COVER SYSTEMS FOR MINE CLOSURE AND REHABILITATION – TWO CASE STUDIES

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INTRODUCTION

The design of a cover system for mine waste must always depend on site-specific conditions. This paper presents two case studies, El Sherana airstrip (ESA) cover, Northern Territory, Australia and Whistle Mine Backfilled Open Pit Cover System, Ontario, Canada, focusing on cover system design criteria, design methodology, and performance monitoring, in the context of the site-specific conditions at these two sites.

CASE 1 − ESA COVER SYSTEM IN SOUTH ALLIGATOR VALLEY, KAKADU NATIONAL PARK, NORTHERN TERRITORY, AUSTRALIA

Uranium mining activities in the South Alligator River Valley area in the Northern Territory of Australia took place as far back as 1953. The overall production from the mines was approximately 1,000 t of U_3O_8. The South Alligator Valley is semi-arid with an average annual rainfall of 1,382 mm/year and average annual potential evaporation (PE) 2,218 mm/year.

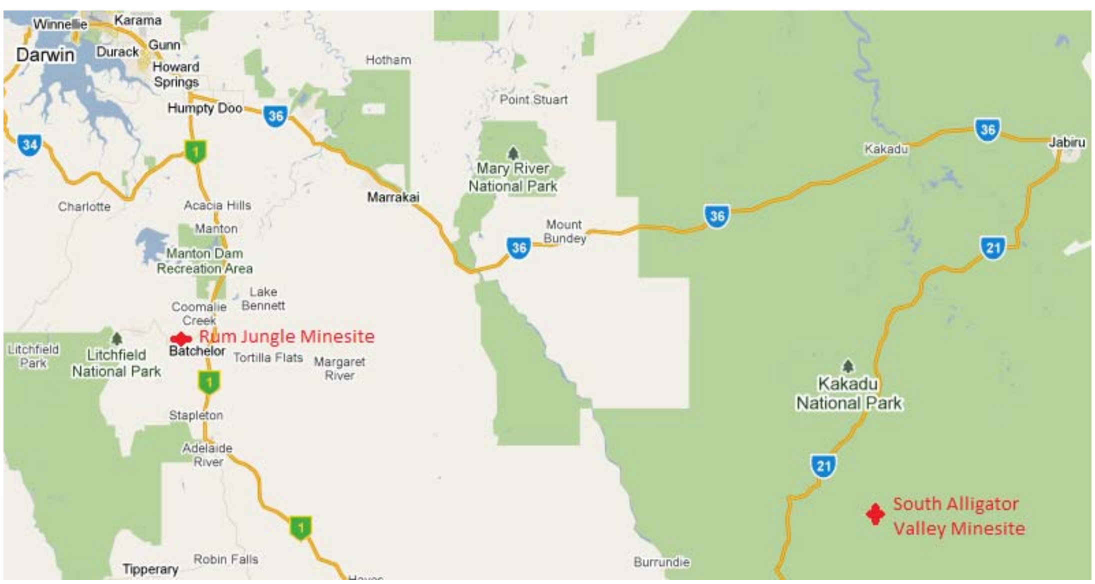

Figure 1: Location of South Alligator Valley minesite.

The overall objective of rehabilitation for this site is to design a containment facility to safely protect radiologically contaminated materials. The containment is to (1) limit ingress of net percolation into the waste from the surface as a primary containment system and (2) limit egress of solutes from the base of the containment as a secondary containment system. The containment facility shall be constructed such that low permeability barriers have a design life of not less than 300 years, and a structural life of not less than 1,000 years.

The cover system and landform stability are the key aspects of the primary containment system design, while solute transport through the containment is the main interest of the secondary containment design. The following tasks were completed:

- Material characterization – Geotechnical, geochemical, and radiometric analyses.
- Landform stability – Two scenarios were considered.
- Cover system - Four cover system alternatives were simulated.
- Containment - The waste is encapsulated by 0.5 m of compacted clay.
- Seepage – Seepage was predicted for 30 years.
- Regional groundwater flow and mass transport - The mass transport model was simulated for 300 years.

The designed cover system incorporated a 0.5 m thick compacted clay layer (CCL) overlain by minimum of two (2) meters growth medium. The base (and sides) of the containment wastes is underlain by another 0.5 m thick CCL (Figure 2).

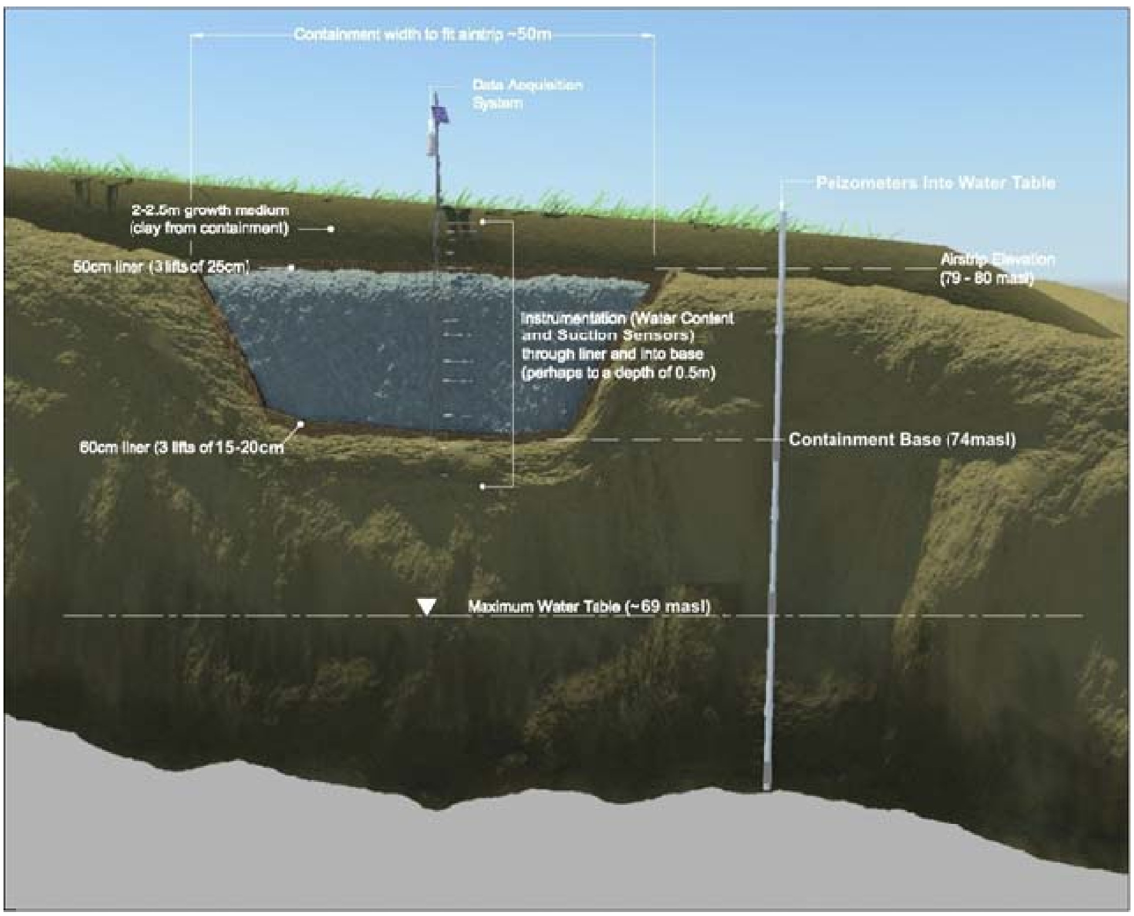

Figure 2: Visualization of a cross-section through the containment facility.

Monitoring and instrumentation of the containment focused on several variables. These were erosion and landform stability, vegetation, cover system water balance monitoring, and leachate monitoring. Instrumentation consisted of three main sensor stations evenly spaced along the long axis of the containment (Figure 3).

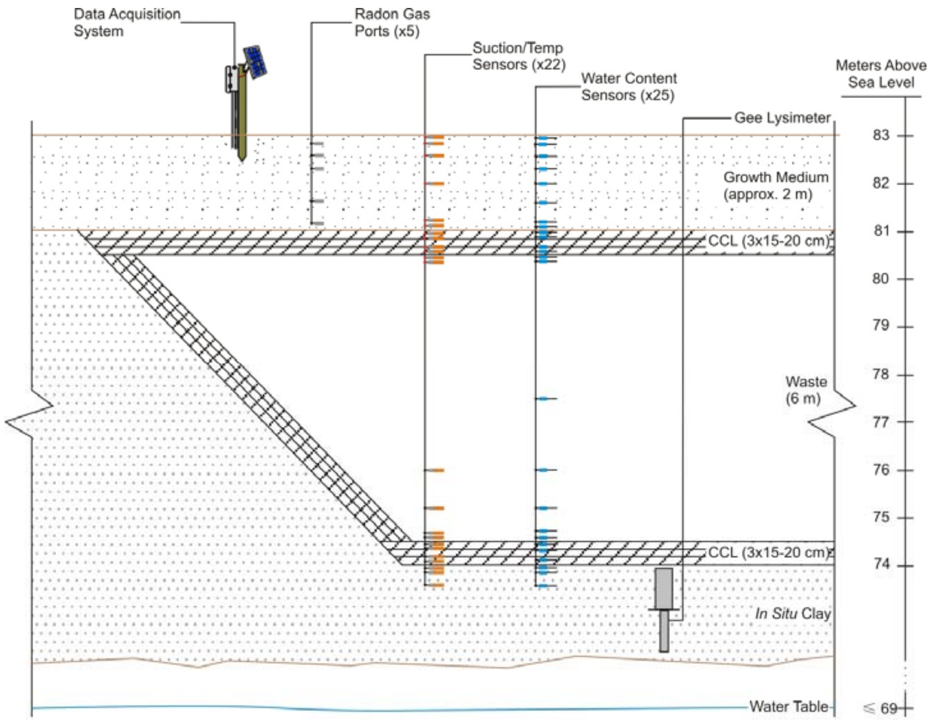

Figure 3: Schematic of one containment sensor station.

CASE 2 - Whistle Mine Backfilled Open Pit Cover System, Ontario, Canada

The Whistle Mine site is located approximately 37 km north of Sudbury, Ontario, Canada (Figure 4). Mining of nickel ore occurred between 1988-1991 and 1994-1998. Approximately 7 million tonnes of waste rock was produced. Whistle Mine site is semi-humid; and the mean annual precipitation and potential evaporation for the region is approximately 870 mm and 520 mm, respectively.

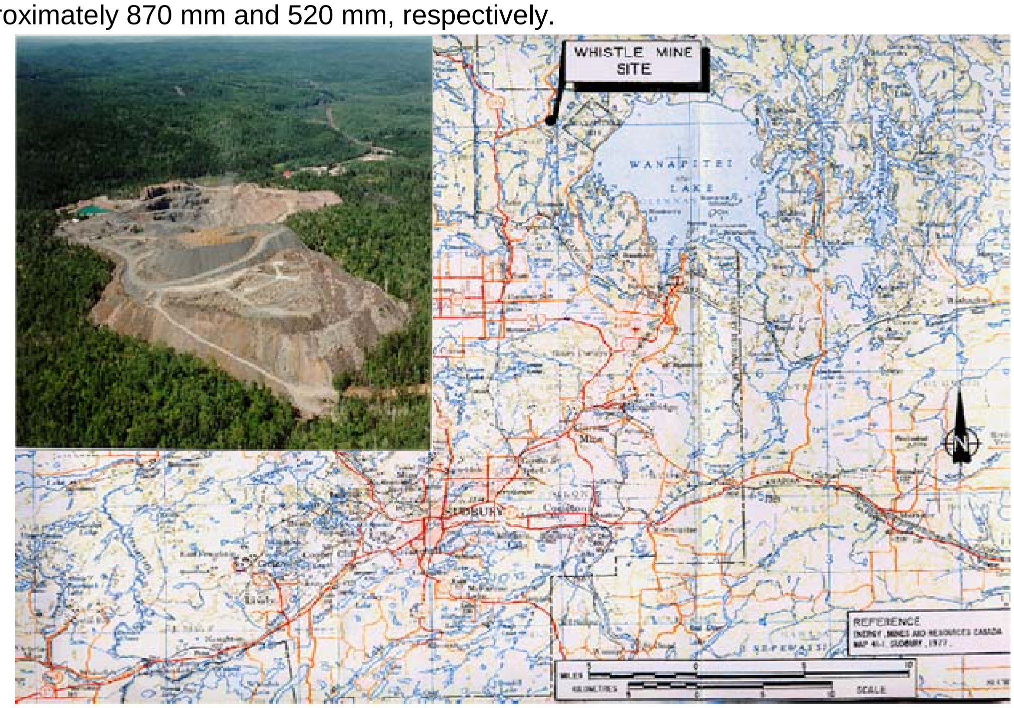

Figure 4: Location of the Whistle Mine site and site plan (after MEND 1997).

The cover design objectives are:

- Reduce O2 ingress to acceptable levels as determined from geochemical modelling;
- Reduce net percolation to less than 5% of annual precipitation; and
- Provide a medium for sustainable vegetation and be resistant to erosion.

The following tasks were completed:

- Determination of the preferred material for the barrier layer;
- Laboratory characterization of the barrier layer and growth medium materials;
- Soil-plant-atmosphere numerical modelling for determination of the minimum cover layer thicknesses;
- Slope stability analyses of the preferred pit cover system;
- Landform evolution and erosion numerical modelling;
- Design of a performance monitoring programme; and
- Consideration of the potential impacts of various physical, chemical and biological processes on sustainable performance.

The designed final landform had three major components; namely, the cover system itself, the surface water management system, and the surface water collection system (Figure 5). The final cover system design consisted of 0.5 m of compacted silty clay overlain by a minimum of 1.2 m of non-compacted granular fill material (pit-run).

Figure 5: Ultimate landform design implemented for the Whistle Mine backfilled pit cover system (from Ayres et al., 2005).

Monitoring instruments were installed during construction of the cover system (Figure 6). Field data being collected included precipitation, oxygen and carbon dioxide pore-gas concentrations above and below the barrier layer, net percolation through the pit cover, runoff, and *in situ* volumetric water content, matric suction and temperature of the cover and upper waste rock materials.

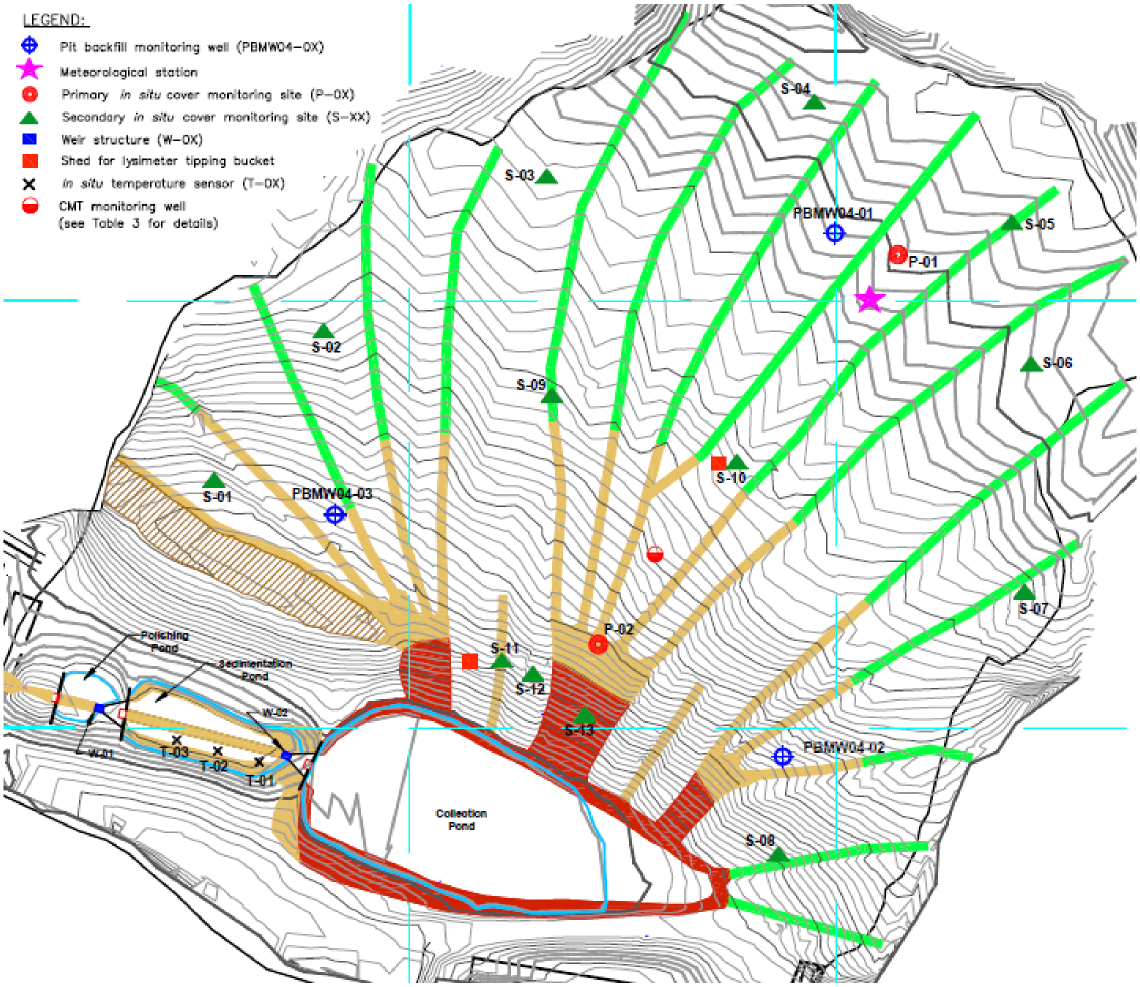

Figure 6: Monitoring plan at Whistle Mine backfilled open pit cover system.

SUMMARY

The presented two cases are located in two different climatic areas. The following experiences were gained:

- Cover system design and performance monitoring should always be on the basis of site-specific conditions.
- The cover material characterization is a key aspect.
- Field test trials are one of the crucial steps.
- The landform design should be based on the long-term (over 100-year) sustainability and is coupled with cover system design.
- A robust thickness of growth medium is important to ensure longevity of cover performance.
- Numerical simulations increase fundamental mechanism understanding, design options, and cover performance predictions, and hence greatly improve the cover design practice.
- The cost of the cover system should be evaluated on the basis of the total life of the cover.

REFERENCES

Ayres, B., Lanteigne, L.; and O'Kane, M., 2005, ‘Design and construction of the backfilled pit cover system at Whistle Mine, Canada: a case study,’ Proceedings of Securing the Future 2005, International Conference on Mining and Environment. Skelleftea, Sweden, June 27-July 1, 2005.

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