Well Blowout in Acheson Alberta
Emergency Response & Environmental Management

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Thomson Hydrogeologic Ltd.
The Well

- Acheson 100/02-26-052-26W4M
- Drilled in 1952 by Imperial Oil
- Completed in the Leduc D-3A Pool
- First brought onto production in 1962
- Slightly sour (225 ppm H₂S)
- ~ 25 m Northeast of 102/02-26 Well
The Location

- Parkland County
  - Agricultural/Rural Residential
- ~ 200 m North of Enoch Cree Nation
- ~ 700 m West of Edmonton City Limit
- Multiple Regulatory Stakeholders
  - Provincial – EUB & AENV
  - Federal – HC
  - Municipal – CHA
- Multiple Community Stakeholders
The Blowout

- Routine Workover
- Pulled tubing out on 11-Dec-2004
- Downhole casing failure occurred during wellhead pressure reading on morning of 12-Dec-2004
- Uncontrolled release of gas and well fluids at surface (primarily salt water)
- ~ 150 joints of tubing fell from rack on leaning service rig derrick into crater eroding around wellhead
Service rig destabilized by fluid flow
Rapidly expanding erosion crater
Well Control

- Surface-kill operations attempted
  - Required wellbore entry through existing surface equipment
  - Efforts to stabilize swaying wellhead on 13-Dec-2005 resulted in unplanned ignition
  - Fire extinguished on 14-Dec-2005
  - Inspection revealed wellhead BOPs too damaged by fire for surface wellbore entry
  - Well purposely re-ignited on 16-Dec-2005
Well Control

- Two relief wells were drilled
- 103/02-26 (northwest) to intercept and mill into the 100/02-26 production casing and allow kill fluids to be pumped into the wellbore
- 104/02-26 (southeast) to drill into the Leduc formation in close proximity to 100/02-26 as a backup to 103/02-26
The relief wells are being drilled for well control:

Conventional - Heavy fluid is circulated down the new well into the reservoir and up the uncontrolled well to stop the hydrocarbon/water flow.

S-Shaped - The well bore is drilled using tools and technology that facilitate the intersection of the relief well with the casing of the existing well. Fluids and chemicals are then injected to stop the flow of hydrocarbons/water from the reservoir.

Location of uncontrolled well is 2-26-52-26 W4M

Ignited

Relief Well #1

Est. size of cavern is 60-70 feet diameter. Depth unknown

250m

Relief Well #2

approx. 1200m

"S" Shaped Trajectory

Penetrates Old Wellbore

Water & Gas

Remaining Oil Bed (Target)

1515m

Leduc/D3A Formation

Perforations

Gas

Water
The well was brought under control on 10-Jan-2005
Peace in the crater
Fluid Control

- Fluids flowing at ~ 100 m³/hour
- Crater restricted access to wellhead
- Fluid control became a priority
- Trenches and pits constructed to divert fluids away from wellhead
AREA MAP
SHOWING
EMERGENCY ZONE
FOR
ACCLAIM 2-26-52-26-W4
WITHIN
L.S. 2 - Sec. 26 - Twp. 52 - Rge. 26 - W. 4!
PARKLAND COUNTY
Track hoes excavating the East Pit
Dozers constructing West Pit
Work continues around the clock
Equipment in the crater required heat shielding
Water was also used to cool equipment.
The main trench leading from the crater
Pumping fluids up to the South Pit
Pumping into South Pit
Bailing became more effective due to suspended solids choking the pumps
The South Pit
Fluid Control

- Fluids filled pits rapidly requiring efficient removal and disposal
  - ~ 150 Vacuum trucks worked 24-hours/day
  - 20 separate disposal wells/caverns used
  - ¾ of the facilities reached processing capacity
  - Total fluid hauling & disposal costs were running at $350,000 - $500,000 per day
Vacuum trucks line up
Pumping out the West Pit
Loading the vacuum trucks
Fluid control

- Once the situation was under control alternative options were investigated
- Centrifugation & Flocculation were tested to reduce suspended solids
  - did not work due to inconsistent feed
- Construction of containment cells at Acheson 04-02-053-26W4M treatment pad using contaminated soil and plastic liners
  - enabled reduction to 15 vacuum trucks and use of Acclaim disposal well
- Cost Saving: ~ $ 10 Million
# Slurry Waste Receiving Facilities

<table>
<thead>
<tr>
<th>Disposal Company</th>
<th># Receiving Locations</th>
<th>Volume m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>MROR</td>
<td>1</td>
<td>676</td>
</tr>
<tr>
<td>Newalta</td>
<td>8</td>
<td>7,589</td>
</tr>
<tr>
<td>CCS</td>
<td>9</td>
<td>16,132</td>
</tr>
<tr>
<td>CNRL</td>
<td>1</td>
<td>1,007</td>
</tr>
<tr>
<td>PDS</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Acclaim - Ponds</td>
<td>1</td>
<td>29,900</td>
</tr>
<tr>
<td>Acclaim – injection well</td>
<td>1</td>
<td>12,679</td>
</tr>
<tr>
<td><strong>Total Volume</strong></td>
<td><strong>22</strong></td>
<td><strong>67,990</strong></td>
</tr>
</tbody>
</table>
Well Abandonment

- Abandonment efforts began once the well had been brought under control.
- The breach in the well casing was much deeper than the base of the crater.
- Excavation was required below the water table in very unstable, saturated silt/sand.
- This was achieved using a well point dewatering system and a custom built shoring box.
- Slopes stabilized
- Casing sleeve installed
- Well casing cut to vertical section
But the casing breach is deeper
Much deeper
Lowering the shoring box
Recovered shards of casing
Well Abandonment

- Partial backfilling of the excavation to enable service rig access
- Dewatering system continued to operate to maintain stability
- ~ 12 m$^3$/hour of water produced for disposal
Environmental Protection

- Air Monitoring
- Release Control (fluid control)
- Groundwater Monitoring
- Contaminated Soil Removal (source removal)
- Groundwater Remediation
Air Monitoring

- Air quality monitoring began on the morning of 12-Dec-2004 using hand-held unit ~ 500 m downwind (H$_2$S & LEL)
- Three mobile monitoring units added
- Eight fixed monitoring units set up
- EUB dispatched two mobile units
- AENV dispatched mobile air monitoring lab
- Highest 1-hour average H$_2$S reading 70 ppb recorded on 15-Dec-2005 downwind ~ 500 m
Mobile air monitoring unit
Static air monitoring unit
Groundwater Monitoring

- Unconfined sand aquifer
  - From just below ground surface to bedrock at ~ 30 m
  - Main source of domestic water for acreage properties and residences on Enoch Cree Nation

- Groundwater
  - 30 domestic water wells tested within 2 km
  - Three monitoring wells installed on site
  - Flow velocity = ~ 15 m/yr
Sodium, Chloride and TDS in Water

Produced Fluid

Groundwater Seeping into Groundwater Collected in Well Point Dewatering

Groundwater Collected in Well Point Dewatering

Water Collected from crater Prior to Backfilling the Excavation

Concentration (mg/L)


Na  Cl  TDS

Groundwater

Produced Fluid

Seeping into

Water Collected from crater Prior to Backfilling the Excavation

ACCLAIM Energy Inc.

SOLSTICE Canada Corp.

Thomson Hydrogeologic Ltd.
Geoprobe Testing the Excavation
Locations of vertical soil conductivity probes
May 2005
- Salinity impacts confined to directly beneath the main well pit
- Impacts extent to ~ 18 m below original ground surface
Depth of impacts coincide with depth of failure of the well casing
Groundwater Management

- No evidence of GW impacts in the domestic wells or the on-site monitoring wells
- Following surface restoration a series of vertical conductivity probes are planned
- Subsequently - Piezometer installation & GW monitoring
- Implementation of GW Remediation Plan: Engineering & Risk Management
Soil Management: Objectives

- Waste Characterization: Source & Piles
  - Field screening
  - Lab confirmation
- Remove impacts from the unsaturated zone
  - Pit area
  - Under stockpiles & traffic areas
- Site Reclamation
Ex-situ Volume = \( \sim 35,000 \ \text{m}^3 \)
Soil Piles – Feb 6/05

Ex-situ Volume = ~55,000 m²
Soil Piles – April 18/05

Ex-situ Volume = ~200,000 m³
Pile Sampling

- 571 samples collected and field screened from ~205,000 m³ of solids
- Each sample represented ~350 m³
- 122 samples submitted for analytical verification
**Field-Lab Correlations: Salinity Data**

<table>
<thead>
<tr>
<th>Correlation coefficients</th>
<th>Field EC</th>
<th>Field Cl</th>
<th>Lab EC</th>
<th>Lab SAR</th>
<th>Lab Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field EC</td>
<td>1.00</td>
<td>0.94</td>
<td>0.92</td>
<td>0.88</td>
<td>0.91</td>
</tr>
<tr>
<td>Field Cl</td>
<td>0.94</td>
<td>1.00</td>
<td>0.98</td>
<td>0.91</td>
<td>0.95</td>
</tr>
<tr>
<td>Lab EC</td>
<td>0.92</td>
<td>0.98</td>
<td>1.00</td>
<td>0.95</td>
<td>0.99</td>
</tr>
<tr>
<td>Lab SAR</td>
<td>0.88</td>
<td>0.91</td>
<td>0.95</td>
<td>1.00</td>
<td>0.94</td>
</tr>
<tr>
<td>Lab Cl</td>
<td>0.91</td>
<td>0.95</td>
<td>0.99</td>
<td>0.94</td>
<td>1.00</td>
</tr>
</tbody>
</table>

- Compared field and lab results for over 400 samples
- Field EC had high correlations with Field Cl, Lab EC, Lab SAR, Lab Cl
- Field Cl had high correlations but problems with readings (silt)
- Field EC is best to predict Lab EC and Lab Cl (especially Cl<5,000 mg/kg)
### Field-Lab Correlations: Hydrocarbon Data

<table>
<thead>
<tr>
<th>Correlation coefficients</th>
<th>Field HCs: PetroFLAG</th>
<th>Field HCs: OVA</th>
<th>Lab HCs: Light HCs</th>
<th>Lab HCs: Heavy HCs</th>
<th>Lab HCs: Total HCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field HCs: PetroFLAG</td>
<td>1.00</td>
<td>0.19</td>
<td>0.47</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Field HCs: OVA</td>
<td>0.19</td>
<td>1.00</td>
<td>0.16</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Lab HCs: Light HCs (BTEX + F1)</td>
<td>0.47</td>
<td>0.16</td>
<td>1.00</td>
<td>0.65</td>
<td>0.66</td>
</tr>
<tr>
<td>Lab HCs: Heavy HCs (F2+F3+F4)</td>
<td>0.60</td>
<td>0.15</td>
<td>0.65</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Lab HCs: Total HCs</td>
<td>0.60</td>
<td>0.15</td>
<td>0.66</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

- Compared field and lab results for over 150 samples
- Prior work: OVA good for light HCs, PetroFLAG good for heavy or total HCs
- Initial results:
  - OVA weak with all,
  - PetroFLAG weak
- OVA <100 ppm: no correlation
- OVA >100 ppm: strong correlation with lighter HCs
Delineating Impacts – Main Pit

Water Table @ ~ 13 m
Excavation = ~3 hectares
East Pit – Closure Samples
Excavation Sampling

- More than 900 samples were collected and field tested from the walls & floors
- More than 300 samples submitted for analytical verification
Geophysics Map – 1.5 m

Acclaim Energy 2-26-52-26-W4 Spill Site - GEM 2 - Bulk Soil Conductivity - 19050 Hz (approx 1.5 m) 29 Jun 2005
UTM Coordinates - WGS84 - UTM Zone 12
Geophysics Map – 5 m
Geophysics Hot Spot for Removal
Soil Management

- Clean/impacted soil handled separately
- Impacted soil - landfilled
- All impacts in the unsaturated zone have been removed from the pit area
- Minor surface impacts identified with geophysics – currently being removed
# Soil Waste Material Balance

<table>
<thead>
<tr>
<th>Waste Source</th>
<th>Type</th>
<th>Volume (m³)</th>
<th>Volume (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-26 Red-zone</td>
<td>Impacted</td>
<td>33,777</td>
<td>50,666</td>
</tr>
<tr>
<td></td>
<td>Geophysics hotspots</td>
<td>11,446</td>
<td>17,168</td>
</tr>
<tr>
<td>2-26 Non-red zone</td>
<td>Impacted</td>
<td>98,511</td>
<td>147,767</td>
</tr>
<tr>
<td></td>
<td>Geophysics Pit Hotspots</td>
<td>2,000</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>Geophysics Surface Impacts</td>
<td>10,350</td>
<td>15,525</td>
</tr>
<tr>
<td><strong>Sub-total: 2-26</strong></td>
<td><strong>Impacted Soil</strong></td>
<td><strong>149,084</strong></td>
<td><strong>223,625</strong></td>
</tr>
<tr>
<td>4-02 Solids</td>
<td>Berms &amp; Sludge</td>
<td>33,323</td>
<td>49,985</td>
</tr>
<tr>
<td></td>
<td>Injection Well</td>
<td>10,284</td>
<td>15,426</td>
</tr>
<tr>
<td><strong>Sub-total: 4-02</strong></td>
<td><strong>Impacted Soil</strong></td>
<td><strong>43,607</strong></td>
<td><strong>65,411</strong></td>
</tr>
<tr>
<td>2-26 Red-zone</td>
<td>Clean</td>
<td>9,494</td>
<td>14,241</td>
</tr>
<tr>
<td>2-26 Non-red zone</td>
<td>Clean</td>
<td>14,967</td>
<td>22,451</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Clean Soil</strong></td>
<td><strong>24,461</strong></td>
<td><strong>36,692</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>224,152</strong></td>
<td><strong>325,727</strong></td>
</tr>
</tbody>
</table>
Soil Management – Residual Impacts

- **Main Pit:** Salinity, F2 hydrocarbon & boron impacts remain in the saturated zone
- **West Pit:** Salinity impacts remain at the base (saturated zone) of the west pit
- **South Pit:** Minor salinity impacts remain in the saturated zone (EC – 3.61 dS/m)
04-02 Pond Remediation
04-02 Slurry Ponds

- Characterization
- Remediation
- Reclamation
4-2-53-26-W4 Oct-18-05 Material ready to haul to landfill.
Questions???