Phyto-Utilization of Leachate

An Alternate Approach for the On-Site Management of Leachate

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LEACHATE MANAGEMENT SPECIALISTS, LLC
“Finding A Better Way”
Special THANK YOU to:

for allowing use of project data and images
Phyto-Utilization™ in the Solid Waste Industry

Topics

- Technology Background
- Hybrid Poplar Case Studies
- Vetiver the “Super Grass”
- Vetiver Grass Case Study
Phytoremediation Definition

“The use of vascular plants... to either remove and control contaminants, or to spur contaminant breakdown by microorganisms in the rhizosphere.”

McCutcheon and Schnoor (2003)
Technology Background

“Phyto-Utilization™” Definition

The use of fast-growing (non-invasive), highly-tolerant plants to CONSUME industrial wastewater (leachate) to greatly reduce or eliminate the need for other disposal methods in a GREEN and sustainable way.
“Phyto-Utilization™” Definition

“Putting plants between ASTs and WWTPs”
Phyto-technology Research Conducted by

- Government agencies
- Academic
- Private industry
- Lab Studies >>> Field Trials >>> Full Scale
Technology Background

Sounds simple, but much is involved
Multiple Disciplines

- Engineering
- Agronomy
- Biology
- Soil Science

- Hydrology
- Chemistry
- Irrigation
- Computer Science

Multiple Trades

- Pipe fitters
- Electricians
- Excavation / construction

Projects can and will fail without proper expertise and practical experience.

Intellectual Property Rights Apply
Technology Background

Types of Plants Used

- Trees – Hybrid Poplar / Willow
- Grasses – Vetiver (warmer climates)
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
Landfill Leachate as a Resource?

Leachate Analysis (Contaminants)

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

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Leachate as a Resource

CONTAMINANTS = NUTRIENTS

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

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

How does it work?

- Biological
- Physical
- Chemical

Processes

- Above and below ground
- Inside and outside of the plant

Microbial colonies on roots
Technology Background

- **Rhizodegradation** = Microbes present in rhizosphere (root zone) mineralize contaminants.
  - Root secretions (called **Exudates**) enhance process.

- **Rhizofiltration** = Contaminants are absorbed to plant roots as water flows through rhizosphere. Root secretions aid process.

- **Phytosequestration** = Contaminants are sequestered on the plant roots in the rhizosphere. Aided by plant exudates and proteins.
Technology Background

Multiple Processes Occurring Simultaneously

- Rhizodegradation
- Rhizofiltration
- Phyto-sequestration
- Phyto-extraction
- Phyto-degradation
- Phyto-volatilization
- Phyto-stabilization

“A lot is going on”
Water Balance in a Phyto System

Percolation =

Initial Moisture + Precipitation + Irrigation + Run on

- Final Moisture
- Evaporation
- Transpiration
- Runoff

Conceptual Ecap Design
Water Balance in a Phyto System

KEY Take Away

Net Evapotranspiration (ET)
Determined through ET Modeling

ET of a Phyto Cap ➔ Traditional Grass Only Cap

Additional capacity = leachate irrigation
Water Balance in a Phyto System

KEY Take Away

Net Evapotranspiration

Phyto System

Traditional
Leachate Production versus Seasonal ET Capacity ‘S’ Curve
Phytoremediation in the Solid Waste Industry

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Case Studies – Hybrid Poplar Trees
Jeffco Landfill - 2007
Republic Services
St. Louis, Missouri
Hybrid Poplar
Site Information

- **Project Goals**
  - Reduce Leachate Disposal Costs
  - Implement GREEN Technology
  - Utilize Leachate Year Round (cold-weather climate)
  - Low O&M effort
Tree Planting
December ’07
Jeffco – First Growing Season

April 2008
Jeffco – 5 Months Post Planting

September 2008
## Jeffco Results

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td>Leachate Volume (millions)</td>
<td>2.9 (partial)</td>
<td>4.3</td>
<td>4.25</td>
<td>4.95</td>
<td>3.8</td>
<td>2.0</td>
<td>3.4</td>
<td>4.0 (est)</td>
<td>29.6</td>
</tr>
</tbody>
</table>

Not a single load of leachate has left the site since system startup

T&D avoided = $0.058 \times 29,600,000 = >$1.8 million
ACEC National Winners
Engineering Excellence Competition
In Top 25 Engineering Projects Nationally – Gala in Washington D.C.
South Barrington Landfill
Republic Services
Chicago, Illinois
Hybrid Poplar
>4,000 trees
Leachate Storage

Phyto Area
Installation Conditions (WET)
Tree Row Layout
Spring 2010 – First Growing Season
System startup, drip irrigation initiated
System startup, drip irrigation initiated

Large Area
Small Doses
Large Timeframe
Volume Analysis
Precipitation Analogy

- South Barrington typical operation
  - 10,000 gal per day max
  - 27,100 gal per inch of rain/ac
  - NET is 0.05” rain event

- System Cycling: $5 \times 0.01”$ rain event = a light sprinkle

**Agronomically speaking, volumes are minimal**
Unmanned Facility – System designed to be self adjusting to: leachate generation, leachate quality and changing backpressure
Easy Access, Easy Maintenance
Remote telemetry used to monitor system, make changes to operation
South Barrington

- Through December 2015:
  - Processed **8.4 M** gal
  - Avoided 1,680 tanker trips
  - >65,000 miles not driven
  - >10,800 gal diesel not burned
- No odor problems
- Neighbors like trees
Environmental Benefits
Carbon Footprint Reduction

- **Emissions Avoided**
  - Diesel not burned = 2,000 gallons/yr
  - >23 tons CO₂/yr not emitted

- **Sequestered by Trees**
  - 13 tons CO₂/ac/yr sequestered

- >100 tons CO₂/ year
Phytoremediation in the Solid Waste Industry

Topics
- Technology Background
- Hybrid Poplar Case Studies
- Leachate Management Specialists
- Vetiver Grass
- Vetiver Grass Case Study

www.leachate.us
Leachate Management Specialists

- Dedicated solely to providing better solutions to managing leachate
- Industry leaders (considered national and international experts)
- Providing innovative, environmentally-sound, cost-saving solutions
Leachate Management Specialists
Company Philosophies

Project Management Philosophy
- Always work in Client’s best interests, unquestionably
- Leverage Client’s resources (time and capital) wisely
- Make your day just a little bit easier

Engineering Philosophy
- Provide outstanding technical expertise
- “There’s got to be a better way”
Leachate Management Specialists
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Phyto-Utilization in the Solid Waste Industry

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Vetiver Grass
An Amazing Plant for Phyto-Utilization™

Impressive Aboveground Growth
Vetiver – An Amazing Plant

Has many advantages over traditional grasses

- ‘C4’ Photosynthetic CO₂ Fixation Pathway
  - Faster Growth Rate/ Biomass Production
  - Higher Demand for Nutrients/Moisture
Vetiver – Extremely Tolerant

High Tolerance To:
- pH 3.5 – 10 s.u.
- Metals
- Salinity (TDS)
- Ag Chemicals
- Nitrogen compounds
- Non-Invasive

Landfill in New South Wales, Australia
Leachate Consumption
20 MGY (55,000 gpd)

http://www.vetiver.org/USA-USDA-NRCS_Sunshine.pdf
Adaptable to Warmer USDA Zones ~8 - 10
Phytoremediation in the Solid Waste Industry

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Gulf Pines Landfill
Republic Services
Biloxi, Mississippi
Vetiver Grass

First project of its kind in North America
Fully Established
Gulf Pines Results

- Significant environmental benefits
- Leachate costs cut 50+% 
- >$10,000 per month savings
- Through March 2016
  - >5 million gallons consumed
  - >$450,000 disposal costs avoided

- First of its kind project in North America
2012 National Awards Banquet

“Grand Award” for First Place in Category
Leachate highly contaminated with Cr, Cd, Cu, Pb and Zn
Leachate Seep – Example – Side slope of landfill

Flows to nearby creek
One year post planting... Problem Solved
Surface Water Quality and Slope Stabilization

Hedge slows runoff, sediment trapped, surface water quality improved

Thick thatch aboveground and root system underground form physical and bio-filter
Mexico – Vetiver planted on steep slope for stabilization
10 months post planting
Hydroponic Applications – Leachate Ponds
Benefits of Phyto-Utilization™

- A Truly GREEN, Sustainable Technology
  - Reduced carbon footprint
  - Corporate sustainability reports / PR opportunities
- Significant Cost Reduction (25-50%)
- Zero Discharge Potential
  - Not dependent on POTW
    - Changing discharge limits
    - Blamed for their problems
    - Can be cut off (more and more w/ UV disinfection)
    - Price increases
- Year-Round Leachate Management
Benefits of Phyto-Utilization™

- 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
- New Alternative to Consider
Phyto-Utilization Results

Cumulative US System Results

>50 Million Gallons Processed
>$3 Million In Leachate Disposal Costs Avoided
>2,000 Tons GHG Emissions Avoided
Phyto-Utilization™ of Landfill Leachate

THANK YOU
Brad Granley, PE
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www.leachate.us

Old

New