~?  
clay

- ↓ Clay availability drives cost
- ↓ Slope
- ↓ Longevity
- ↓ Repairs
- ↓ Warranty
- ↓ O&M
- ↓ Leakage Concerns



# DESIGN ASPECTS

- ➡ Overall Slope stability and interface friction
  - ➡ Anchor trench pull out
  - ➡ Subdrain conveyance
  - ➡ Cell Layout & Flexibility
- 
- A series of white diagonal lines of varying lengths and thicknesses, located in the bottom right corner of the slide, creating a modern, abstract graphic element.

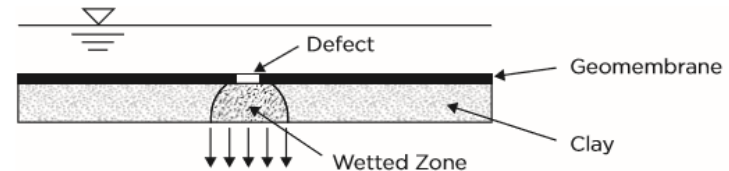
# A WORD ON LEAKAGE

- ↓ Depends on storage depth
- ↓ Clay: Estimated with Darcy's Law
  - ➔ Permeability =  $1 \times 10^{-6}$  cm/s
- ↓ Membrane: dependent on defects
  - ➔ Giroud equation
    - ↯ Defect density and shape
    - ↯ Subgrade soil
    - ↯ Intimacy
- ↓ Typical Rates:
  - ➔ 130 to 3,000 gal/acre-day
  - ➔  $10^{-6}$  soil  $\approx$  500,000 gal/year per acre

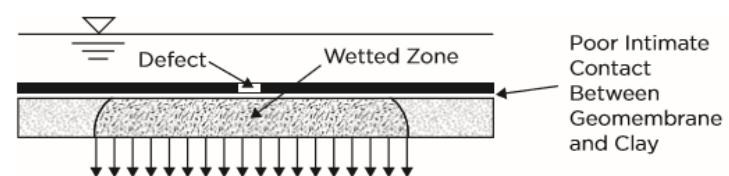
$$Q = k \frac{H}{L} A \text{ or } kiA$$

$$k = \left[ \frac{L^3}{L^2 T} \right],$$

**Figure 1a**  
Good Intimate Contact



**Figure 1b**  
Poor Intimate Contact



# PONDS AS ASSETS: CO

- ↓ Low capital cost
- ↓ Simple Components
- ↓ Simple Design





# PONDS AS ASSETS: COST

- ↓ Low capital cost
- ↓ Simple Components
- ↓ Simple Design



# PONDS AS ASSETS: MAINTENANCE

- ↓ Straightforward monitoring
  - ➔ pH, dissolved oxygen, freeboard
  - ➔ BOD at lab
- ↓ Reliable Equipment
- ↓ Chemical addition type unnecessary



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[www.countyofnapa.org](http://www.countyofnapa.org)

**David Morrison**  
Director

## Winery Wastewater Reporting Requirements

The following summarizes the monitoring requirements:

1. **Weekly monitoring** throughout the year for DO, pH, freeboard and odor.
2. **Monthly monitoring** throughout the year for BOD and total flow.
3. **Quarterly online reporting only** throughout the year; crush needs no separate submission.

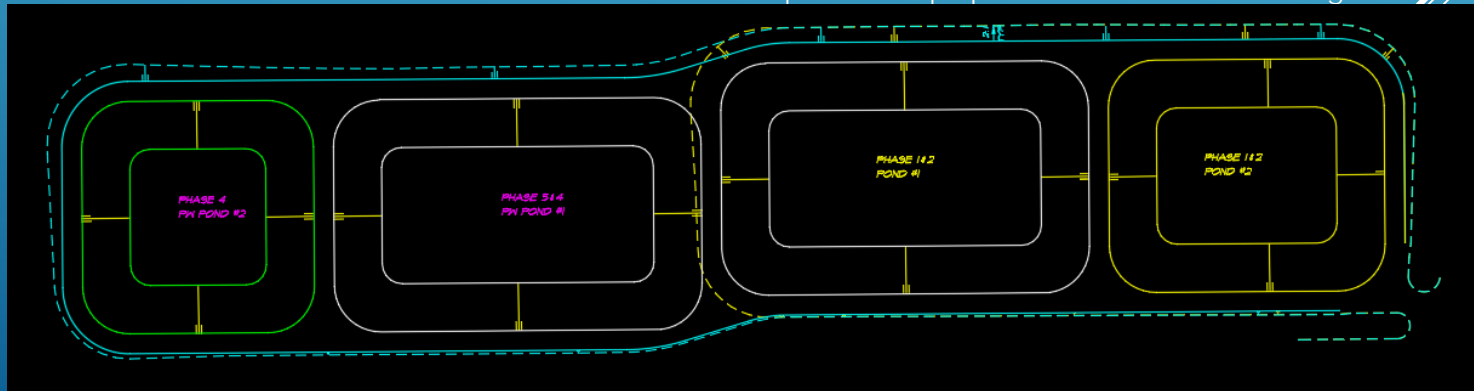
# PONDS AS ASSETS: EXPANSION

## ↓ Flexibility:

- ➡ Improve aeration
- ➡ Build new cells
- ➡ Add pretreatment
- ➡ Add polishing



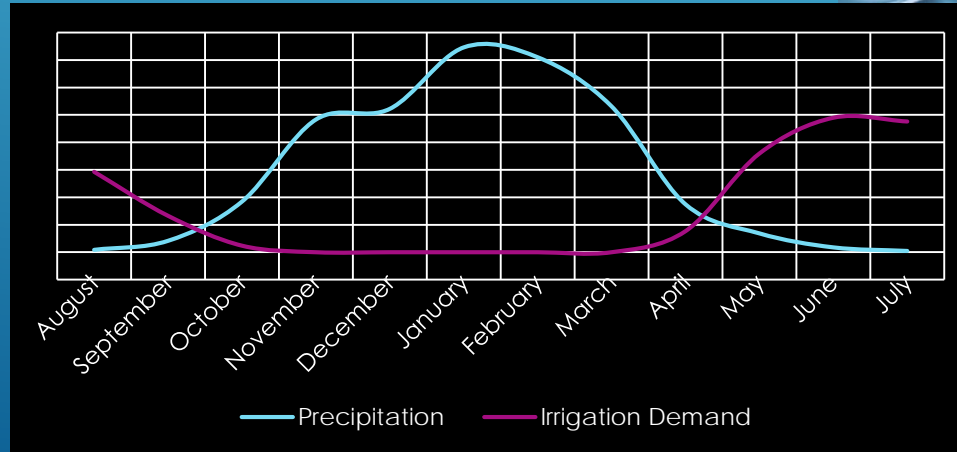
<http://www.triplepointwater.com/efficient-lagoon-aeration>





# PONDS AS ASSETS: STORAGE

- ↓ Long retention time (60-90 days)
  - ➔ Equalization
  - ➔ pH buffering
- ↓ Effluent storage
  - ➔ Allows seasonal transfer
  - ➔ Stormwater diversion



# PONDS AS LIABILITIES: TREATMENT

- ↓ Effluent Quality
  - ➡ BOD around 60-90 mg/L typical
  - ➡ TSS similar
- ↓ Algae
  - ➡ Additional solids
  - ➡ Maintenance
- ↓ Winery Irrigation Reuse
  - ➡ Water quality
  - ➡ Irrigation timing
- ↓ Change in Regulation?



# PONDS AS LIABILITIES: SLUDGE

- ↓ Biosolids Formation Inevitable
  - ➡ Byproduct and Residual
- ↓ Management & Planning
  - ➡ Cost forecasting
- ↓ Removal: Costly and Slow
  - ➡ Potential for damage
- ↓ Retention Time
- ↓ Endogenous Decay





# PONDS AS LIABILITIES: STORAGE

- ↓ Slow to Fill = Slow to Empty
- ↓ Emergency Repairs...
- ↓ Startup Concerns
- ↓ Inertia
- ↓ Water Losses:
  - ➡ Evaporation
  - ➡ Infiltration



# PONDS AS LIABILITIES: ENERGY

- ↓ Energy Cost  $\propto$  Organic Load & Aeration Efficiency
  - ➔ Saturated DO vs Minimum
- ↓ Control Strategy:
  - ➔ No Controls << Timer Based << DO Sensor Based
  - ➔ Increases Maintenance/O&M



# PONDS AS LIABILITIES: AGE

- ↓ Earth Dams require maintenance
- ↓ Maintenance Program:
  - ➡ Valves
  - ➡ Vegetative cover
  - ➡ Embankment Slope
  - ➡ Leak Detection
- ↓ Liners Fail
- ↓ What was that pipe for?



Photo Credit: William Croyle, California Department of Water Resources

# CASE STUDY EXAMPLE: SLUDGE





# CASE STUDY EXAMPLE: SLUDGE





# CASE STUDY EXAMPLE: EROSION



# CASE STUDY EXAMPLE: FLOATING LINER



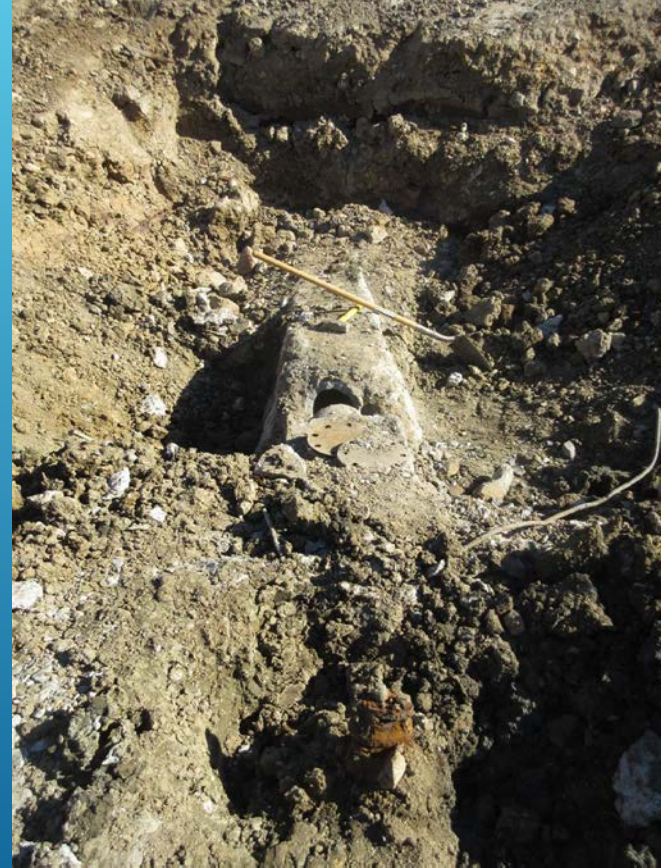


# CASE STUDY EXAMPLE: FLOATING LINER





# CASE STUDY : ABANDONED INFRASTRUCTURE




# REFERENCES & QUESTIONS?

<https://geosynthetic-institute.org/papers/paper15.pdf>

[http://www.gseworld.com/content/documents/technical-notes/Hydraulic\\_Equivalency.pdf](http://www.gseworld.com/content/documents/technical-notes/Hydraulic_Equivalency.pdf)

<https://www.epa.gov/landfills/municipal-solid-waste-landfills>

<https://www.epa.gov/sites/production/files/2014-09/documents/lagoon-pond-treatment-2011.pdf>

Three parallel white diagonal lines are positioned in the bottom right corner of the slide, extending from the right edge towards the bottom left.