Muskeg River Mine External Tailings Facility

NORTH POOL DEPOSIT PERFORMANCE

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Outline

- Background
- North Deposition History and Results
- Trafficability and Capping
- Summary
Background

- Co-deposition of thickened tailings (TT), coarse sand tailings, and the processed tailings from solvent recovery (TSRU tailings) was used to develop a fines enriched sand and sandy fines deposit within the External Tailings Facility (ETF) at Shell Canada’s Muskeg River Mine (MRM)

- An understanding of the composition, strength and consolidation behaviour of a tailings deposit is necessary both during the operational phase of a deposit and to support closure design

- Characterization and performance monitoring of the NPD provides base line criteria and indicator of future NPD type deposits

- This presentation will summarize the deposition history, performance results to date, and ongoing and future work
Composition Of Tailings Stream Forming North Pool Deposit

- Whole Tailings slurry
  - Water
  - Fines
  - Coarse
  - Whole Tailing
  - Coarse Sand Tailings
  - Sand Deposits
  - Recycle Water
  - Fluid Fine Tailings
  - Thickener Deposit (TT)
  - TSRU Deposit

- PSV
- Froth treatment & solvent recovery
- Diluted Bitumen to Scotford
- Thickeners
- Warm Water Tank
- Recycle water

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Depositional History of North Pool Deposit Isolated Ponds (2003 and 2004)
Depositional History of North Pool Deposit
Cross Dyke Breach (2005 and 2006)
Depositional History of North Pool Deposit Co-disposed Beach (2007 - 2009)
Depositional History of North Pool Deposit Co-disposed Beach (2010 - 2012)
Current North Pool Deposit
2015 Tailings Investigation
Fines Content and Solids Content Distribution

[Diagram showing elevation (masl) with scales and legend for fines content and solids content distribution.]

KEYPLAN
SCALE 1:100,000
Assessment of Strength Development

- A comparison of CPT undrained shear strengths in annually repeated investigation locations shows gradual strength gain
Highlights

Historic Slurry Averages:
- TSRU: Solids content 16 ± 5%, Fines44m 54 ± 8%, Bitumen 5.7 ± 1.2%
- TT: Solids content 29.8 ± 3.3%, Fines44m 34.5 ± 8.2%, Bitumen 1.5 ± 0.5%
- CST: Solids content 48 ± 2%, Fines44m 10 ± 8%, Bitumen 0.5 ± 0.02%

Deposit:
- Coarse CST/WT observed close to CST/WT discharge points
- CST may have caused some compaction of TSRU below the final elevation of the splitter dyke
- Co-deposition of TT and CST and TSRU resulted in a fines enriched and sandy fines deposit
- Average solids content and fines of 70 % and 28% in the NPD deposit
- Average undrained shear strength of BBW is 14kPa and 34kPa for BAW
- Average SC of 73% and SFR of 4.3 within 250 of beach and decreases to 68.5% and SFR 2.3 within 500-1000 m of the beach
- Average SC and SFR from year to year ranged 73% to 67% and 3.2 to 1.8 respectively
Consolidation Analysis

- Ongoing analysis using a zonated approach for further consolidation modelling is being evaluated for landform design and closure design.

- Preliminary zonation developed based on factors such as fines content, solids content, and zones of cell compaction.

Preliminary Zonation
Trafficability and Capping Studies

- Trafficability studies have been conducted in some areas of the NPD for pipeline extensions
- Deposit is trafficable in certain areas of the NPD (BAW)
- Indications are that cap placement is feasible in these areas with equipment of similar bearing pressure
Long Term Activities

- More geotechnical investigation will be done to characterize some areas where more data is required to complete the land form design

- Additional instrumentation and environmental studies will be done as required

- The performance based approach will be used during placement of cap and ongoing settlement will be accommodated as much as practicable
Summary

- Data from depositional history, CPT and sampling were used to develop a broad understanding of the NPD.

- Characterization of the NPD will provide inputs for regulatory reporting, operations support, future deposit optimization, tailings planning, and closure design.

- For closure designs, further consolidation analysis will be done for the zones identified in the deposit.

- Some areas of the NPD is trafficable. More work is ongoing on high fines deposits and other deposits as required.

- More work may be done to include the development of a process which may effectively model the strength of the deposit in a 3-D block model.

- Environmental characterization will be included in future work.
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CLASSIFICATION OF NPD

The diagram illustrates a ternary plot for the classification of NPD (Non-Pipeline Deposits) based on the content of Solids, Water, and Fines. The axes represent the percentage content of each component, with the triangle dividing the space into three regions:

- **Sand Matrix** for regions with high Sand and low Water and Fines.
- **Fines Matrix** for regions with high Fines and low Sand and Water.
- **Water Matrix** for regions with high Water and low Sand and Fines.

Points on the plot indicate the composition of various NPD samples, allowing for a visual assessment of the ratio of Solids, Fines, and Water content.
# Results of 2015 Investigation

## Property | Value
--- | ---
Average Solids Content | 71.1%
Clay-Size Fraction (<2 μm)* | 4.5%
Fines Fraction (<44 μm)* | 28.3%
Average Bitumen Content | 3.6%
Average Water Content | 25.3%
Average Dry Density (kg/m³) | 1,341
Average SFR | 2.5

## Nominal Beach Length

| | 0 m – 250 m | 250 m – 500 m | 500 m – 1000 m |
--- | --- | --- | ---
Average Solids Content | 73.8% | 72.3% | 68.5%
Clay-Size Fraction (<2 μm)* | 2.5% | 3.2% | 4.6%
Fines Fraction (<44 μm)* | 19.0% | 23.4% | 30.6%
Average Bitumen Content | 3.1% | 3.6% | 4.7%
Average Water Content | 23.2% | 24.2% | 26.9%
Average Dry Density (kg/m³) | 1421 | 1379 | 1276
Average SFR | 4.3 | 3.3 | 2.3

## Depositional Period

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Average Solids Content | 73.2% | 69.3% | 68.0% | 67.7%
Clay-Size Fraction (<2 μm)* | 3.5% | 5.65% | 5.91% | 5.54%
Fines Fraction (<44 μm)* | 23.6% | 33.6% | 35.1% | 32.3%
Average Bitumen Content | 3.3% | 4.0% | 4.4% | 4.4%
Average Water Content | 23.5% | 26.6% | 27.6% | 27.9%
Average Dry Density (kg/m³) | 1406 | 1291 | 1257 | 1247
Average SFR | 3.2 | 2.0 | 1.8 | 2.1
Strength Parameters

MRM ETF NORTH POOL DEPOSIT BBW
UNDRAINED SHEAR STRENGTH DISTRIBUTION

Average = 14 kPa
Mode = 1 kPa
Maximum = 111 kPa
MRM ETF NORTH POOL DEPOSIT BAW
UNDRAINED SHEAR STRENGTH DISTRIBUTION

Minimum = 8 kPa
Average = 34 kPa
Mode = 30 kPa
Maximum = 99 kPa