Crazy Horse Sanitary Landfill Closure with an Exposed Geomembrane “Hybrid”
Crazy Horse Sanitary Landfill

Operational 1934 – 2010

Module 1 was on NPL List. (Closed 1988)

LFG Flare(s)
29-MMBtu/Hr & 72 MMBtu/Hr

LFGTE – 1.5 mW current interconnect.

Leachate Treatment (Recirculation During Postclosure)
Final Closure Design – Stage 1

Final Cover
Original Design

ET Cover – Too Wet.

Foundation Layer
50-mil Structured LLDPE geomembrane (“Supergripnet”)

8-oz NV Geotextile

Vegetative Cover

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50-mil STRUCTURED LLDPE GEOMEMBRANE LINER/DRAINAGE LAYER

8-oz NV Geotextile

2 FT VEGETATIVE SOIL
Final Closure Design – Stage 1

Design Issues
Stability
MHA_{Rock} = 0.5 g!
Required Buttressed Fills in Some Locations

Usual Postclosure Maintenance Concerns;
Settlement, Vegetative Cover Erosion
Regarding Vegetative Soil Import

Would have been ~200,000 CY,
Between 9,000 and 10,000 Trips,
Up to 600,000 Diesel Miles (JCLF),
Up to 900 MT of eCO₂ Emissions

For CHLF, Poor Access = High Transport $$

More So Today!
Exposed Geomembrane with Solar PV Laminates

- Wind uplift would have required additional anchor trenching along slopes. (~50 feet C.C.)
- Solar power is expensive (~ $12 million at CHLF)
- Regulators demanded Postclosure Pledge of Revenue include capitalization of exposed geomembrane replacement.

Deal Killer!

- “Next” was a Exposed Geomembrane “Hybrid”
Final Closure Design Stage 3

Exposed Geomembrane Hybrid

Claimed Benefits

- Eliminates vegetative cover layer
  (Photo LaSalle/Grant Parish Landfill in Jena, Louisiana)

- Supports Rigid Solar Panel Installation

- Reduces Need for Vertical LFG wells

Resists wind uplift pressures
Trade Name = Closure Turf®

Patented Components

- Structured geomembrane (AGRU’s Supergripnet)
- Double layer woven PE geotextile
- Sewn HDPE artificial grass
- Coarse to medium sand ballast

- An Entirely Synthetic Final Cover System
- (Well, except for the sand)

Traditional Final Cover System

Closure Turf Final Cover System
Crazy Horse Design Considerations

Increase in Peak Run-off Discharge

- Synthetic Final Cover Curve Number = 95
  - With Solar Panels, 98

peak discharge required attenuation (Sluice Gate over Basin Outlet)

CCRWQCB subscribes to Low Impact Development (LID) Guidelines.
Crazy Horse Design Considerations

Wind Resistance

Exposed Geomembrane Susceptible to Wind Uplift Stresses.

Application of Sand Ballast to Hybrid’s Artificial Component Resists Uplift and Shear

Uplift (Normal Force) Response: Uplift Force Peaks and Then Declines
Crazy Horse Design Considerations

Wind Resistance Tested by Georgia Tech

Shear Force Governs. Continues to Increase.

Design Wind Speed for Pacific Coast = 85 MPH (ASCE-07)

Required Applied Ballast Sand Weight Due to Wind Uplift and Shear Force

\[ W_{\text{sand}} = \tau / \tan \phi_s \times 1.5 + P \] (with \( \phi_s = 33^\circ \))
Final Closure Design Stage 3

Final Closure Plan
Approved By:
Monterey County Dept. of Health (LEA)
Central Coast Regional Water Quality Control Board
Cal Recycle (formerly CIWMB)
Final Closure Design Stage 3.1

Revised Project Elements
- Exposed Geomembrane
- Hybrid
- Combined with Vegetative Cover

First
- Revised Drainage Infrastructure

Closure Turf product was tested for concentrated flow hydraulics (ASTM D 6460)
- Sand washed out at low shear values (0.6 psf)
- Cemented sand mix (3:1 sand:lime-cement) resisted hydraulic shear forces as high as 15 psf
- Calculated hydraulic shear at Crazy Horse < 5.5 psf
- Cumulative cemented sand loss ~ 0.025 inches
Final Closure Design Stage 3.1

Revised Project Elements

Drainage Infrastructure:
Replaced overside drain pipe with overside chutes

Hydraulic Shear Test Results

Limiting Shear via ASTM D 6460

\[ y = 1E-04 x^3 - 0.0013 x^2 + 0.0089 x \]
\[ R^2 = 0.9967 \]

Limiting Shear = not achieved, but projected > 20 psf

Source: TRI/Environmental Inc.
Final Closure Design Stage 3.1

Revised Project Elements

Second Exposed Geomembrane Hybrid as Travel Surface

Two Vehicle Scenarios
1. Maintenance Traffic (Pickup Trucks, ATVs)
2. Fire Department Water Tender

- GVWR = 12,000 lbs

- GVWR = 55,000 lbs

- 45 psi

- 120 psi
Final Closure Design Stage 3.1

Revised Project Elements

Second Exposed Geomembrane Hybrid as Travel Surface

Designed for Puncture, Tensile, and Braking Force

Previous roadway design of:

To:

- Geomembrane Hybrid as Travel Surface designed for Puncture, Tensile, and Braking Force.
# Geotextile Reinforcement - Traffic

## Components

- 4-oz Geotextile for Light Vehicle Roads
- 12-oz Geotextile for Fire Dist. Water Tender Roads

- 50-mil LLDPE structured geomembrane (AGRU’s Supergripnet)
- Double layer woven PE geotextile
- Sewn HDPE artificial grass
- Coarse to medium sand ballast

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Add non-woven geotextile Reinforcement

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Closure Turf Final Cover System
Final Closure Design Stage 3.1

Revised Project Elements

Third:

PVC Pipe on vs. HDPE Pipe

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HDPE – Very Tough, but
High Thermal Expansion
- Requires extensive anchoring

PVC Pipe – Lower Thermal Expansion
- Currently in Use
- Not UV Resistant - Requires Painting (and Repainting)
Post Closure Maintenance

“Different” Postclosure Maintenance
Reduce with Proper CQA

Occurs Along Boundary. Get out the Roundup!
Reduce with Proper CQA

Poor Sand Placement = Turf Damage from….

Sand Ballast Replacement

Volunteer Vegetation
Questions?

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