Pipeline Installation by the Hole Intersect Method to Protect Facilities Crossing Under Navigable Waterways
• L-57A (18”) installed 1949 by Standard Oil. Floated during flooding of Mildred Island, and is partially decommissioned.
• L-57B (22”) installed 1974 through the levy cross sections.
• 25% of PG&E’s daily peak winter demand is supplied by Mc Donald Island.
The loss of supply from Mc Donald Island would cost between $200 million to $1 billion.
McDonald Island levy breech
Levee Breech = Scour
Scour is bad for buried structures!
<table>
<thead>
<tr>
<th>Island</th>
<th>Date of Flood</th>
<th>Probable Cause of Levee Failure</th>
<th>Levee Break Dimensions</th>
<th>Levee Break Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mildred Island</td>
<td>November 1982</td>
<td>High Water Failure</td>
<td>Width: 190 ft.</td>
<td>Max. Scour Depth: None</td>
</tr>
<tr>
<td>Bradford Island</td>
<td>1983</td>
<td>High Water Failure</td>
<td>Width: 190 ft.</td>
<td>Max. Scour Depth: None</td>
</tr>
<tr>
<td>New Hope Tract</td>
<td>February 1986</td>
<td>High Water Failure</td>
<td>Width: None</td>
<td>Max. Scour Depth: None</td>
</tr>
<tr>
<td>Glanville Tract</td>
<td>February 1986</td>
<td>Overtopping</td>
<td>Width: None</td>
<td>Max. Scour Depth: None</td>
</tr>
</tbody>
</table>

But How Deep?
• Pipe Spec: 24” DSAW, 0.750 WT, Gr. X-70, w/ 16 mils FBE (Mfg: Nippon Steel)
• Open Cut Coating: 1” concrete added over FBE for buoyancy control
• HDD Coating: 40 mils Powercrete over FBE
HDD Design

- Pipeline outside of modeled scour zone.
- Entry / Exit min. 300’ from levee toe and min.
- Depth > 60’ below bottom of channel.
- All bending radii produce acceptable combined stresses during hydrotesting.
- Avoid fracture of the formation.

<table>
<thead>
<tr>
<th>Crossing</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empire Cut</td>
<td>6,420’</td>
</tr>
<tr>
<td>Middle River</td>
<td>5,820’</td>
</tr>
<tr>
<td>Old River</td>
<td>6,800’</td>
</tr>
</tbody>
</table>
Empire Cut HDD
To avoid “Frac-Out”: Keep downhole pressures below the “theoretical” limit pressure of the formation.

Hire an experienced Driller!
Geotechnical data to surmise formation limits.

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Depth (feet)</th>
<th>Sample No.</th>
<th>Grain Size (mm)</th>
<th>Pores (nest)</th>
<th>Pores (vol%)</th>
<th>Density (g/cm³)</th>
<th>Moisture Content (%)</th>
<th>Plasticity Index</th>
<th>Pasting Power (%)</th>
<th>Brittle Point (%)</th>
<th>UC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-2.5-1</td>
<td>0</td>
<td>&lt;0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(PT) PEAT - Dark brown, very soft, low plasticity</td>
</tr>
<tr>
<td>4-5-1</td>
<td>0</td>
<td>&lt;0.25</td>
<td>20</td>
<td>204</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gray</td>
</tr>
<tr>
<td>4-10-1</td>
<td>0</td>
<td>&lt;0.25</td>
<td>22</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ML) SILT - Gray, soft, low plasticity</td>
</tr>
<tr>
<td>4-20-1</td>
<td>3</td>
<td>0.75</td>
<td>88</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(SM) SILTY SAND - Gray, loose, fine grained</td>
</tr>
<tr>
<td>4-25-1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(LM) CLAYEY SILT - Gray, stff, low plasticity</td>
</tr>
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<td>(SM) SILTY SAND - Gray, loose, fine grained</td>
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</table>
• Utilize hole intersect method of HDD to keep downhole pressures low.

• Use Conductor Casing
• Utilize hole intersect Method of HDD to keep downhole pressures low.
• Use Conductor Casing
The Big Boy

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**HERCULES**

**3 Rigs Owned & Operated**

**Drill Rig Specifications**
- **Height:** 33' 6"
- **Lengths:** 53'
- **Width:** 8' 6"
- **Horsepower:** 1500+ HP (750 HP ea)

**Drill Rig Capacity**
- **Torque Capacity:** 160,000 Ft/Lbs
- **Max Spindle Speed:** 40 RPM
- **Thrust/Pull:** 1,260,000 Lbs

**Drilling Specifications (Dirt)**
- **Maximum Recommended**
  - Back Ream: 96'
  - Drilling Distance: 8,000'

**Drilling Specifications (Rock)**
- **Maximum Recommended**
  - Back Ream: 60'
  - Drilling Distance: 8,000'

**Survey System Specifications**
- **Type:** Downhole probe
- **Accuracy:** +/- 0.1' All Angles
- **Max Locating Depth:** Unlimited

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**MICHELBS**

A DIVISION OF MICHELBS CORPORATION

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Brownsville, WI 53916
Telephone: (920) 563-3132
Fax: (920) 563-3429
www.michelbs-inc.com

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**OPERATIONAL EXCELLENCE**
Digging in the Delta
Why the gap???
Q: How many lawyers does it take to ruin a good project?

A: **Just One**

- Litigation over MND
- Condemnation
- Challenge at CPUC
- $1.4 Million spent on Lawyers
Conductor Casing
Drill Stem
Hydrotested & Ready to Pull
The Pull
Gently Cradled Into the Hole
Instrumentation to Monitor Drilling Operations
McDonald Island May 30th Piezometer Readings From 7:41 am to 2:06 pm

Approximate Average Pore Pressure Prior To Spike = 30.4 psi
Approximate Maximum Pore Pressure Spike = 40.6 psi
Approximate Drop In Pore Pressure Prior To Spike = 20.7 psi

Loss Of Returns - Turned Pump Off - Begin To Pull Rods
Pump Turned On
Drill Head Below Piezometer - Average Pressure Approximately 31.3 psi

Anatomy of a Frac-Out
Slope Inclinometer Data
We Done Good !!!!

Michels’ HDD project team prepares to install 6,500 ft of 36" HDPE pipe stringing under Lassen Buttes near Shingletown, CA, for PG&E. Crews used innovative technology to minimize risk to a loved beach during installation in the sensitive area.