“Natural Systems” for On-Site Industrial Wastewater Disposal

Leveraging Natural Processes to Solve Practical Problems

Industrial Applications

Solid Waste Industry

www.ccenv.us  www.leachate.us

“Finding A Better Way”

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Topics

• “Natural Systems”
  • What does this mean?

• Introduction to Three Technologies
  • Phyto-Utilization Systems
  • W.A.I.V. – Wind Aided Intensified Evaporation
  • Microbially Enhanced Brine Evaporation

• Constructed / Engineered Wetlands
“Natural Systems” = ???

“A **Natural System** is one that strategically takes advantage of and **leverages the ability of natural processes**...

- Evapotranspiration
- Wind movement
- Solar radiation
- Evaporation
- Plant and biological processes

...to solve practical problems.”
Natural Systems

• Trade space for “energy”
  • Energy = $$$ Money / Resources $$$
    • Electricity
    • Chemicals
    • Man power
    • Transport trucks
    • Mechanical complexity
    • O&M
• Lower Environmental Impact
Natural Systems

- **GREEN**
- Sustainable
- Lower energy footprint
- Reduced carbon footprint
- Few moving parts
- Highly skilled labor not necessary
- Less maintenance
- Lower costs
Natural Systems

- Phyto-Utilization™
- W.A.I.V.™
- Microbially Enhanced Brine Evaporation
- Engineered Wetlands
Natural Systems

Phyto-Utilization™ Systems

Tree-Based Phyto System

Vetiver-Based Phyto System
A plant-based, sustainable system that **CONSUMES** liquid (leachate) on-site (i.e. no hauling) through the evapo-transpiration process.

Highly tolerant, high water-demand plants: poplar trees (left), vetiver grass (right)
Landfill Leachate as a Resource!

Main Components are Water and Contaminants
Leachate as a **Resource**

- Hybrid Poplar and Vetiver grass = high water demand

LEACHATE = MOISTURE

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Landfill Leachate as a Resource?

Leachate Analysis (Contaminants)

- Nitrogen (ammonia)
- Phosphorous
- Potassium
- Magnesium
- Sulfur
- Calcium
- Iron
- Boron
- Manganese
- Zinc
- Copper
- Sodium
- VOCs
Leachate as a Resource

CONTAMINANTS = NUTRIENTS

Macro-Nutrients
- Nitrogen (ammonia)
- Phosphorous
- Potassium
- Magnesium
- Sulfur
- Calcium
- Others

Micro-Nutrients
- Iron
- Boron
- Manganese
- Zinc
- Copper
- Others

CONTAMINANTS = NUTRIENTS
Phyto-Utilization – Project Examples

Jeffco (St. Louis)
South Barrington (Chicago) and
Gulf Pines Landfills (Biloxi)

• Project Goals
  • Implement GREEN Technology
    • Better for the environment and reduce carbon footprint
  • Reduce Leachate Disposal Costs
  • Utilize Leachate Year Round (cold-weather climates)
  • Low O&M effort
TYPICAL FIELD LAYOUT

South Barrington Landfill

Leachate Storage Tank

Force-Main Piping

Phyto Area
MECHANICAL SYSTEM

Unmanned Facility – System designed to be self adjusting to: leachate generation, leachate quality and changing backpressure
Easy Access, Easy Maintenance
Fully Developed Vetiver Hedgerows Biloxi
Key Components:
- Lined Area – protective of groundwater
- Influent - Distribution network (piping / coarse bedding material)
- Subsurface and/or surface distribution
- Growth Media
- Freeboard
- Rainfall Diversion
- Plants (vetiver grass)
Key Components:
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Benefits of Natural Systems

- **GREEN, Sustainable Technology**
  - Reduced carbon footprint
  - Corporate sustainability reports / PR opportunities

- **Significant Cost Reduction**

- **Zero Discharge Potential**
  - Not dependent on POTW
    - Changing discharge limits
    - Blamed for their problems
    - Price increases
    - Can be cut off (more and more w/ UV disinfection)

- **Year-Round Leachate Management**
Benefits of Natural Systems

- Thousands of Fewer Miles Driven by Tanker Trucks
- Less Truck Traffic through communities
- Reduced Liability
- Less Wear on Local Roads
- Habitat for Wildlife
- Aesthetic Improvement for Area
- National Award Winning Technology
- Reduce Financial Assurance Premiums
- Newer Alternatives to Consider
Environmental Benefits Example

Natural System Solutions

- 3 MGY System, over first 5 years
  - 15 million gallons total
  - Avoids 3,000 tanker trips
  - If 35 mi one-way, then 210,000 miles not driven
  - 35,000 gal diesel not burned
  - CO2 emissions lowered

2010 Republic Services corporate sustainability report... “*We factor in that every trip we make and every mile of road we cover has an environmental impact of its own.*”
National Engineering Excellence Awards
In Top 25 Engineering Projects Nationally
Washington D.C.

Jeffco - Poplar Trees

Gulf Pines - Vetiver

www.leachate.us
## What it is NOT
- No Spray
- No Mists
- No Aerosols
- No Blowers or Fans
- No Drift
- No Fuel

## What it IS
- New to the US Market
- Fundamentally Basic, Simple System
- Wind Driven
- Lower Disposal Costs than Traditional Technologies

A completely new evaporative technology
Developed for the Desalination Industry
Adapted for Other Industries

- Solid Waste
- Mining
- Chemical Producers
- Manufacturing
- Power Industry
- In lieu of Injection Well
- Metals Finishing
- Pharmaceuticals
- Others
**Explanation**

- High density of wetted surface area within a very small footprint
- Wind causes enhanced, intensified evaporation
- Few moving parts
WAIV
Wind Aided Intensified Evaporation
System Components

1. Controls (PLC)
2. Tank
3. Pump (circulation and sump)
4. Containment
5. WAIV Unit

Figure 3-2 WAIV™ Unit
Unit Components

1. Specialized Wetted Surfaces ("Sails")
2. Liquid Distribution
3. Tensioning System
4. Containment
5. Support Blocks and Framing
Open Flow Between Sails
Containment Cross Section

Designed to meet requirements of facility type and State requirements
Simplified Process Flow

1 = Supply
2, 3, 4 = Distribution
5 = Wind / Evaporation
6, 7 = Circulate

Repeat
“Unit” Information:

- Modular, scalable
- 0.6 to 1.8 MGY/unit
- ~1,600 to 5,000 gpd/unit
- ~25’ x 65’ footprint/unit
- >62,000 ft^2 of surface area
- 1.4 acres of surface area
~62,000 sf (1.4 acres) of surface area in ~62 x 25’ footprint

~1.3 football fields of surface area
WAIV Construction

Copping Landfill - Australia
WAIV Construction

Berm, Liner and Concrete Blocks
WAIV Construction

Galvanized Steel Frame
Top cross-members installed to support sails
WAIV Setup – 1 Unit
Distribution Piping

WAIV Surfaces and Distribution Piping Installed
Distribution Piping

Secondary Containment (can be simple HDPE)
Extensive Research and Validation

Ben-Gurion University of the Negev

Backed by Science
Cumulative Evaporation

Cumulative Evaporation
Extensive Research and Validation

Validation of Evaporation Modeling with Actual Evaporation Data
Examples of WAIV Systems Around the World

1. Leachate: Copping Landfill - Tasmania, Australia
2. Produced Water - Coal: Santos - Queensland, Australia
3. Concentrated Brine: GM– Ramos Arizpe, Mexico
4. Desalination: Pettavel Winery – Victoria, Australia
5. Desalination: Mekorot – Ketziot, Israel
Final WAIV Comments

• High degree of applicability
• Developed with science
• Proven in field with many improvements
• Beneficial for the environment
• Beneficial to community
• Lower costs
Natural Systems

Microbially Enhanced Brine Evaporation of Highly Saline Solutions

Halophile = salt loving micro-organism
A Biologically Sustainable System to Eliminate Highly Saline Concentrates

**Background**

- Top 5 Halophilic Microbiologist in the World
Rankings – Confirmed!!

1. Alabama (5-0)
   REC: 13-1  PTS: 1621
   TREN: N

2. Georgia
   REC: 13-2  PTS: 1454
   TREN: N

3. Our Halophilic Microbiologist

4. Clemson
   REC: 12-3  PTS: 1363
   TREN: N

5. Ohio State
   REC: 12-3  PTS: 1354
   TREN: N

2. Our Halophilic Microbiologist

Cheerleaders in action!
A Biologically Sustainable System to Eliminate Highly Saline Concentrates

Background

- Top 5 Halophilic microbiologist in the world
- 35-year career, retired professor
- Discovered 30+ years ago
- >1,300 microbes isolated
- Projects in US and Canada
- Awarded US Bureau of Reclamation Grant for 2020 (looking for participants)
- Applicable for use in evaporation ponds with TDS 80,000 mg/L and up. 100,000 mg/L, 200,000+ mg/L
How Does It Work?

**Untreated Brine**
Evaporation limited & decreases with higher salt content

**Treated Brine**
Evaporation increases with higher salt content

**Treated Brine**
Exponential growth of microbe populations

**Brine Evaporation Rate**

**Salt Crystallization**
(can be removed)

**Nutrients Added**

**Microbes Added**

**Colony Growth**
How Does It Really Work?

- Increased temperature
  - Microbial metabolism
  - Color change
- Increased opacity / sunlight penetration
How Does It Really Work?

• Increased temperature
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• Increased opacity / sunlight penetration

• Increased “Activity” of the microbes
  • (proprietary information / our ‘special sauce’)
How Does It Really Work?

- Increased temperature
  - Microbial metabolism
  - Color change
- Increased opacity / sunlight penetration
- Increased “Activity” of the microbes
  - (proprietary information / our ‘special sauce’)
- Partially unknown
  - Do microbes ‘sweat’ the water?
  - Increased surface area from micro disruption of surface
What Results Can be Expected?

- Increased evaporation rates
  - The greater the salt content, the better the results
- Degradation of VOCs
- Degradation of some fats and oils
- Utilization of nutrient compounds

- Meet or exceed evaporation rates of fresh water
Steps to a Project

- **Step 1 – Viability Testing.** We ensure that there are no major bio-inhibitors and that we can efficiently grow cultures in your brine.

- **Step 2 – Customization.** We determine what combination of microbes and nutrient mix works best with your brine.

- **Step 3 – Implementation.** We grow cultures and mix nutrients which are shipped to your site for pouring into your brine pond.

- **Step 4 – Long Term.** Continued addition of inoculum and nutrients for inflow volume.
Applications

• End Game for Zero Liquid Discharge (ZLD)
  • Post volume reduction processes
    • High recovery RO
    • Mechanical / thermal

• Existing disposal options
  • Crystallization
  • Haul to WWTP
  • Deep-well injection
  • NPDES discharge
  • Land application

Photo source: Water Online
Photo source: LA DNR
Photo source: scienceabc.com
Applications

Industries

• Mining & solution mining wastewaters
• Electric power generation
• Oil and Gas industry
• Manufacturing
• Hide (leather) brines
• Many others

• Recovery of valuable salts / beneficial reuse
Characteristics and Advantages

- No external energy input
- No mechanical equipment
- No additional infrastructure or buildings are required
- No sprays or mists
- No drift or odors
- No pretreatment required
- No control systems, plumbing, or electricity

- All energy used is FREE
- Adaptable and Flexible – works in salt concentrations where others techniques fail
Characteristics and Advantages

- Proprietary microbe and nutrient mixes
- Non-pathogenic and not genetically modified
- Quickly die outside of highly saline environment
CASE STUDIES
Brine Disposal in Alberta, Canada December 1995

- Evap of untreated brine = ~85 mm
- Evap of fresh water = ~145 mm
- Evap of treated brine = ~300 mm
Case Study
Cargill Meat Packing Facility

• Hide curing process

• **Project Objective: eliminate off site disposal**
  (deep well injection, discharge and/or hauled away to WWTP)

• In lab testing / Class A pan evaporation units

• Full lagoon treatment
  • 36,000,000 gallon volume in a 4.5 acres
  • Began 8/16/2019
Sequence of events in treatment #1

Fat layers begin to degrade (2 - 3 weeks)

Note color changes and larger open areas

Untreated  Treated
Appearance of small crystals on surface
3 weeks of treatment

Note ➞ Surface dimples are floating crystals
Some fat is still present but is being degraded
Evaporation of treated brine increased >25% over first month
Crystal Production to date

Treated 52 lbs salt

Untreated 31 lbs salt

67% Increase in Salt Production
Brine Clarity

6 weeks of treatment

Un-treated  Treated  Un-treated  Treated
Current Status

- Working as designed
- Microbial population still climbing
- Evaporation rates still increasing
Main Takeaway

- **Natural Systems** can solve **Big Problems**

Add them to your list

- Phyto-Utilization™ Systems
- W.A.I.V.™ – **Wind** Aided **Intensified** e**V**aporation
- Microbially Enhanced Brine Evaporation
- Constructed/ Engineered Wetlands
Industrial Wastewater Disposal with Natural Systems

THANK YOU

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