The Leachate Treatment and Disposal Albatross

"Water, water everywhere…."

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Presentation Outline

- Importance of Leachate Management
- Why an Albatross
- Leachate Minimization w/ Emphasis of Understanding Water Balance
- Why the Albatross is Getting Heavier
- Possible Approaches for Growing Issues

Why is it Important?

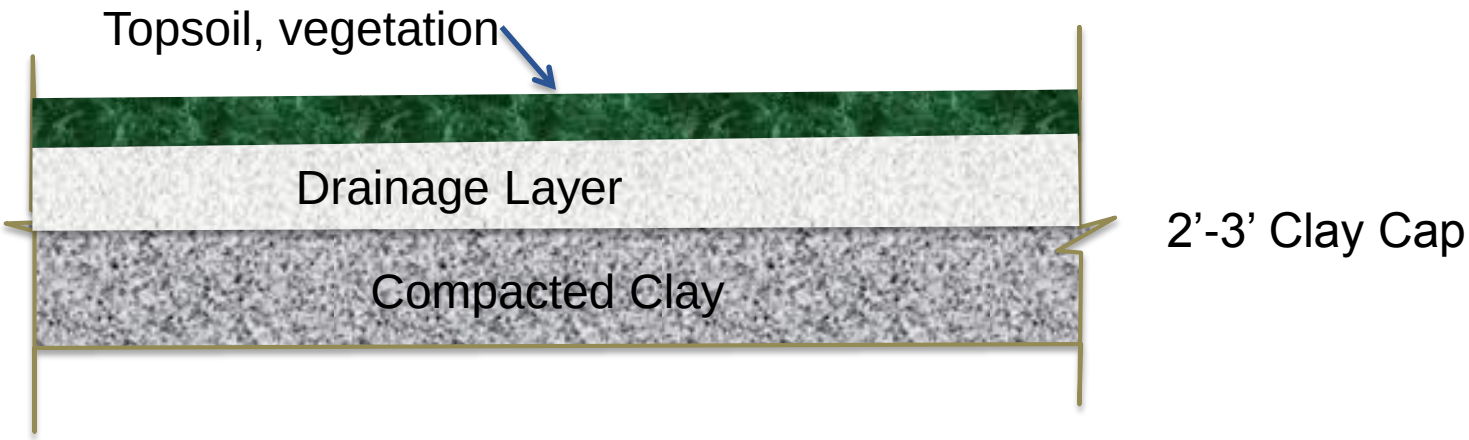
- In a word – Cost
- Some basic cost numbers:
  - If you are fortunate
    - Perhaps $0.01/gallon or less
  - If you are average
    - Range likely of $0.03 to $0.08/gallon
  - If you are unfortunate
    - >$0.10/gallon

What do these cost numbers mean?

- End of 2013 – 26 Active MSW Landfills in NY
- 2010 NYSDEC leachate estimate– 310,000,000 gallons
- If NY were fortunate: $3,100,000 per year
- If NY were average: $17,000,000 per year
- If NY were unfortunate: $31,000,000 per year

What about those closed sites?

- Do these look familiar:



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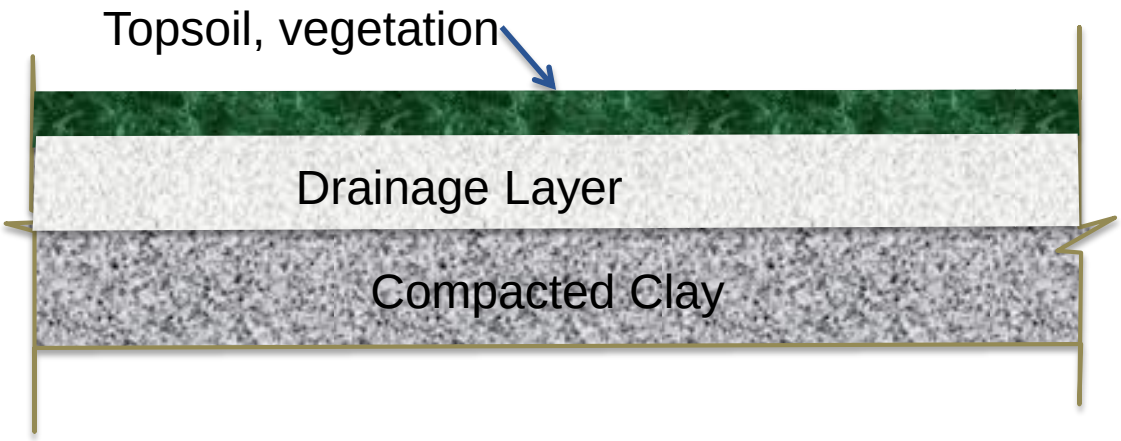
What about those closed sites?

- And now with infiltration:

2’ Soil Cover
10”-15”/year



2’-3’ Clay Cap
10”-15”/year

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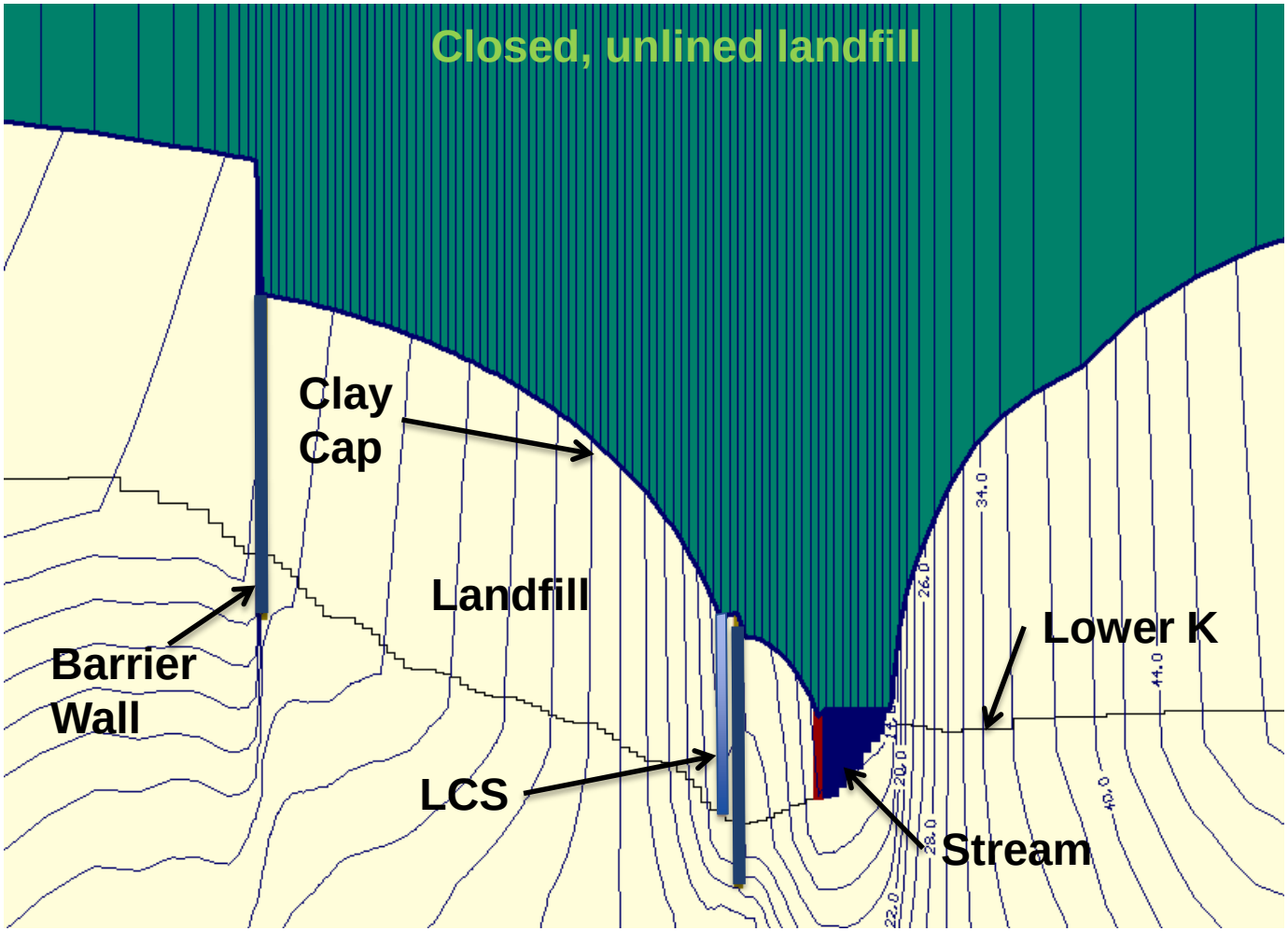
So….

- 25 acre, old closed site
- 10”/year infiltration
- 6,800,000 gallons of leachate (~19,000 GPD)
  - Fortunate- $68,000/year
  - Average - $375,000/year
  - Unfortunate - >$680,000/year

Very quickly, because everyone knows

- Divert stormwater run-on
- Promote stormwater runoff
- Recirculate
- Cap
- Understand water balance

Groundwater modeling for water balance



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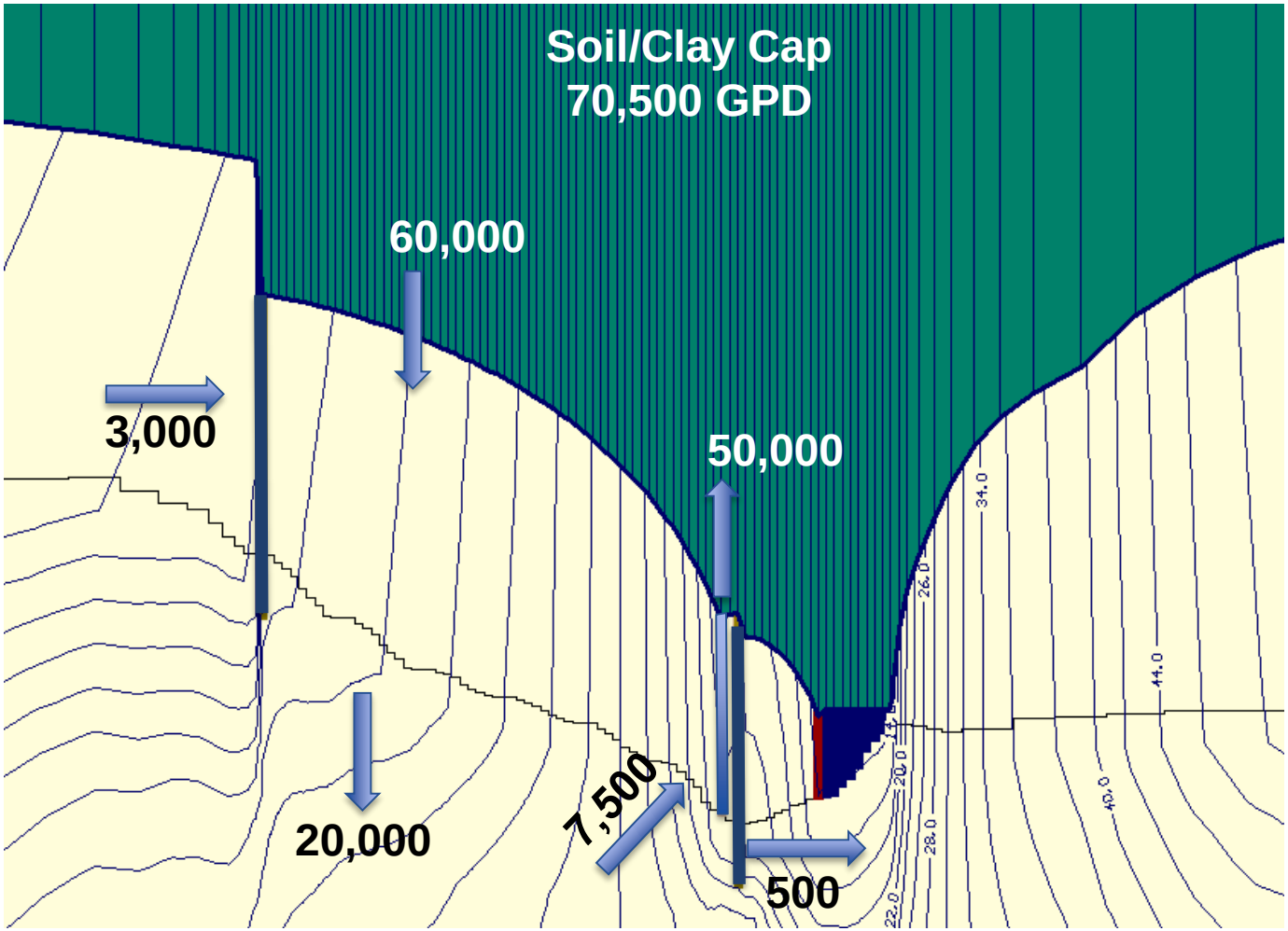
Groundwater modeling for water balance



Values in GPD

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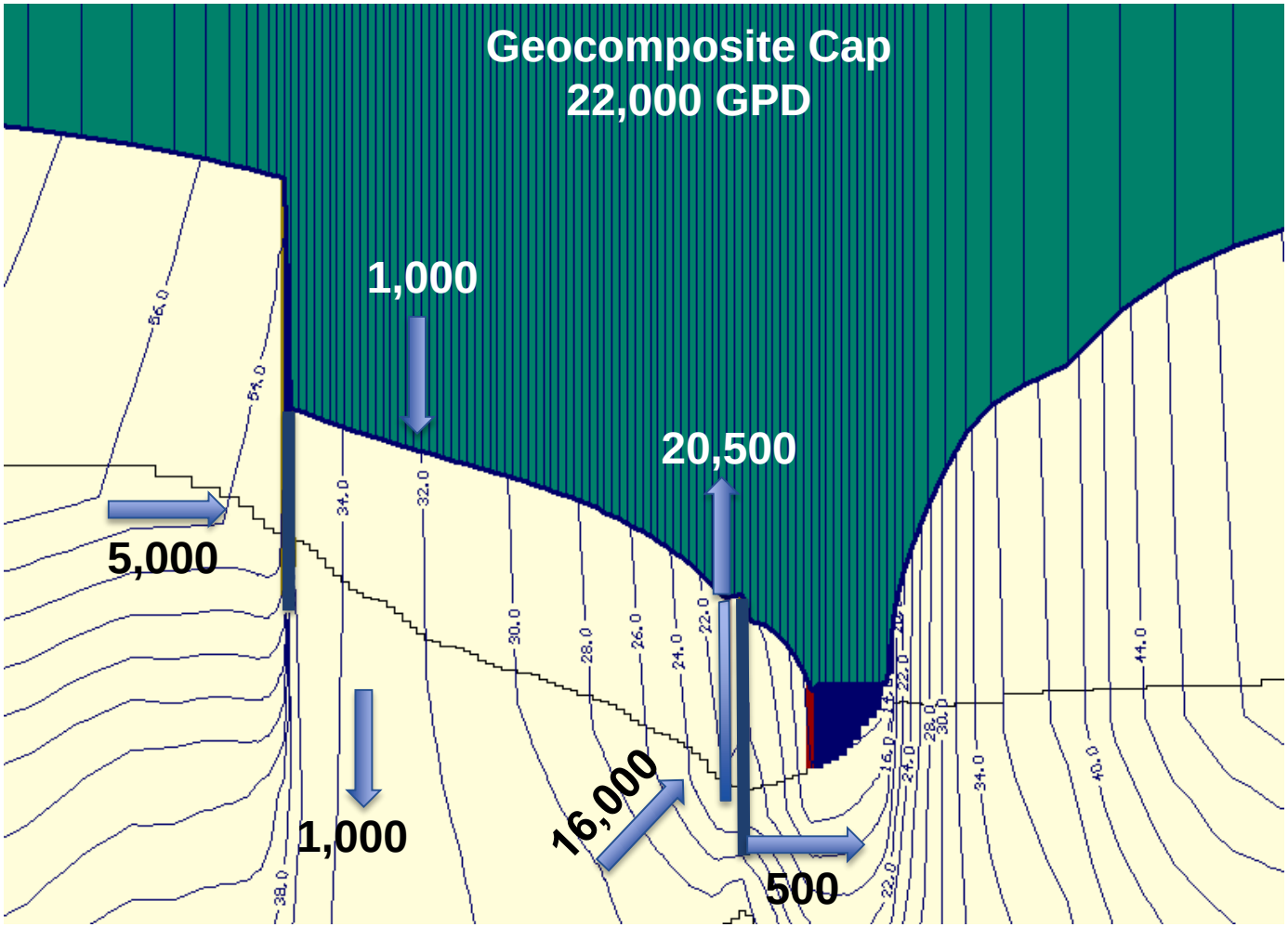
Groundwater modeling for water balance



Values in GPD

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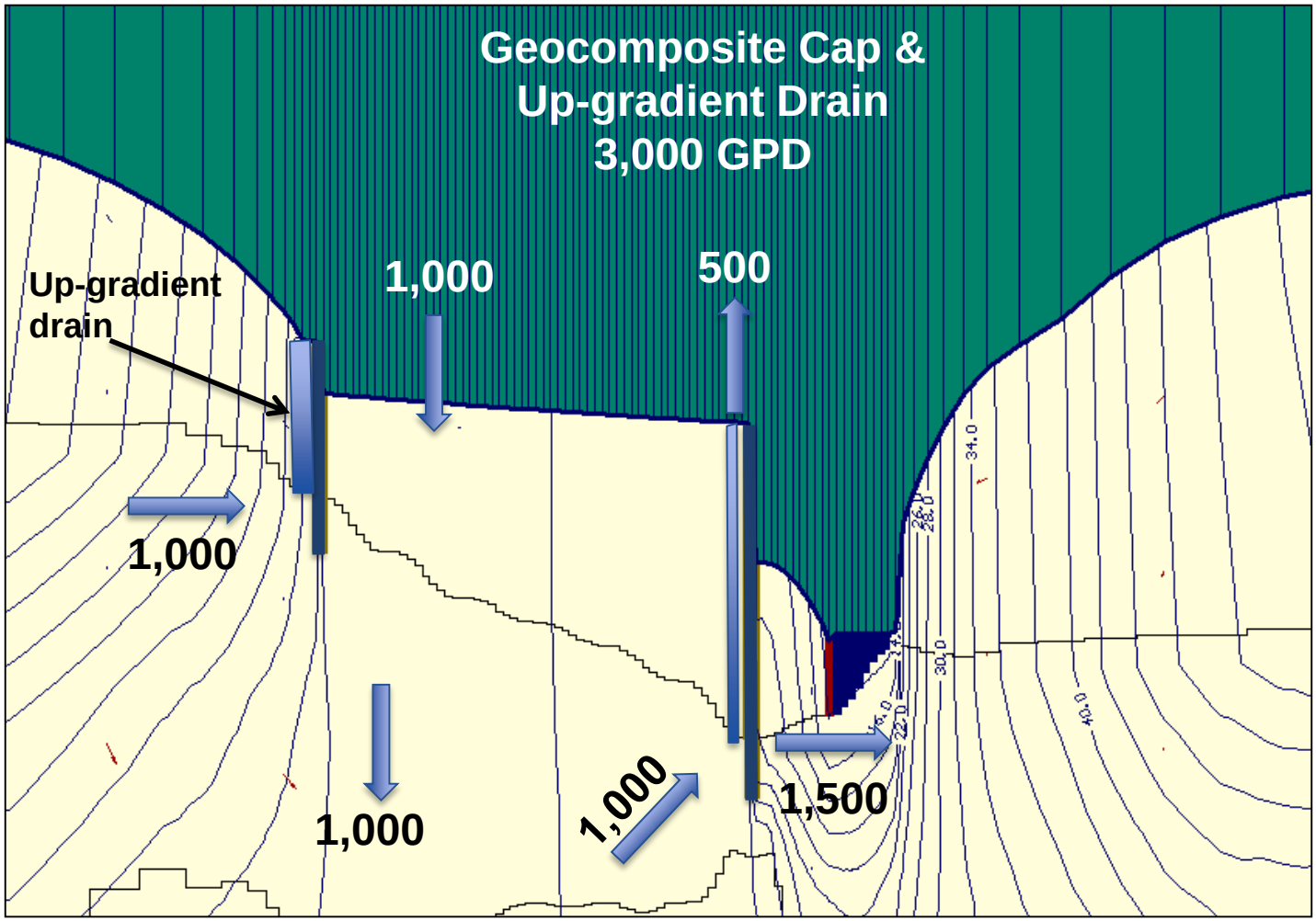
Groundwater modeling for water balance



Values in GPD

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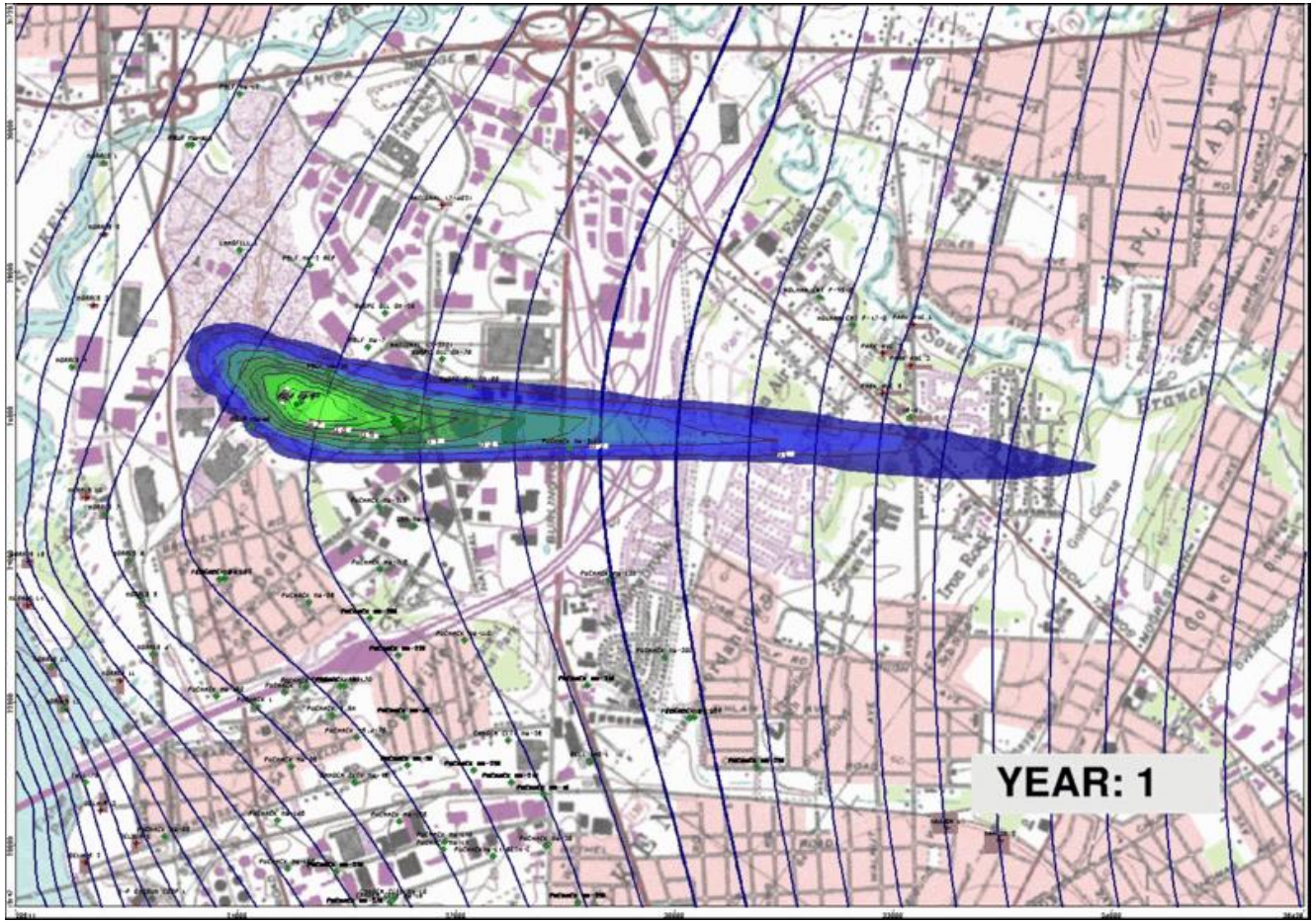
Why an Albatross?

"…the Albatross about my neck was hung"



A quick note – at some point think MNA

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Why the Albatross will get heavier

- POTWs – historically the low cost alternative
- New issues at POTWs
  - rDON
  - UV Transmittance
  - TDS
  - Metals

Chemical Characteristics of Leachate

Parameter	Range	Comment on Treatment
pH	4.5 to 9.0	Can be easily adjusted
Total dissolved solids, TDS (mg/L)	1,700 to 25,000	Conventional treatment ineffective
Chloride (mg/L)	150 to 1,400	Conventional treatment ineffective
Total organic carbon, TOC (mg/L)	30 to 29,000	Conventional treatment ineffective
BOD_5 (mg/L)	20 to 57,000	Removed by biological treatment
Organic nitrogen (mg/L)	14 to 2,500	Conventional treatment ineffective
UV transmittance		Conventional treatment ineffective
Volatile organic compounds (VOC)	Highly variable	Removed by air stripping
Metals: Arsenic (mg/L) Cadmium (mg/L) Chromium (mg/L) Copper (mg/L) Lead (mg/L) Nickel (mg/L) Zinc (mg/L)	0.01 to 1.0 0.0001 to 0.4 0.02 to 1.5 0.005 to 10 0.001 to 5 0.015 to 13 0.03 to 1000	Removal is highly variable

Source: Christensen et al. *Appl. Geochem.* **2001**, 16, 659-718.

UV Transmittance and TOC

- Leachate organic component can contain up to 75% humic acids
  - Less biodegradable - causes BOD/COD ratio of leachate to decrease over time
  - Humic acids absorb light and lower UVT
  - Increases treatment costs or limits effectiveness of disinfection at POTWs that use ultraviolet (UV) disinfection

rDON

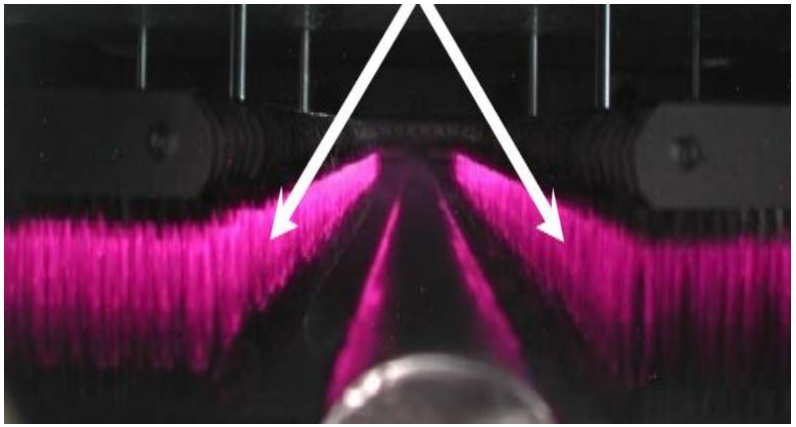
- Refractory Dissolved Organic Nitrogen (rDON)
  - A percentage of total nitrogen is refectory organic nitrogen and difficult to biodegrade Total Nitrogen = NH_3-N + NO_3-N + NO_2-N + org-N
  - Nutrient removal at WWTPs is ineffective at removing rDON (typically between 0.5 and 1.5 mg/L in municipal wastewater)
  - States are currently working to identify criteria values for nutrients in receiving waters
  - POTWs are dealing with their own issues trying to meet low total nitrogen effluent limits - will be reluctant to accept additional rDON load

Landfill Leachate Treatment

- Treatment methods for dealing with TDS, rDON and UVT:
  - Advanced oxidation
    - Ozone
    - Perozone ($O_3 + H_2O_2$)
    - TiO_2/UV
    - Fenton's reagent ($Fe^{2+} + H_2O_2$)
    - Non-thermal Plasma
  - Physical Treatment
    - PAC
    - Ultrafiltration (UF) / Reverse Osmosis (for TDS)
    - Membrane filtration
    - Evaporation

Non-thermal Plasma

Short, high-voltage pulse creates non-thermal plasma



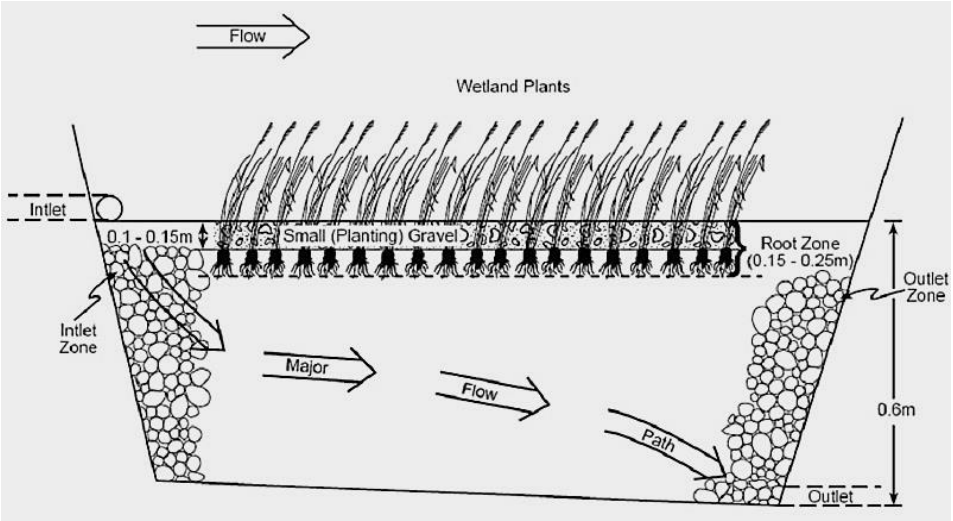
- The "4th state of matter"
- Applies to organics
- More widely used in air
- Creates hydroxyl radicals
- Very limited data on leachate
- N removal 50-80%?
- Limited cost data (1¢/gal)

Constructed Wetlands

- Passive treatment for removal of rDON and TOC
- Wetlands construction: $50,000 to $150,000/Acre

Potential biodegradation by fungi, actinomycetes, bacteria

Actinomycetes abundant in the soil environment



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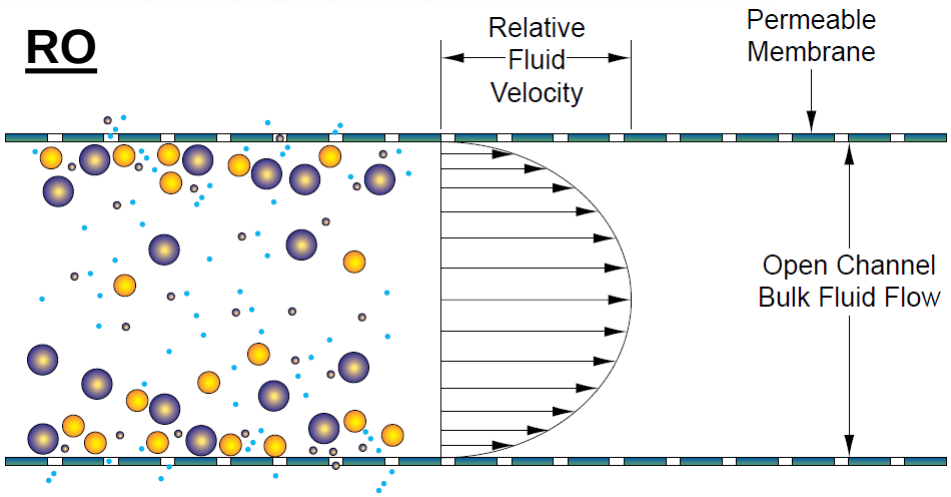
Removal of TDS

- Removal of TDS is only accomplished by reverse osmosis
  - 20,000 gpd, $500,000 to $1,000,000 capital
  - Operating costs in the range of $0.02 to $0.03 / gal
  - Fouling issues, but does address all the constituents
  - Since R/O essentially produces a TDS-free effluent, use careful process monitoring to produce a blended effluent that meets permit limits
  - High throughput technologies are becoming available (e.g. Vibratory Shear Enhanced Processing or VSEP

Vibratory Shear Enhanced Processing (VSEP)



- Higher throughput
- Torsional oscillation to provide shear, minimize fouling
- ~$300,000 for 10-20 gpm unit only
- Operating cost <1¢/gal?

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Conclusions

- Leachate treatment is difficult, long-term, expensive, and worsening
- Apply conventional leachate reduction methods
- A water balance/model could be your best tool
- Growing issues with TDS, rDON, UVT
- Technologies need further application and data

Thank You and Questions

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