Case Study:
Rehabilitation of a Soil Dike
for a Wastewater Treatment Facility

Presented At
A.S.C.E. N.C. Section Meeting
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by
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The Wastewater Pond
Outboard Slope of Dike

Impacted Cypress Trees

Wetlands

Woody Vegetation
Area of Distressed Cypress Trees
Possible source of distress.
Typical water level at the toe of the outboard slope.
Dry season.
Seep Area

Hand Augered Piezometer
Exploring Seep
Repair Goals

• Prevent seepage from impacting the wetlands
• Improve dike stability
• Least cost
Information About the Dike

- Dike constructed 40+ years ago
- Constructed entirely of soil
- No geosynthetic or soil liner in Pond
- No cutoff or toe drain in the dike
- Outboard slopes approx. 3H:1V
CROSS SECTION THROUGH THE EXISTING SOUTH BAY DIKE
Summary of Physical Characteristics

- Top of dike at approx. EL 32 ft (MSL)
- Toe approx. EL 15, but as low as EL 8
- Flood stage of nearby creek ~EL 15 ft.
- Pond water approx. EL ~28 ft.
Questions:

- What type of soil was used for the dike?
Questions:

• What were the materials used for the dike?
• Was there any quality control?
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• Was there any quality control?
• What is the stability of the dike?
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• Was there any quality control?
• What is the stability of the dike?
• What is the water level/phraetic surface through the dike?
Questions:

• What were the materials used for the dike?
• Was there any quality control?
• What is the stability of the dike?
• What is the water level in the dike?
• What records are available regarding the dike?
Dike Raised in 1993
1993 Geotechnical Evaluation by S&ME, Inc.

- Dike was raised by as much as 3 or feet along the segment with the seep.
- Report covers an investigation prior to increasing the dike height
- Does not provide as-built documentation
Map of 1993 S&ME Borings
Boring Log from 1993
## Index Properties 1993 Samples

### Gradation Test Results

<table>
<thead>
<tr>
<th>Boring Number</th>
<th>B-2</th>
<th>B-5</th>
<th>B-7</th>
<th>Borrow Pit</th>
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<tbody>
<tr>
<td>Depth (Ft.)</td>
<td>8.5-10</td>
<td>6-7.5</td>
<td>13.5-15</td>
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<td>100</td>
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### Atterberg Limits

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<tr>
<td>Depth (Ft.)</td>
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<td>Percent Moisture</td>
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<td>Liquid Limit</td>
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<td>Plastic Limit</td>
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<td>Plasticity Index</td>
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<td>USCS</td>
<td>CL</td>
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</table>
Triaxial Shear Results 1993

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
Boring No.: 8-7
Depth: 22-23.5'
Soil Description: Gray & Tan CLAY - Trace to Some Fine Sand

\[ c^' = 590 \text{ psf} \]
\[ \phi^' = 7.9 \text{ degrees} \]

\[ c = 720 \text{ psf} \]
\[ \phi = 5.0 \text{ degrees} \]
Exploration Geoprobe Samples
Approximate Dike Cross Section

CROSS SECTION THROUGH THE EXISTING SOUTH BAY DIKE
Geoprobe Sample Results
Geoprobe Sample Results GP-6
Questions

• 2005 Geoprobe sample results different from 1993 results.
• 1993 results said sandy clay or clayey sand
• 2005 results showed less than 15% fines.
Conclusion:

- Sand is prevalent in the area
- Most other dikes are constructed of sand
- Seepage coming through sand dike
Conclusion:

- Sand is prevalent in the area
- Most other dikes are constructed of sand
- Seepage coming through sand dike
- Let’s try a pump test!

- If successful, then install a series of wells
- Overlap the radii of influence
- Contain the seepage
Hydrometer – Geoprobe Sample

<table>
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<tr>
<th>Elapsed time</th>
<th>R measured (%)</th>
<th>Temp. (°C)</th>
<th>Composite R</th>
<th>R (K factor)</th>
<th>Diameter</th>
<th>R² (%)</th>
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<td>0.013305</td>
</tr>
</tbody>
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Soil Specimen Data

- Time = Dry Material (gpm): 40.62
- Weight of Material (gpm): 0
- Weight of Material (gpm): 0
- Weight of Dry Material (gpm): 40.62

Other Corrections

- Other: 3.99
- Percent from #10: 0.000
- Specific Gravity: 2.7 Assumed
Atterberg Limits – 2005 Boring Sample
Piezometer in Geoprobe Boring
Remedies

• A series of pumps
Remedies

- A series of pumps
- Sheet Pile
Remedies

- A series of pumps
- Sheet Pile
- Slurry Cut-off Trench
Remedies

- A series of pumps
- Sheet Pile
- Slurry Cut-off Trench
- French Drain Collection Trench at the Toe
Wetlands
Proposed Collection Trench

EXISTING SOUTH BAY DIKE

DISTANCE FROM THE TOE OF THE DIKE MAY VARY FOR SAFETY

EXTEND BARRIER MEMBRANE OVER THE TOP OF THE COLLECTION TRENCH

BARRIER MEMBRANE (60 MIL HDPE OR GEOSYNTHETIC CLAY LINER)

COLLECTION STONE (NCDOT 467M OR EQUAL)

6" PERFORATED PIPE

EMBEDDED COLLECTION TRENCH INTO PEEDEE CONFINING LAYER

SEEP COLLECTION TRENCH

TOP OF PEEDEE CONFINING LAYER

FILTER GEOTEXTILE

DIRECTION OF SEEPAGE
Proposed Collection Sump
Start of Trench Excavation
Excavating the Sump at the North End of the Collection Trench
Reaching Confining Clay Layer
Collection
Sump
Installing the Sump Riser and the Collection Pipe
The Perforated Collection Pipe Installed in the Trench
Permitted Wetlands Impacts
Standing Water Above the PVC Geomembrane
PVC Geomembrane
Southwest End of the Trench
As-Built Collection Sump

**SUMMARY**

- **8" CPE (Type S), Perforated Seep Collection Pipe, in NCDOT No. 57 Stone**
- **30 mil PVC Boot on 8" Pipe, Encased in Concrete**
- **W/ 1.5 inch PVC Discharge Pipes**
- **4" CPE (Type S), Solid Riser**
- **Two 1 HP Submersible Pumps See Figure 4**

**NOTES**

1. Sump Invert was measured relative to the top of the riser.
2. "CPE" is Corrugated Polyethylene Pipe, "Type S" is Smooth Interior.

**SUMP PLAN VIEW**

- Concrete base, 5'x5'x6'

**SUMP SECTION**

- Compacted Backfill (Typ.)
- Approx. Inv. = -7.5 MSL

**SUMP PLAN VIEW**

- 30 mil PVC Geomembrane
- Cushion Geotextile
- Approx. Inv. = -3.5 MSL
- 8" CPE (Type S), Perforated Seep Collection Pipe, in NCDOT No. 57 Stone
- 30 mil PVC Boot, Wrapped Around 8" Pipe
- Peedee Confining Stratum
- Concrete base, 5'x5'x6"
Restoration in Progress
Construction Complete – View to Southeast
Construction Complete – View to North