SUNCOR POND 5 COKE CAP
THE STORY OF ITS CONCEPTION, TESTING, AND ADVANCE TO FULL-SCALE CONSTRUCITON

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Abstract

The Pond 5 Tailings Impoundment at the Suncor Energy Oil Sands Mine north of Fort McMurray, Alberta, was turned over to the mine's reclamation department in 2009 for closure. At the beginning of 2010, construction of a pond-wide coke cap, part of the proposed final cover, was begun. In the two years preceding construction of the pond-wide coke cap, the authors undertook extensive laboratory and field trials of a prototype coke cap.

This paper describes the theoretical and practical work done to formulate a viable and safe coke cap—in effect the cap that is now under construction across almost the entire pond.

We describe field testing to characterize the tailings; laboratory testing undertaken to characterize the response of the tailings to planned construction procedure; and two prototype covers constructed in the winters of 2008 and early 2009 to test and confirm theoretical analyses and designs.

1 Introduction

Suncor Energy, Inc. plans to close the Pond 5 tailings impoundment at the Suncor oil sands mine north of Fort McMurray by 2019. This paper describes the design and construction between 2008 and 2010 of a coke cap over the soft tailings; the coke cap will serve as the basal layer of the planned final cover that will include a thick sand layer, soil, vegetation, drainage swales, and a lake. In addition, the coke cap provides access to the surface of the tailings for equipment and

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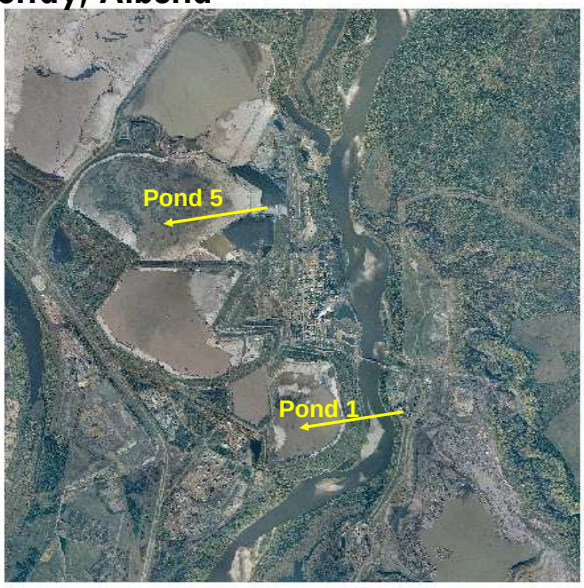
possible installation of wick drains that may be used to promote dewatering and hence consolidation of the tailings.

2 Description of Pond 5

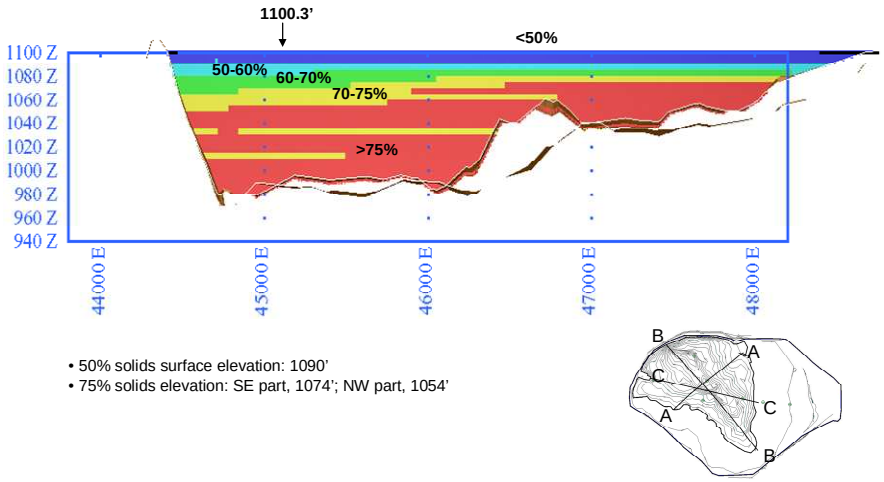
Pond 5 has been in use since the mid 1950s. It is roughly fan-shaped and extends about 3 km north south and about 5 kilometers east west (Figure 1.) The west and north perimeter dikes were constructed of tailings sand to a height of upwards of 100 m to enclose a mined-out open pit.

Figure 1. Suncor Tailings Ponds
Fort McMurray, Alberta



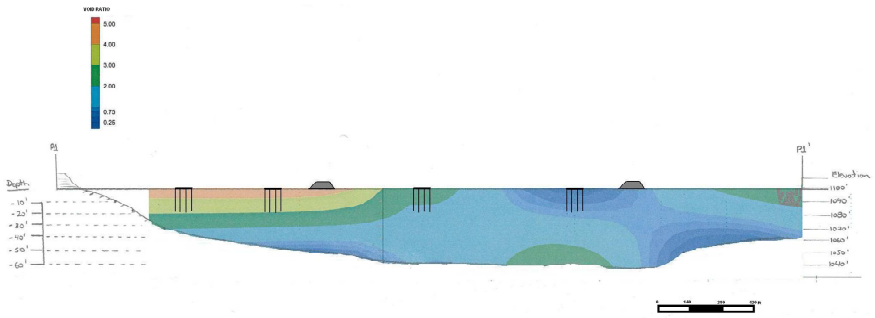
The tailings vary considerably. The upper layer is very soft, low strengths (less than 1 kPa) clayey materials that are still essentially fluid at void ratios of up to five. The strength and sand content increase with depth to the bottom of the pond that is deeper than 50 m. (Figures 2 and 3.)

Figure 2. 2009 Pond 5 Solids Section B



- 50% solids surface elevation: 1090'
- 75% solids elevation: SE part, 1074'; NW part, 1054'

Figure 3. Estimated Pond-wide Void Ratio Distribution



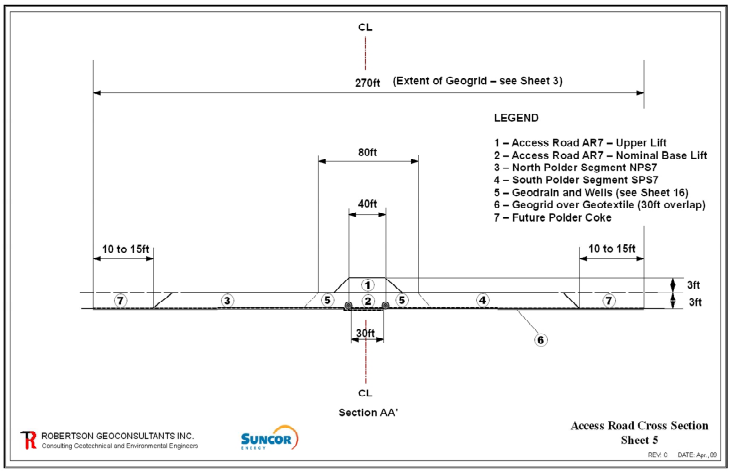
- Preliminary west-east section clearly shows variability of void ratio with both depth and lateral extent across the pond. Section also shows possible wick drain configurations within proposed polders. (Horizontal extent is approx. 5000 ft.)

3 The SAFE Cover

In 2008 and 2009 the authors and many others, recognized at the end of this paper, conceived of what we called the Semi-Anchored, Floating Experimental (SAFE) Cover. We recognized that

there is a large volume of coke available at site and the coke is essentially a waste product. The coke is light and floats on the fluid tailings.

Figure 4. 2008 & 2009 Access Road Section



On the basis of successful covering of uranium mill tailings at Wismut, we decided to construct a prototype cover as follows (Figure 4):

- Pack or remove winter snow to induce freezing of the upper tailings
- Place a geotextile over the frozen tailings which constitutes a safe access surface. Adjacent rolls of geotextile were overlapped.
- Place a geogrids over the geotextile with the long axis of the geogrids perpendicular to the long axis of the geotextile roll and parallel to the short access of the section. Adjacent rolls of geogrid were overlapped.
- Place an initial lift of coke, one-meter thick, using light equipment, primarily SnoCats.
- Place subsequent lifts of coke up to three-meters thick using heavier equipment.
- Along the Access Road thus constructed continue to transport coke using heavy equipment, including Moxies that weight up to 60 tons fully-loaded.

4 Design Analyses

The concept is simple: the coke floats on the upper tailings (essentially at a factor of safety of one) and the coke is held “together” by the basal geosynthetics. One almost needs no more than Archimedes Principle to establish the geometry of the floating mass.

In spite of this simplicity, we undertook extensive FLAC analyses of various sections and differing equipment loads (Figures 5 and 6.) FLAC is a finite element code that enabled us to replicate both the fluid and soil-like response of the tailings to the loading of the coke cap and imposed equipment.

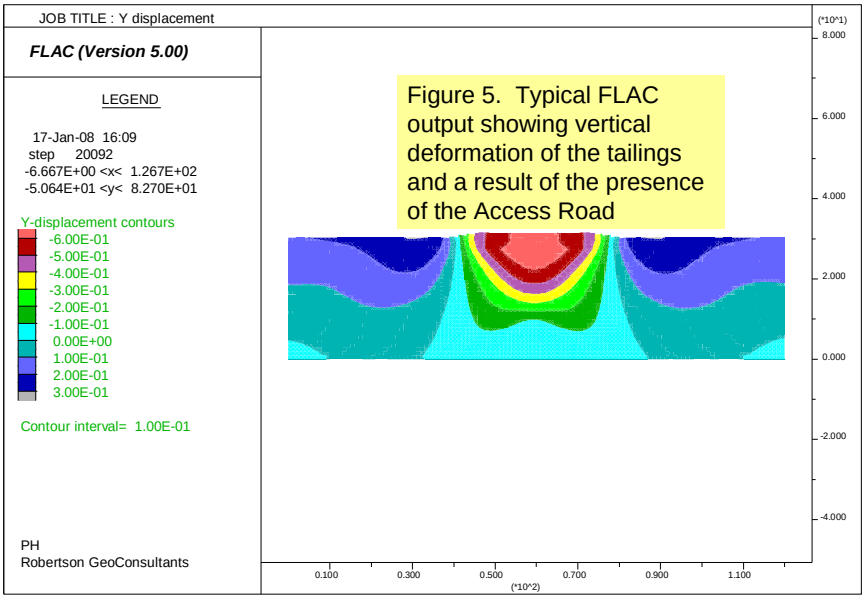


Figure 5. Typical FLAC output showing vertical deformation of the tailings and a result of the presence of the Access Road

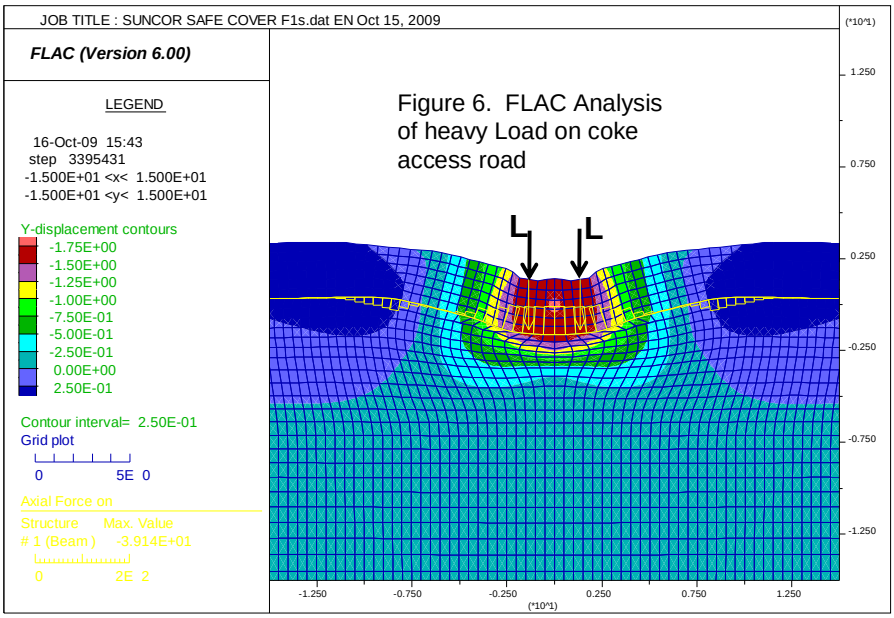


Figure 6. FLAC Analysis of heavy Load on coke access road

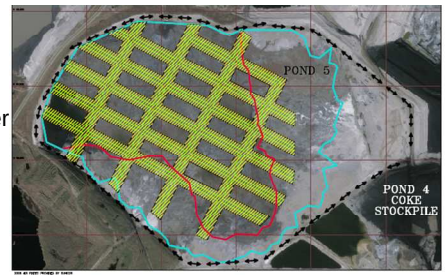
Detail of 'F1s' file (Coke thickness = 3m & geogrid stiffness = 350 kN/m) with vertical displacement contours in meters. (L = 110 kN/m & max tension in grid = 39.1kN/m)

5 2008 & 2009 Construction

In 2008 we constructed a series of coke cap access roads out over beach materials at the south west corner of the pond (Figure 7.) In 2009 we extended a coke cap access road out from the west dike of the Pond and over deep, soft tailings. On the basis of the success of these prototypes, a decision was take to proceed to full-scale construction in the winter of 2010.

Figure 7. 2010 Design Overview

- Construct a network of floating roads across the pond
  - Maximize construction in winter
- Infill the internal areas with conventional approach
  - Late summer (desiccation) or winter
- Leads to trapping as opposed to squeezing the MFT



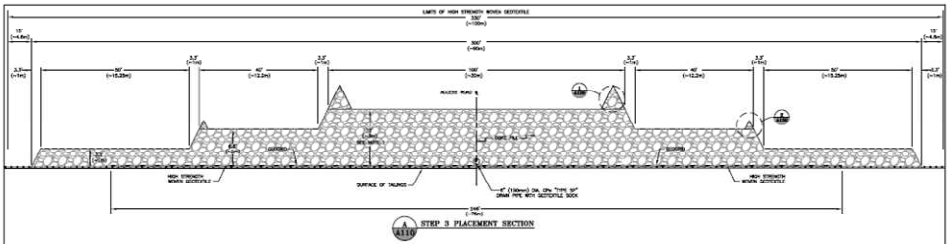
6 2010 Construction

To provide for pond-wide coke delivery, it was decided to construct a series of access roads across the pond (Figure 8). The design of these access roads is essentially as for the access roads of the 2008 and 2009 road, except that a stronger, seamed geotextile was used.

Because the winter was shorter than usual only eleven kilometers of access road was constructed. It is planned to construct the remainder in the winter of 2010 and 2011. Construction proceeded without any incidents.

Figure 8. 2010 Access Road - Cross Section

- High Strength Woven Geotextile on the tailings
  - 100 m wide
  - 4.5 m x 100m long panels seamed perpendicular to road alignment
  - 82.5 kN/m strength including seams
- Biaxial geogrid on the geotextile (75 m wide)
- 3 m of coke, 30 m wide for Articulated Truck traffic
  - Bottom 1 m of coke is 90 m wide. 5 m on each side left for mud wave.
- Drain down the middle of the road with sumps at intersections



Vertically Exaggerated

7 Acknowledgements

We acknowledge Andy Robertson who knew the Wismut covers and had the insight to apply the ideas to Suncor. He supported and encouraged us through all phases.

Peter Byrne, now a retired UBC professor, and Ernie Naesgaard, and independent consultants were there to remind us of the basics of fundamental soil mechanics and to undertake the FLAC analyses.

Gordon McKenna of BGC and Richard Dawson and Erin Olsun of Norwest provided invaluable peer review and new ideas through all phases of work.

AMEC and their staff compiled the 2010 detailed designs and oversaw construction. We cannot note them all, so refer to but two: Gordon Pollack and Ed McRoberts who had the courage to take our small-scale success and turn them into large-scale successes.

None of this would have happened without the Suncor field staff: Neil Jevning and Ivan Decker who managed all construction, Joseph Fournier who looked after things from his office

overlooking the pond, and the managers of the Suncor reclamation group, Bill Tully and Mat Le Blanc, who had to manage us and the large budgets.