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 SOLID WASTE
 Management Conference
 Davenport
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**A Goo Review: EREF, Hinkley Center & Progressive
 Environmental Research/Experience Update**
Steven Carl – President, Progressive Environmental Services







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Previous Research

28 samples primarily from landfills in North America









9ICEG

Proceedings of the 9ICEG
 9th International Conference on Environmental Geochemistry
 15-19 June 2013 / Doha, Qatar
 In memory of the late Professor 2013
 www.9iceg.org/9ICEG2013-13

**Characteristics of Black Goo From Leachate Collection Systems at
 Two North American Landfills**

Mohamed Yilmaz*, Raul L. Olson*, Yu-Tsun-Craig H. Bennett*, Yusef B. Edri*, and Sabrina Bradshaw*



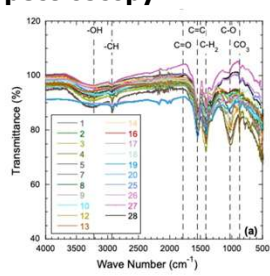
**Environmental Research
 & Education Foundation**
Lighting the way towards a more circular economy

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Fourier Transform Infrared Spectroscopy (FTIR)

- FTIR identify major chemical bonds and functional groups in a sample
- Consistent peaks indicate C-H, C-H₂, C-O, C=O, C=C, and CO₂ features.
- Remarkably similar FTIR spectra from Goos collected from broad ranges of landfills

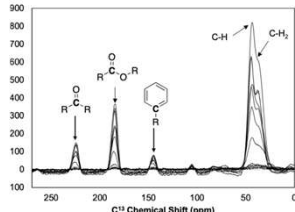


Source: Dr. Benson's AAES Webinar
<https://www.aaes.org/assets/docu/library/AAESWebinar-20250320.pdf>

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Solid-State Nuclear Magnetic Resonance (ssNMR)

- ssNMR identify carbon-based **organic structure** in the solid samples
- Spectra indicate Black Goo has C-H₂, C-H, and C=O bonds
- Remarkable similarity among Goos

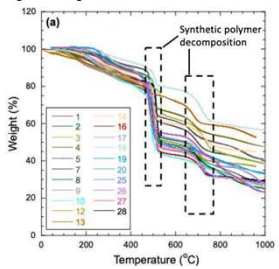


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Thermogravimetric Analysis (TGA)

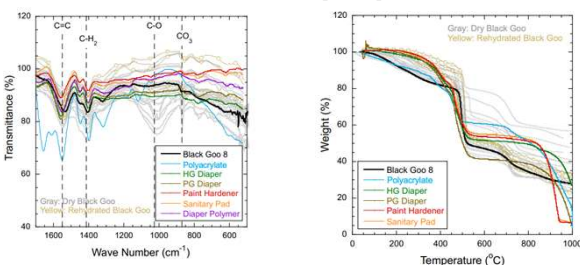
- TGA measures how a sample loses mass as temperature increases
- Weight loss at 500°C indicates **synthetic polymer structures (e.g., polyacrylate)**
- Polyacrylate: diaper, meat pads, dewatering agent, wastewater treatment flocculating agent, and more
- Polymer content varies from 14% to 40%



Source: Dr. Benson's AAES Webinar
(<https://www.aaes.org/assets/docu/library/AAESWebinar-20250320.pdf>)

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FTIR and TGA of Goo & Polyacrylates



FTIR & TGA of goo are very similar to polyacrylates

Source: Dr. Benson's AAES Webinar
(<https://www.aaes.org/assets/docu/library/AAESWebinar-20250320.pdf>)

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Previous Research

- Black Goo have very similar composition (**Note: Goo is now plural***)
- Hydrophilic superabsorbent polymers contribute to the Goo
- Black Goo are largely abiotic (not biological), but microbial communities that live on Goo probably affect their physical behavior
- No magic solution, *keep it moving is the key*
- ** Steve's note*

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Survey Results

- 12 landfills interviewed
 - 6 without Black Goo
 - 6 with Black Goo (4 from FL)
- 6 without Black Goo
 - 3 are slurry-wall landfills
 - 2 ash monofill
 - 1 MSW landfill
- 6 with Black Goo
 - All accept sewage sludge; one landfill started to observe Black Goo after a spike sludge disposal 5 years ago

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Sample Collection

- 9 Black Goo samples & paired leachate samples from 7 **MSW** landfills
 - 4 from gas collection and control systems (GCCS)
 - 5 from leachate collection and removal systems (LCRS)

Sample Category	Black Goo	Corresponding Leachate	General Location
GCCS	BG1	LC1	Florida
GCCS	BG2	LC2	Florida
GCCS	BG3	LC3	Florida
GCCS	BG4	LC4	Northeastern U.S.
LCRS	BG5	LC5	Northeastern U.S.
LCRS	BG6	LC6	South-central U.S.
LCRS	BG7	LC7	Southeastern U.S.
LCRS	BG8	LC8	Florida
LCRS	BG9	LC9	Southeastern U.S.

- One Black Goo from an ash landfill; one from an CDD landfill
- Two biosolids & diaper polymer

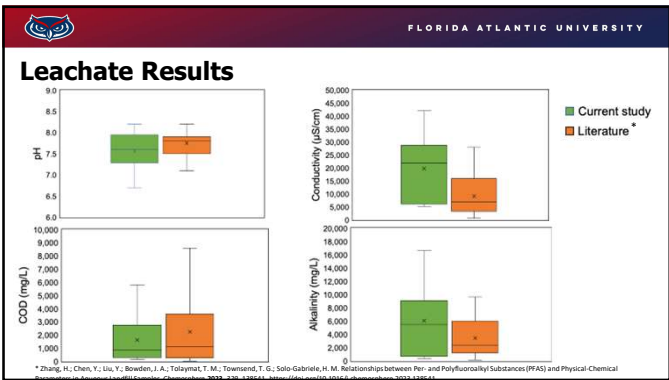
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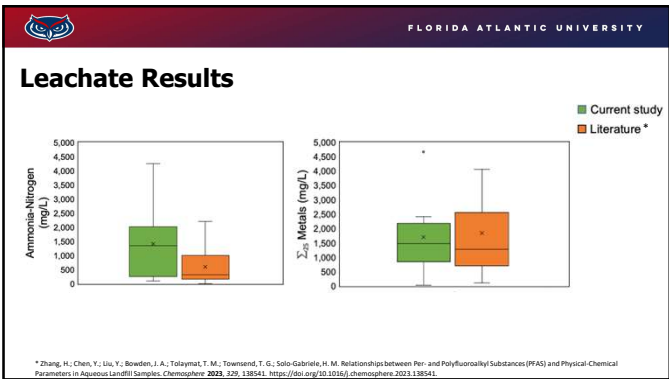
Black Goo Characterization

- Moisture content
- Loss on ignition (LOI)
- TGA : thermal behavior
- FTIR: chemical bonds functional groups
- ¹H Nuclear Magnetic Resonance (NMR): extractable organic compounds
- Scanning electron microscopy with energy-dispersive spectroscopy (SEM/EDS): microstructure and elemental composition
- ICP-AES: metal content
- PFAS

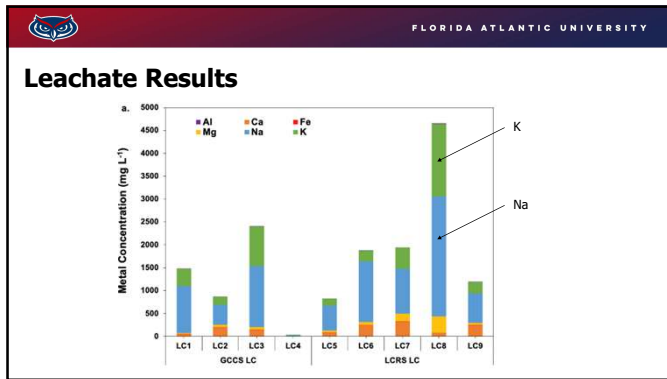
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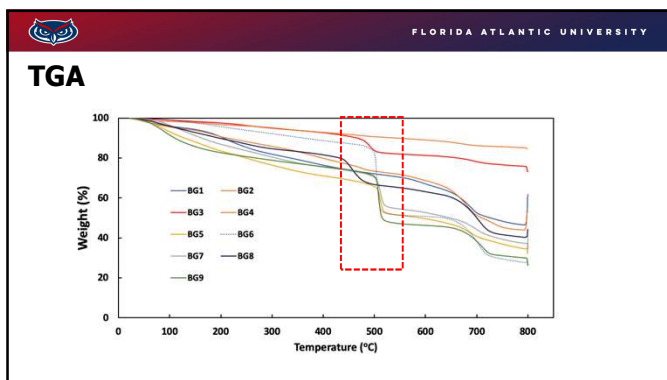
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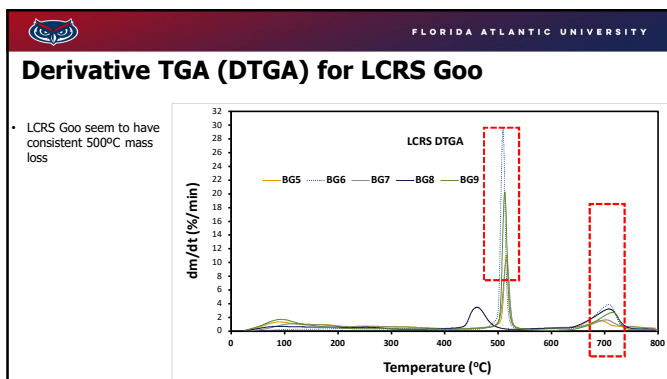
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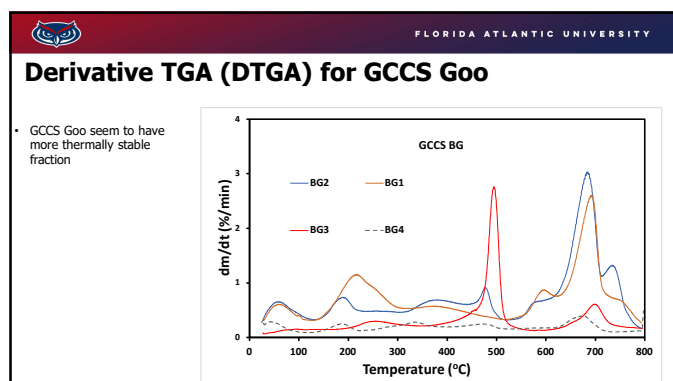
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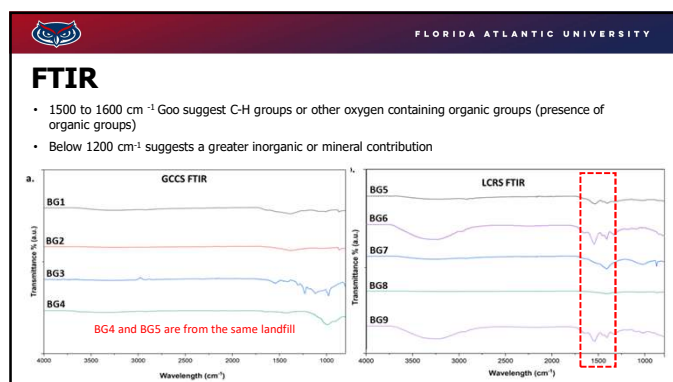
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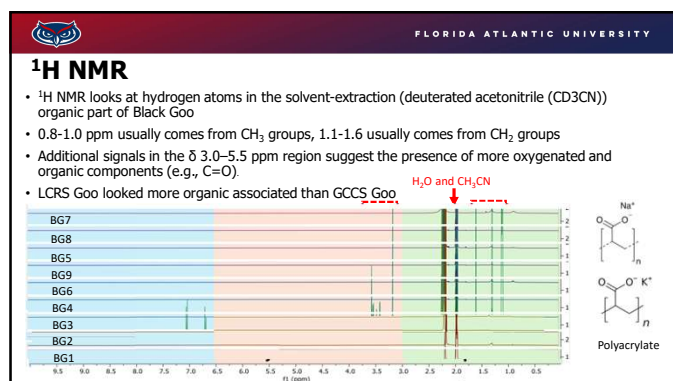
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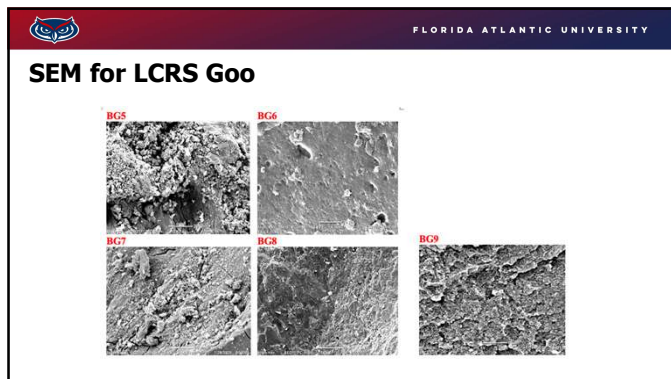
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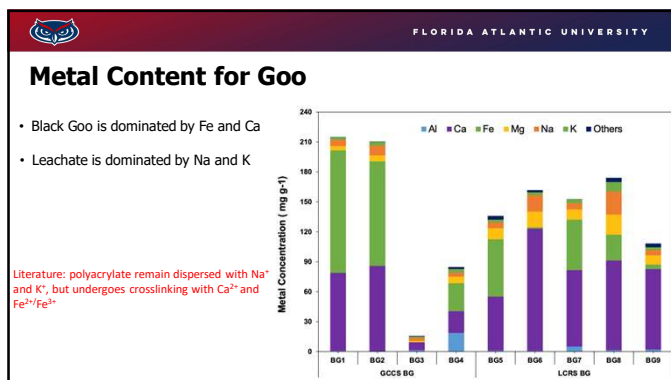
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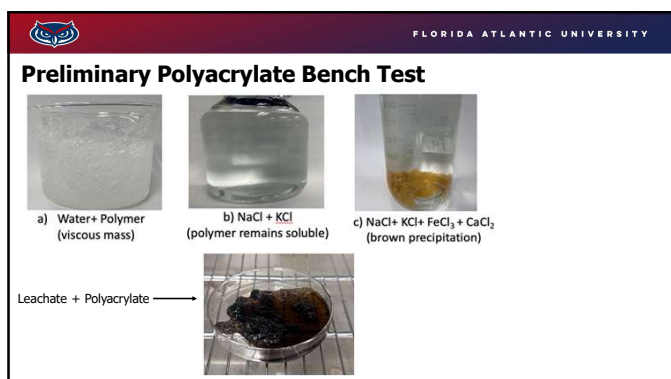
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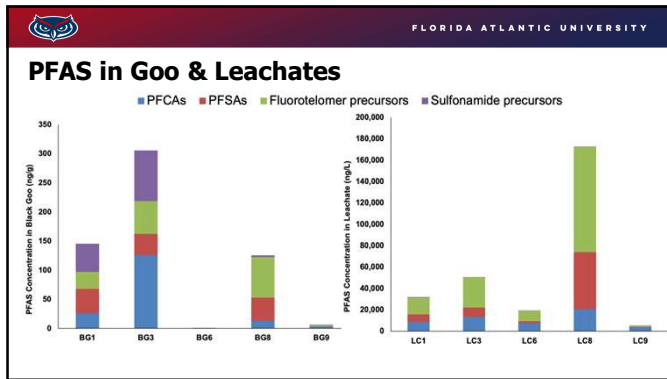
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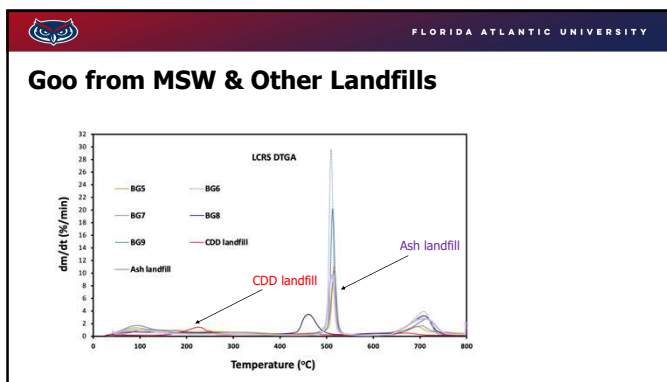
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Initial Microbial Characterization of Goo

- Dense microbial population were observed
- Goo samples yielded 10^8 - 10^9 cells per gram
- Black Goo is biologically active, but microbial involvement in formation is still unclear

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Summary

- Black Goo occurs in both GCCS and LCRS, but the location, spread, and impact vary by system
- Black Goo is not a single uniform material
- LCRS Goo are more organic associated, while the GCCS Goo are more variable and mineral-rich
- Goo is dominated by Fe/Ca while leachates are dominated by Na/K
- Goo is biologically active
- Current treatment appears mostly temporary

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Future Research Needs

- Understand Black Goo formation mechanisms
- Determine whether microbes contribute to Black Goo formation
- Test treatment options and evaluate effectiveness for different goo types
- Develop redundant means to determine liquids levels in the landfills.
- Determine true impact of liquids levels in the landfills.
- Develop programs for maintaining flow.

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Pipes & Pumps



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Black Goo



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Conclusion: “Keep it Moving”

- Goo tends to accumulate in cooler quiescent zones (low shear)
- Polyacrylates dissolve in solution, but will agglomerate as concentration increases and temperature and fluid shear decrease.
- Keep the fluid moving (shear stresses) to keep the polymer flowing with liquid and not as separate sticky phase. *

***With PES Conclusion:
Get it in the Budget**

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Scale & Goo---Not just black

- Problem is not just a thing, It's a spectrum
- Scale => Goo: stages of leachate plugging problems.
- Plugging problem is a Cause and Effect.
- Concentration of constituents is not known and is likely variable. **SCALE & GOO & TAFFY**. Alone or all 3.
- Other critical factors?: PFAS, Metals (Fe, etc), Organics (Ammonia, etc.) . Groundwater contamination.

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Real Problem?

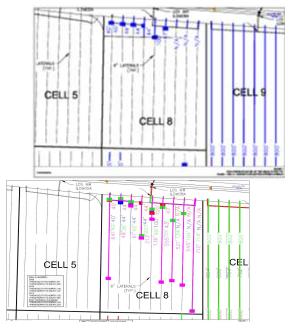
Plugged Systems.

Leachate on the liner.

Contamination of Groundwater.

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Today's Solutions and Strategies



1. Do nothing, wait
 1. (Inventory Management).
 2. Manual cycling of pumps.
 3. Pull pumps up the riser.
2. Jetting
3. Jet and Vac
4. Continuous Chemical Feed
5. Chemical Cleaning

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PROGRESSIVE
ENVIRONMENTAL SERVICES

Pipe & Well Renew SLF
V. High concentration for LFs



1. AC 6400
2. Kroff
3. Muriatic Acid
4. Hydrogen Peroxide
5. Sulfuric Acid

Does it Work?
Keeps pump clear, does not solve the problem.

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Chemical Cleaning



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PROGRESSIVE
ENVIRONMENTAL SERVICES

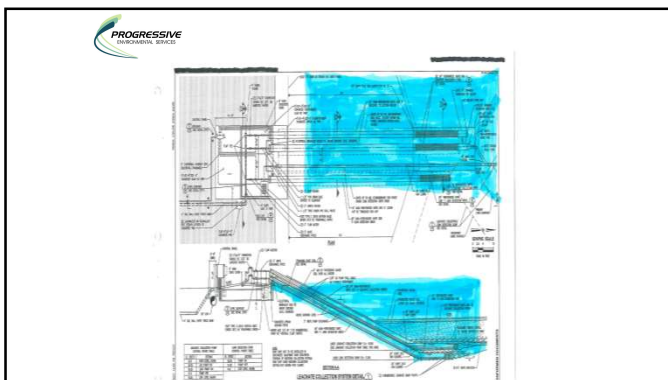
The Questions

- How bad is it?
- How long has it been this way?
- What Scales/Goo/Taffy are we dealing with? Age? Progression?
- What are the design/disposal issues?

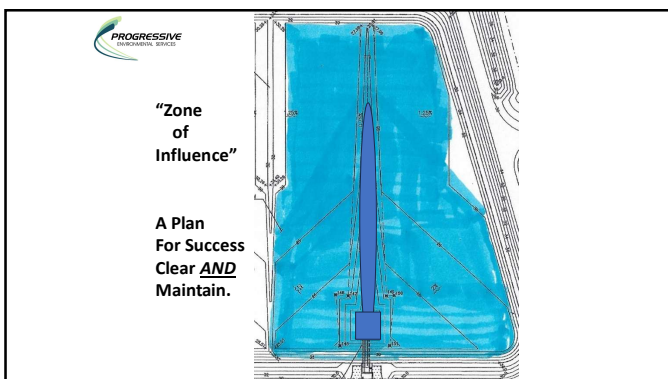
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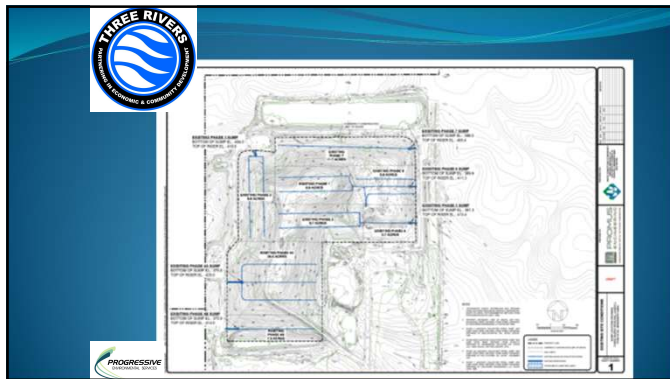
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MS Chemical Cleaning Results

- Restored from 550-600 to 800-850 CFM
- Power Engine & Evaporator both running
- Huge reduction in Leachate in the cells
- 30%-40% increase in Gas Collection

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Cleaning Results: South Carolina LF

- **New Results: Condensate Sump, Pipes & Wells**
 - Before: 8 inches of Vacuum
 - After: 52 inches of Vacuum
 - 3 days later: 22-25 inches of Vacuum
 - 1 Week later: 32-35 inches of Vacuum
 - Same one year later
- Still Following.....

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Cleaning Results: 1,500' of 18" Gas Main

Vacuum at Flare: -60 inches

Vacuum at the section end: -22 to -24 inches

Post Cleaning: -60 inches at end and up into the landfill.

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Signs of Problems/Issues

- High Liquid Levels in sump
- Slow recharge rates
- Short pump run times
- **30+ minutes to fill –**
- **20 seconds to pump out**
- High operating pressures



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Signs of Problems/Issues



Ponding, Seeps, Spots of dead/dying grass, Other?

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*"Protecting What's Been Built,
Questions, Answers and Surmisals"*

***"Protecting the Environment
is a daily choice."***

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***"Protecting What's Built,
Restoring What's Broken"***
