WHITEHAVEN COAL

Concept Cover Designs for Waste Storage Facilities at Blackwater Mine

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DOCUMENT AMENDMENT RECORD

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CONTENTS

DOCUMENT AMENDMENT RECORD II
1. INTRODUCTION 1
1.1 Limitation 1
2. COVER MATERIALS 2
2.1 Spoil Properties 2
2.1.1 Tertiary Spoil 2
2.1.2 Unweathered Permian Spoil 3
2.2 Desirable Cover Material Properties 4
3. WASTE MATERIALS 5
3.1 Tailings Characterisation 5
3.1.1 Physical Properties 5
3.1.2 Chemical Properties 6
3.1.3 In Situ Properties 6
3.2 Coarse Rejects Characterisation 7
3.2.1 Physical Properties 7
3.2.2 Chemical Properties 8
3.2.3 In Situ Properties 8
4. CONCEPTUAL COVER DESIGNS 8
4.1 Hazards at Closure 8
4.2 Objectives and Concepts 11
5. NCPP TSF 12
5.1 Description 12
5.2 Surrounding Environment 12
5.3 Cover Design 13
5.3.1 Specific Hazards 13
5.3.2 Cover Concept Design 13
5.3.3 Design Details 14
5.3.4 Construction Methodology 14
6. LALEHAM TSF 15
6.1 Description 15
6.2 Surrounding Environment 16
6.3 Cover Design 16
6.3.1 Specific Hazards 16
6.3.2 Concept Cover Design 17
6.3.3 Design Details 17
6.3.4 Construction Methodology 18
7. R72 WSF 18
7.1 Description 18
7.2 Surrounding Environment 18
7.3 Cover Design 19
7.3.1 Specific Hazards 19

7.3.2 Concept Cover Design 20
7.3.3 Design Details 20
7.3.4 Construction Methodology 20

8. R74 TSF 21
8.1 Description 21
8.2 Surrounding Environment 21
8.3 Cover Design 22
8.3.1 Specific Hazards and Concept Cover Design 22
8.3.2 Design Details 23
8.3.3 Construction Methodology 23

9. BOTTOM DAM TSF & ROM3 AREA WSF 24
9.1 Description 24
9.2 Surrounding Environment 24
9.3 Cover Design 25
9.3.1 Specific Hazards 25
9.3.2 Concept Cover Design 25
9.3.3 Design Details 26
9.3.4 Construction Methodology 26

10. BONNIE DOON TSF 27
10.1 Description 27
10.2 Surrounding Environment 27
10.3 Cover Design 28
10.3.1 Specific Hazards and Concept Cover Design 28
10.3.2 Design Details 28
10.3.3 Construction Methodology 29

11. RAMP 36 REJECTS DUMP 29
11.1 Description 29
11.2 Surrounding Environment 30
11.3 Cover Design 30
11.3.1 Specific Hazards 30
11.3.2 Concept Cover Design 31
11.3.3 Design Details 31
11.3.4 Construction Methodology 31

12. FUTURE WORK 31

13. REFERENCES 32

L I S T O F T A B L E S

Table 4-1: Potential Hazards at Closure..... 10

L I S T O F F I G U R E S

Figure 2-1: Physical Characteristics of Tertiary Spoil 3
Figure 2-2: Geochemical Characteristics of Tertiary Spoil..... 3
Figure 2-3: Physical Characteristics of Fresh Permian Spoil..... 4
Figure 2-4: Geochemical Characteristics of Fresh Permian Spoil 4
Figure 3-1: Particle Size Distribution of Coarse Rejects in the Bowen Basin 7

1. INTRODUCTION

Whitehaven Coal requested Henderson Geotech Pty Ltd to develop conceptual cover designs for Tailings Storage Facilities (TSFs) and coarse rejects areas at Blackwater Mine, in Central Queensland. The cover designs are intended to support preparation of the rehabilitation planning part of the progressive rehabilitation and closure plan (PRC Plan) for the mine.

This report provides an overview of relevant characteristics of potential cover materials (mining spoil) and waste materials (tailings and coarse rejects). It then describes the existing waste emplacements and potential hazards after mining, leading to objectives for earthen covers. Finally cover designs proposed to meet those rehabilitation objectives for the following facilities:

- NCPP TSF;
- Bonnie Doon TSF;
- Laleham TSF;
- Ramp 72 WSF (tailings and coarse rejects);
- Ramp 74 TSF;
- Bottom Dam TSF and ROM3 Rejects Area WSF; and
- Ramp 36 WSF.

Note that the cover designs have been developed based on material characteristics and accepted practice as understood at the time of preparing this report (August 2024). Before cover construction commences, detailed cover designs will be developed that will use the latest information and data available for each specific facility.

1.1 Limitation

This report has been prepared by Henderson Geotech Pty Ltd for Whitehaven (Client) for the purpose of supporting the Progressive Rehabilitation and Closure Plan for Blackwater Mine. No parties other than the Client and the Department of Environment, Science and Innovation are authorised to rely on this report without the prior written consent of Henderson Geotech Pty Ltd.

This report is, in part, based on information provided by the Client or by other parties on behalf of the Client (Client-supplied information) in addition to data collected by Henderson Geotech Pty Ltd from the public domain. Henderson Geotech Pty Ltd has not always verified the accuracy of such information and makes no representations regarding its accuracy. Henderson Geotech Pty Ltd is not responsible for the consequences of any error or omission in Client-supplied information.

Henderson Geotech Pty Ltd has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same specialist field for projects of a similar nature and at the time and in the jurisdiction where the services were rendered. Henderson Geotech Pty Ltd makes no warranty, express or implied.

The conceptual cover designs described in this report do not have the level of analysis required for detailed design and are applicable only to the scenarios and inputs also described herein. A new concept design will be required for the particular waste storage facility if there are changes to:

- Final landform geometry;
- Post-mining land use, especially a change requiring different vegetation;
- The approach to surface water management on the relevant final landforms (i.e. free-draining or ponding); or
- The understanding of end-of-mining and long-term groundwater levels in the vicinity of in-pit TSFs.

2. COVER MATERIALS

Spoil at Blackwater Mine is produced by the excavation of sedimentary strata overlying and between coal seams within the Rangal Coal Measures and broadly comprises:

- Unconsolidated and poorly consolidated sediments – small proportions of sandy Quaternary alluvium, usually mixed with Tertiary gravelly, sandy and silty clays.
- Weathered Permian –sand-silt clay mixtures with similar characteristics to Tertiary.
- Fresh Permian – spoil derived from predominantly fine to medium grained sandstone is typically clayey sandy gravel. Overburden/interburden with a higher proportion of siltstone/mudstone produces spoil trending toward gravelly clayey sand; some of the gravel fragments may break down over time.

2.1 Spoil Properties

2.1.1 Tertiary Spoil

Regionally, Quaternary alluvium is generally very shallow and limited to creek floodplains. Consequently, it is rarely excavated as a discrete stratum but is instead combined with Tertiary spoil. At pit and mine scale, the proportion of Quaternary alluvium is rarely sufficient to affect spoil properties.

Figure 2-1 summarises grading and index properties of Tertiary spoil from test results reported for Blackwater and various other mines across the Bowen Basin. It shows that the material is ‘typically’ sandy or silty clay with minor gravel; however, the size grading of individual samples varies over a wide range. The small number of Blackwater samples were typical of the norm and did not include any results with higher proportions of sand or gravel. Experience is that gravel fragments – being weathered rock – often break down with moisture and handling. Basic geochemical properties are summarised in Figure 2-2: using the categories in Hazelton & Murphy (2007), Tertiary spoil is typically moderately to strongly alkaline, moderately to highly saline, strongly sodic, and potentially dispersive. Once again, a proportion of results were well outside the main cluster. The samples from Blackwater Mine trended toward the high side of the distributions for alkalinity and salinity.

Physical and geochemical properties of weathered Permian spoil are usually similar to those of Tertiary spoil. Hence, the two materials are often not differentiated in spoil management practice.

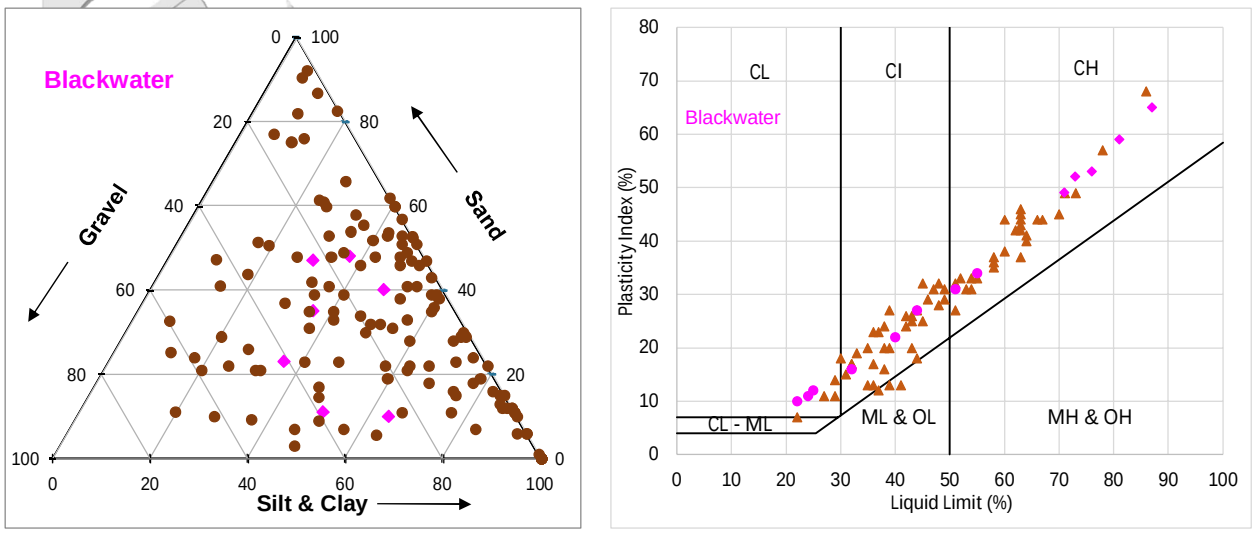


Figure 2-1: Physical Characteristics of Tertiary Spoil

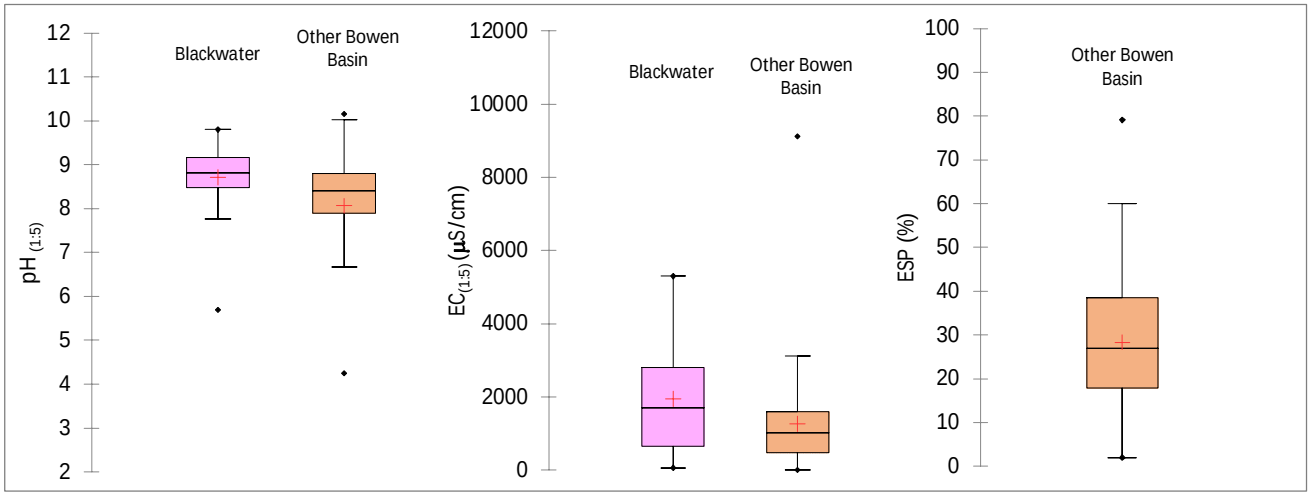


Figure 2-2: Geochemical Characteristics of Tertiary Spoil

2.1.2 Unweathered Permian Spoil

In a similar manner, Figure 2-3 summarises grading and index properties of spoil from fresh Permian overburden/interburden at Blackwater Mine and in the Bowen Basin generally. In contrast to Tertiary spoil, gravel is generally the major size fraction in fresh Permian spoil; however, the limited results available from Blackwater suggest a higher proportion of silt and clay than is typical of the Bowen Basin. Geotechnically, the spoil would be Category 2 (Simmons & McManus, 2004), that is, 'matrix supported'. Note also that the fines do not exhibit high plasticity, both at Blackwater Mine and throughout the Bowen Basin.

Geochemically, fresh Permian spoil ranges from mildly to-strongly alkaline, is variable with regard to salinity and sodicity, and is potentially dispersive (Figure 2-4). If the small number of Blackwater samples are typical of Permian spoil at the mine, it will tend toward the low end for salinity and sodicity.

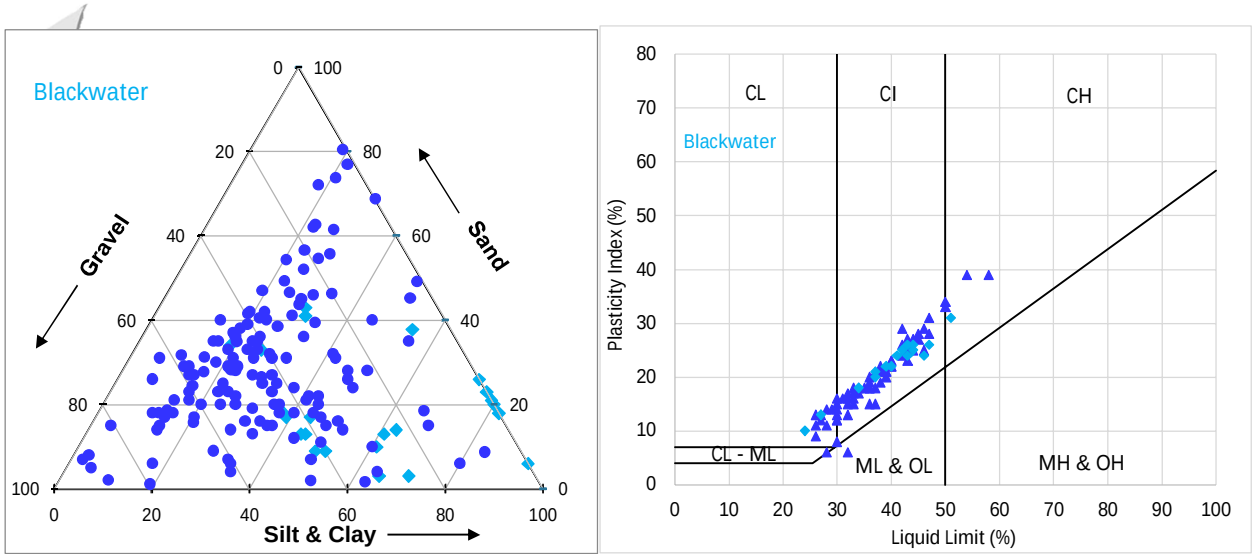


Figure 2-3: Physical Characteristics of Fresh Permian Spoil

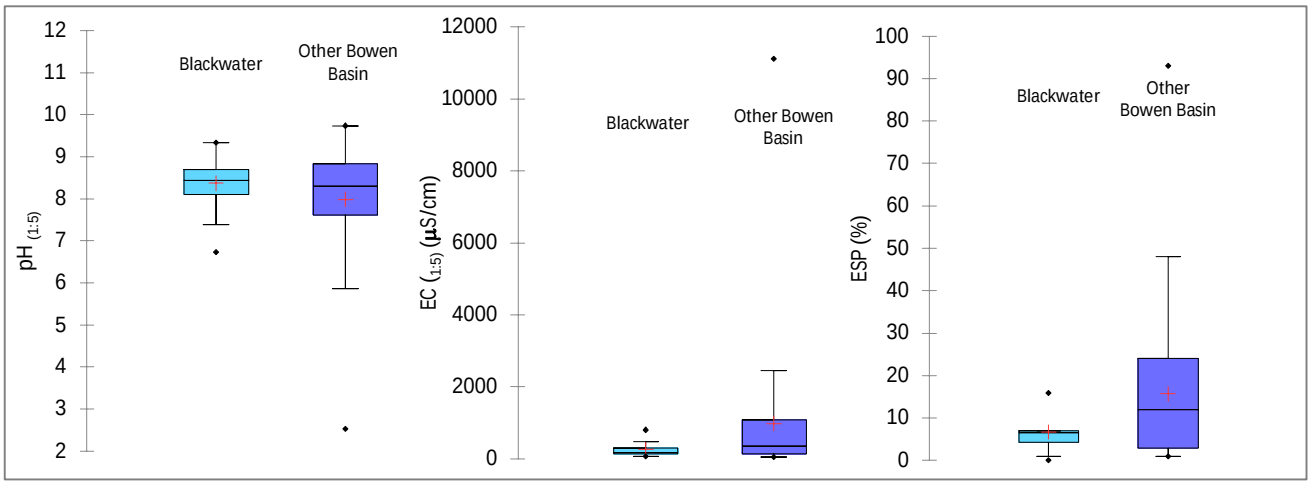


Figure 2-4: Geochemical Characteristics of Fresh Permian Spoil

2.2 Desirable Cover Material Properties

A cover system over chemically hostile material will ideally

- Allow shallow rainfall infiltration to support vegetation and reduce erosion from runoff;
- Not allow infiltration to seep down to the hostile material;
- Not allow solute from the hostile material to flow upward into the root zone or into surface waters;
- Decrease oxygen penetration to restrict acid generation reactions, if there is significant net Potential Acid Generation.

These criteria impose conflicting requirements on cover materials: high permeability allows initial infiltration but low permeability limits deeper seepage; greater clay content reduces permeability but lower clay content reduces matric (capillary) water suction potential. For example, clay-rich spoil from Tertiary and weathered Permian overburden/interburden could be placed to achieve

low permeability but doing so would increase its tendency to allow upward water movement due to capillary action (matric suction potential). Conversely, gravelly spoil would have less tendency to promote upward water movement but might be too permeable to prevent deep infiltration into the tailings.

Water is the most effective barrier to oxygen penetration – either as a permanent water cover or, more commonly, filling pore spaces in the cover material and in tailings themselves. This again presents a conflict in the tailings: maintaining saturation would decrease oxygen movement but dewatering promotes strength gain. In the cover, a higher clay content generally leads to greater water-holding capacity and therefore a higher degree of saturation (water in the pore spaces).

The outcome of this is that a multi-layer cover system is often required, with different spoil types placed to utilise the desirable properties of each and to balance the conflicting requirements. An alternative would be a thick cover of undifferentiated spoil, with the depth of material compensating for poorer cover properties.

Based on geologic boundaries along the planned final highwalls, the thickness of Tertiary/weathered overburden ranges from about 15m to 60m. The 40km of pit length in the middle of the mine will be more than 120m deep. On these bases, and allowing for bulking, future mining of a strip 60m wide will produce more than 1Mm^3 of Tertiary/weathered spoil and 10Mm^3 of fresh Permian spoil per kilometre of length. 1Mm^3 would provide 2m depth of cover over 50Ha of CHPP waste. Consequently, the quantities of both weathered and unweathered spoil available will be easily sufficient to allow selection of suitable materials.

3. WASTE MATERIALS

3.1 Tailings Characterisation

3.1.1 Physical Properties

WSP (2023) presents grading and plasticity index test results for tailings samples from Blackwater Mine. Based on those data, in accordance with AS 1726:2017 (Standards Australia Limited, 2017), the tailings are generally classified as low liquid limit Sandy SILT (ML) and intermediate plasticity Sandy CLAY (CI). A larger private database of results confirmed these descriptions and provided further information, specifically, tailings from NCPP TSF (the historic Blackwater operation) tended to contain more sand while tailings from the old South Blackwater operation contained more silt. However, both fall within the size range encountered across the Bowen Basin and are expected to behave cohesively (like intermediate plasticity clay).

Median solid particle density of samples from NCPP TSF was 1.7 t/m^3, with 80% of results falling tin the range from 1.5 t/m^3 to 2.4 t/m^3. By contrast the median for samples from the southern CHPP was 1.6 t/m^3 and the eighty percentile range was 1.4 t/m^3 to 1.7 t/m^3. Considering the different soil particle densities of coal (~1.4t/m^3) and general overburden (~2.6t/m^3), this suggests that the tailings vary from essentially all coal to no coal. The lower particle densities in the southern TSFs probably reflect the particular configuration of the CHPP that produced them.

Oedometer consolidation tests were reported for five samples, with the following median parameter values:

- Compression Index C_c = *0.14*

- Recompression Index C_r = *0.02*
- Coefficient of permeability k_{sat} = *2e-9 m/s*
- Coefficient of consolidation c_v = *60m²/yr*, but varied over a wide range

These values are close to the median of collated results measured for coal tailings in the Bowen Basin.

3.1.2 Chemical Properties

Geochemical characterisation studies for two TSFs and the NCPP at Blackwater Mine (Terrenus Earth Sciences, 2024) found that half of the tailings (current and historic) have moderate to high potential to generate AMD when they are able to oxidise. The other half of the samples analysed had relatively low potential to generate AMD. Historically, low pH in CHPP waters was an issue for the old South Blackwater Mine operations.

Fresh tailings were assessed as generally slightly saline, while aged tailings were generally slightly to moderately saline. The difference may be partly due to sulphide having oxidised to sulphate in the aged tailings, but might also reflect geochemical differences in the coal, roof and floor being mined at particular times.

3.1.3 In Situ Properties

In the context of rehabilitation, the most important physical properties of tailings are: strength profiles, which constrain safe placement of capping; and moisture-density profiles, which – in combination with consolidation properties - dictate how much water is squeezed out during consolidation, the consequent vertical settlement, and the timeframe over which that consolidation occurs (The Minserve Group et al, 2003).

Tailings has minimal shear strength when initially discharged (being fluid) and strength is only gained over time as the deposit dewaters, densifies, and develops a drier surface crust. WSP (2023) includes plots from a large number of Cone Penetrometer Tests (CPTs) on NCPP TSF that measure in situ strength based on the resistance to pushing a cone-tipped instrument vertically into the tailings. Only five of the tests were located more than 100m from the walls and many were pushed through a wall lift into the underlying tailings. Where the tailings surface was exposed, the drier (and stronger) crust was typically 1-2m thick, below which the tailings were variable but typically of soft or firm-stiff consistency.

The same report presents 16 CPT plots from Laleham TSF, again with most located close to the edge of the storage area. Existing spoil cover and crusted or consolidated tailings ranged from about 2-9m thick and there were thick layers of soft tailings at depth. Only three CPTs are included for R72 TSF. Two tests in the pit indicated a 3-4m thick desiccated crest with soft-firm tailings below, while the single test in the ramp section (the historic decant pond) showed <1m thick crust over very soft tailings. EDG (2024) presents 7 CPTs for Bottom Dam TSF. The crust depth in these ranged from 1-3m and the underlying tailings were generally of soft consistency but sometimes soft-firm.

It is understood that no strength profiling has yet been undertaken on R74 TSF. Bonnie Doon TSF is still active and profiling will be undertaken after tailings deposition has ceased and the fine waste has had some time to dewater and consolidate.

It is emphasised that strength in TSFs varies with location, depth, and time. As a consequence, testing carried out significantly in advance of cover construction may be useful for planning purposes, but detailed cover design should be based on testing undertaken closer to the start of cover construction. Even then, considering the inevitable variability throughout the emplaced tailings, the construction methodology and schedule should be adaptable to actual conditions encountered.

3.2 Coarse Rejects Characterisation

3.2.1 Physical Properties

Historic size grading data collated from mines in the Bowen Basin and summarised on Figure 3-1 indicates a composition ranging from *GRAVEL with sand* to *Sandy GRAVEL* (Standards Australia Limited, 2017). Current NCPP waste handled as rejects comprises about 80% from the Coarse Circuit that treats the 50mm to 1.4mm size range. The remainder is from the Fine Circuit and is in the 1.4mm to 0.25mm size range. Rejects comprise about 75% of waste produced by NCPP (tailings are produced from the ultra-fine circuit). Noting that gravel is >2.36mm and sand is 2.36mm to 0.075mm, these ranges confirm that coarse rejects currently produced are consistent with the collated historic data.

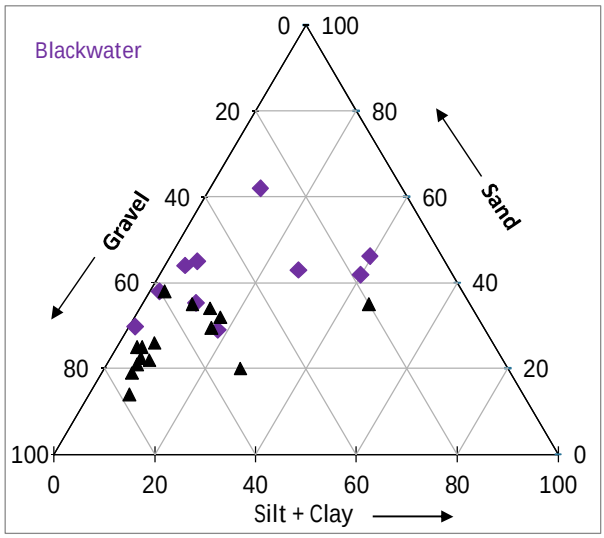


Figure 3-1: Particle Size Distribution of Coarse Rejects in the Bowen Basin

The classification of Sandy GRAVEL is also consistent with field observation that coarse rejects are a non-cohesive non-plastic material exhibiting frictional strength and high permeability.

In coarse rejects, solids particle density (specific gravity) varies with the ratio of fresh Permian spoil (from seam roof and floor) to coal. For example, 20% coal would produce an average solids particle density of about 2.4t/m^3 whereas 40% coal would produce an average of about 2.1t/m^3.

As an unsaturated non-cohesive material, coarse rejects will not experience consolidation settlement overtime. Some settlement is expected as the cover is constructed and imposes vertical load on the rejects and there may be further settlement due to moisture adjustment and particle breakage, but significant movement after the first few years is unlikely.

3.2.2 Chemical Properties

A geochemical characterisation study found that slightly less than half of the coarse rejects sampled at Blackwater Mine have moderate to high potential to generate AMD while the remainder had low to low-moderate potential to generate AMD (Terrenus Earth Sciences, 2024).

Samples of fresh coarse rejects were found to be generally non-saline, whereas aged rejects ranged from non-saline to moderately saline. Based on total sulphur concentration, the potential for saline drainage from sulphide oxidation was assessed as low to low-moderate.

3.2.3 In Situ Properties

The gravelly character of coarse rejects makes them difficult to test appropriately in situ. Five samples from the NCPP tested in 1974, gave a median dry density of 1.3t/m^3. Seventeen laboratory shear test results collated from mines in the Bowen Basin gave a median friction angle of 34° with three-quarters of the results within the range of 28° to 30°.

Because the waste is free draining (highly permeable) and not subject to consolidation settlement, density-moisture profiles are not important for rehabilitation design.

4. CONCEPTUAL COVER DESIGNS

4.1 Hazards at Closure

The Minserve Group (2003) identified potential hazards that may need to be addressed in tailings dam closure. The drivers and controls for these hazards are summarized in Table 4-1. Because Ramp 72, Ramp 36 WSF and ROM 3 Rejects Area also contain coarse rejects, the hazards have been re-phrased for ‘waste’ rather than only tailings, although the hazards relating to strength and consolidation will rarely apply to coarse rejects. As foreshadowed in Section 2.2, some hazard control objectives can impose conflicting requirements on cover systems, with complex interactions. These are discussed in the following paragraphs.

A cover constructed over the tailings at closure may have conflicting effects on seepage hazards (a & b): cessation of tailings discharge and removal of the decant pond both reduce seepage; but the weight of cover layers could temporarily increase pore water pressures in the tailings and consequently increase seepage; and rainfall infiltration through the landform into the tailings and coarse rejects could provide water to continue seepage. The weight effect will decrease over time as excess pore pressure equilibrates, but the cover system should aim to minimise recharge of tailings moisture from deep infiltration. Restricting recharge in this way will control seepage in the long term; however, measures separate from cover system design – for example, cut-off or collection trenches – may also be required over the initial period post-mining.

Acid drainage and/or neutral metalliferous drainage and moderate salinity are the geochemical hazards associated with tailings at Blackwater Mine (refer Section 3.1.2). Acidity and salinity can both have adverse effects on vegetation and consequent metal elevation might have impacts on the higher food chain. Oxygen is required for the chemical reactions that produce acid; to a large extent, oxygen cannot penetrate into water-saturated tailings and consequently, tailings with a degree of saturation greater than about 85% are not expected to produce acid drainage regardless of their acid generating capacity. The unsaturated surface layer of tailings already

contains oxygen for the reactions to proceed – in fact, those tailings have usually already oxidized to some extent before the cover is placed. A saturated layer within the cover system would limit ingress of further oxygen but in practice such a layer would be difficult to sustain in the drought-susceptible central Queensland climate. Furthermore, limiting oxygen penetration would not reduce the hazard from salinity. Given this context, adverse effects on vegetation could occur if water from the tailings flowed upward through the cover or seeped out of the walls or base.

The mechanisms that might drive upward flow against gravity are: soil suction (e.g. capillary action) drawing moisture from more saturated to less saturated layers; and consolidation settlement pushing water upwards out of the matrix of tailings solids. To mitigate the hazards to vegetation (d & e), the cover system should be designed to provide a barrier between solutes in the tailings and the topsoil and subsoil layers.

Consolidation settlement (hazard g) occurs when the loads on saturated tailings cause excess pore water pressures and water flows out of the material to reduce those pore pressures until equilibrium is achieved. The amount of settlement varies with depth and water content of the tailings and with height of overlying landform; consequently, settlement is unlikely to be constant over the TSF. All else being equal, a thinner cover would produce less settlement itself, but there is often a component of ongoing consolidation in the lower tailings due to the overlying tailings, and other hazard control objectives that are not served by minimising cover thickness. In addition, in the long term, greater consolidation has beneficial effects, including that it increases tailings strength to better support surface loads, it reduces the tendency to liquefaction, and it may cause upward flow of pore water that will re-saturate some of the near-surface tailings and thus limit future acid generation. In summary, the cover system needs to accommodate consolidation settlement but should not (and generally cannot) aim to avoid it.

Table 4-1: Potential Hazards at Closure

	Hazard	Source	Receptor	Cover System Controls
a	Contaminants seeping to groundwater	Waste has soluble contaminants that may leach at elevated concentrations AND TSF has permeable layers below base	There is a groundwater resource within the seepage path	Conflicting and complex effects, refer accompanying discussion
b	Contaminants seeping to surface water	Waste has soluble contaminants that may leach at elevated concentrations AND TSF has permeable layers in base	The seepage path daylights at ground surface	Conflicting and complex effects, refer accompanying discussion
c	Contaminants spilling to surface water	Waste has soluble contaminants that may leach at elevated concentrations AND Water can pond at surface	There is a watercourse within the overflow path	Shape landform to shed water OR Shape landform to maintain a permanent water cover without overflow
d	Contaminants affecting vegetation	Waste has soluble contaminants that may leach at elevated concentrations	Vegetation that is sensitive to the contaminants will grow on or near the facility	Complex effects, refer accompanying discussion
e	Contaminants entering food chain	Waste has soluble contaminants that bio-accumulate that may leach at elevated concentrations	Stock or native fauna will regularly eat affected vegetation	Complex effects, refer accompanying discussion
f	Interference with natural surface drainage	The facility significantly alters surface topography	There is a watercourse whose flow regime is significantly altered	Cover system cannot mitigate this; it must be addressed by landform/landscape design
g	Consolidation settlement affecting landform surface drainage	At least part of the waste is saturated and will compress under the weight of overlying tailings and cover	Surface drainage is sensitive to changes in ground slopes and gradients	Conflicting and complex effects, refer accompanying discussion
h	Minor release of waste solids due to erosion	Waste is erodible	Surrounding land or watercourses would be adversely affected by ongoing small amounts of waste	Any intact physical cover will prevent this
i	Major release of waste solids due to embankment failure	At least part of the waste has insufficient shear strength to hold a stable landform without embankment support	Surrounding land or watercourses would be adversely affected by a large amount of waste	Cover system cannot significantly mitigate this; it must be addressed by long-term embankment/ landform design
j	Combustion of waste	At least part of the waste is unsaturated and contains sufficient coal to burn	Surrounding vegetation could be ignited by burning waste OR Air quality is a significant value in the surrounding environment	Any intact physical cover thicker than about 0.1m will prevent this
k	Dust generation	Waste at the surface is unsaturated and includes fine particles	Air quality is a significant value in the surrounding environment	Any intact physical cover will prevent this
l	Equipment bogging in, or sinking into, waste[1]	Waste profile has low strength	Land use requires equipment or infrastructure to be on the landform	Design cover system to support and spread surface loads associated with land use

[11] This hazard was not identified in The Minserve Group (2003)

4.2 Objectives and Concepts

The hazard control measures arrived at in the preceding section essentially reflect the ideal cover material characteristics outlined in Section 2.2 with additional requirements related to load bearing capacity and consolidation. Paraphrasing those requirements, the key objectives of the covers for TSFs at Blackwater Mine are:

- To allow shallow infiltration but minimise recharge of tailings moisture from deep infiltration of rainfall;
- To avoid upward movement of solutes from tailings into the vegetation rooting zone;
- To support and spread pressures from anticipated surface loads enough that the bearing capacity of the tailings is not exceeded; and
- To accommodate long-term consolidation settlement in the tailings, such that the first two objectives and surface erosional stability are not compromised.

On mounded landforms that do not pond water, these objectives can potentially be achieved by two conceptual earth cover configurations, namely:

- A multi-layer cover comprising (from tailings to surface):
    - *Porous, low clay content material placed directly over the waste to limit upward flow;*
    - *A layer of lower permeability material finished with a mounded top surface so that any seepage that does reach it will tend to move laterally rather than downward; and*
    - *Uncompacted subsoil and topsoil shaped to a gently mounded surface, to allow shallow infiltration during rainfall but no surface ponding that would drive deeper seepage.*
- A single cover layer of Category 2 or Category 2-3 spoil (connected matrix of fine-grained material), loose placed but thick enough to perform the required functions without specifically differentiated permeability and matric suction properties.

In situations where it is not practical to construct a mounded cover that will not pond water, the cover will require a different design approach depending on whether the surface pond is ephemeral or permanent.

For ephemeral surface water:

- A multi-layer cover with an engineered very low permeability layer comprising (from base of cover to surface):
    - *Porous, low clay content material placed directly over the waste to limit upward flow;*
    - *A thin compacted clay layer to minimise downward flow;*
    - *A layer of medium- or coarse-grained spoil (*Simmons & McManus, 2004 Category 2-3, 3 or 4) to protect the clay layer from drying and physical damage, and to limit entrapment of fauna.

For permanent surface water:

- The water itself will be the cover, justified by the findings of Senes Consultants (2002) that shallow water covers are effective at greatly reducing the rates of sulphide oxidation, and therefore controlling the consequent production of mobile contaminants. In central Queensland, this type of cover may be appropriate for in-pit TSFs where a permanent pit lake can establish over the tailings, but several other specific constraints would also need to be met.

The choice of cover system for each TSF depends on the specific situation and hazards, availability of cover materials, and vision for landform and land use, as described in following reports sections.

5. NCPP TSF

5.1 Description

NCPP is an active aboveground (turkey's nest) TSF located at the west and south-west of the CHPP and rail loop, and bounded by a minor public road at the north-west.

The original tailings dam commenced in 1970 and comprised a single earthfill embankment across a northern tributary of Deep Creek. The facility has been raised and extended in various stages since then, with downstream and upstream wall lifts constructed of earthfill and, in recent decades, mainly coarse rejects. A final small raise was constructed in 2022 and routine tailings deposition ceased in 2023. There is a small emergency storage capacity remaining.

The TSF is 1.4km north-south and 1.7km east-west, with a footprint, of about 198Ha. Depth of tailings ranges up to 32m. The deposited tailings beach down to a decant pond inside the southern wall of the dam.

5.2 Surrounding Environment

At the northern side, the toe of the TSF is less than 40m from the rail loop. The CHPP is east of that, about 600m from the TSF, but part of the associated industrial area is closer. The north-western wall runs about 40m from a minor public road outside the lease boundary, with a rail line west of the road. Natural ground falls broadly from west to east, such that the TSF is upslope of the CHPP and associated buildings. The tributary of Deep Creek was diverted about 300m south of NCPP TSF, then the creek channel flows north to within about 60m of the eastern wall toe before flowing eastward through a culvert under the main mine haul road. Prior to mining and outside the area of mine disturbance, the dominant land use has been low intensity grazing, except in Amaroo State Forest more than 1.5km west and south-west of the TSF. Regulated vegetation (endangered regional ecosystem comprising acacia dominated open forest, woodland or shrublands) is mapped to the south-west of the TSF; regulated vegetation (riverine) is mapped along Deep Creek.

The final landform design for NCPP TSF is a stand-alone elevated landform surrounded by undisturbed and rehabilitated land at essentially pre-mining elevation. Deep Creek is a watercourse defined by the Water Act 2000.

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian Rangal Coal Measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). That report also included flow path simulations to assess the movement of water particles within the groundwater system post-mining. However, the particles were positioned at mid-depth in the highest saturated aquifer at the start of the simulation. That is, the simulation indicated to fate of water from a surface storage, such as NCPP TSF, if it seeped downward into groundwater, but not the likelihood of such seepage occurring. Geology mapped for the footprint of NCPP TSF is regolith weathered from the Burngrove Formation that stratigraphically underlies the Rangal Coal Measures, with a small area of cemented Tertiary sediment along the western edge. Given this context, NCPP TSF is unlikely to be hydraulically connected to any significant aquifers.

5.3 Cover Design

5.3.1 Specific Hazards

The planned final landform is a mounded shape that will not pond water, so there is no risk of spill to surface water (hazard c in Table 4-1). The TSF altered natural surface drainage as it was constructed, mainly by changing where overland flow from the TSF area enters Deep Creek, but closure will not have significant additional impact (hazard f). Given the proximity, there is the possibility of shallow seepage out of the TSF and into Deep Creek. If seepage did occur, the rate would decrease over time since tailings deposition has ceased (hazard b). A cover system designed to minimize deep infiltration would also reduce long-term seepage. However, as noted in Section 4.1, direct control measures unrelated to cover design might also be required. Any deep seepage from the TSF would tend to follow the excavated ground surface into a final void and therefore would not measurably reach regional groundwaters (hazard a).

As an aboveground TSF, embankments are required to structurally contain low strength tailings, and so embankment failure is a credible scenario (hazard i). However, the cover can only influence embankment stability indirectly and in a limited way – by avoiding accumulation of water and consequent pore pressure increase – and so this hazard will be separately addressed through detailed design for overall decommissioning of the TSF.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

5.3.2 Cover Concept Design

In the context of being rehabilitated to a separate elevated landform, the thick simple cover would generate a larger footprint because the higher surface elevation would involve longer slopes down to natural ground level. It might also be difficult to have a cover thick enough to meet infiltration objectives without it being so thick that its weight would cause excessive consolidation settlement. Consequently, the preferred cover for this TSF is the multi-layer system.

Gravelly fresh Permian spoil would be suitable for the base cover layer. Clay-rich spoil from Tertiary and weathered Permian overburden may be used for the lower permeability layer. Fresh Permian spoil is expected to have lower salinity and sodicity, which would make it also suitable for the subsoil layer, subject to chemical amelioration if testing suggest that is necessary.

Tailings consolidation settlement will vary with tailings depth and water content profile (or conversely, density profile) and with cover thickness, and is expected to occur over a long timeframe – potentially decades. Conceptually, this settlement can be accommodated by making the relevant layers of the cover thicker in the areas where greater settlement is predicted so that mounded interfaces and surfaces will remain mounded after the settlement has occurred.

5.3.3 Design Details

The over-arching objective for rehabilitation of NCPP TSF is to create a landform that permanently contains tailing solids, limits any release of solutes to levels that will not cause environmental harm, and can support managed grazing within a wider grazing enterprise. The following specify minimum layer thicknesses, but actual dimensions could be greater, either to create a landform that sheds rainfall runoff without ponding but also without causing excessive erosion, or from considerations of constructability:

- Bulk shaping fill comprising low clay content spoil and/or coarse rejects with low AMD potential will be spread over crusted tailings. Thickness will be as needed to provide a mounded, free-draining subsurface. The spoil/rejects will have minimal compaction to limit moisture suction potential;
- A 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be at least ten times less permeable than material above and below it. The surface will be shaped to shed any deep infiltration out of the landform when constructed and after consolidation settlement has occurred. This will require the surface of the layer to extend over the crests of the engineered embankments so that any such drainage would exit the landform;
- A 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m if needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to allow a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas;
- Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas.

The magnitude and rate of consolidation settlement depend on composition (size grading), existing pre-consolidation, and the disposition of drainage paths, all of which vary within the three-dimensional tailings deposit. Consequently, estimates are not included in the conceptual cover design; instead, settlement will be assessed and allowed for as part of detailed design and especially by adaptive design revision during the construction phase.

5.3.4 Construction Methodology

The challenge in placing a first layer of cover material over soft fine waste is that the cover needs to be thick enough to spread the weight of the construction equipment (so that the resultant pressure is low enough to avoid bearing failure), without being so thick that the weight of the cover material itself causes bearing failure. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints, but the in situ testing referred to in Section 3.1.3, was restricted to the edges of the tailings deposit. More testing will be required before cover works commence to understand strength conditions across the whole tailings surface and to accommodate those in the construction process.

That is, the construction sequence requires its own geomechanical design, separate from detailed design of the cover system. This will typically involve bearing capacity and/or stability analysis to determine combinations of thickness of the first layer of the bulk shaping and construction plant ground pressures that do not overload tailings strength profiles across the TSF. Even then, considering the inherent variability across the TSF, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as the initial layers are placed.

Once the first layer has been placed, it may possible to proceed using normal spoil dumping practices up to the underside of the low permeability player. The actual dumping strategy should be confirmed by further geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not compromise the final mounded shape of the subsequent low permeability layer.

It is recommended that QC/QA for the low permeability layer be based on coefficient of permeability, which is the geomechanical property that most directly affects cover system performance. For QC, test areas could be prepared using the proposed spoil material and construction methodology for each cover layer. In situ infiltration tests would be undertaken to measure permeability, and the materials and/or methods modified as necessary, until the design coefficients of saturated permeability are consistently achieved. The resultant materials and methods can then be used to construct the whole layer, with further infiltration testing as appropriate to provide QA.

To ensure the desired contrast in permeability, spoil directly above the low permeability layer should be spread in thicker layers where practicable. As the constructed surface approaches the levels of the final landform, areas with the greatest predicted remaining consolidation settlement may be over-dumped to hasten and balance that settlement.

After completion of bulk earthworks, the landform may be left for a period while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile. The area would then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures. The vegetation species mix should be consistent with roots of mature plants not reaching the low permeability layer and with the post-mining land use of managed grazing.

6. LALEHAM TSF

6.1 Description

Laleham is an inactive TSF with in-pit and aboveground sections, the latter being formed by embankments across a hillslope, with the western end possibly founded in spoil. It is located about 1.2km south-east of the old South Blackwater Mine CHPP.

The in-pit section was present in 1984 and the embankment was under construction. The tailings surface was capped with clayey spoil by the end of 1994 but the exposed (downstream) embankment slope has not been structurally modified since original construction.

The TSF extends 0.4km north-south and 0.6km east-west, with a footprint of about 13 Ha. The depth of tailings in the in-pit section is not known but the main embankment is about 10m high. The capped surfaces are generally flat, except for a depression at the eastern side of the aboveground section that was probably caused by tailings consolidation.

6.2 Surrounding Environment

The in-pit area of the TSF wraps around the end of a laterised sandstone ridge to the north. Two small mine water dams, Duck Pond and Fish Bowl, are 100-200m to the west. The eastern side of the aboveground part of the TSF is bounded by a road around the western toe of the Ramp 74 northern in-pit spoil dump; Ramp 74 in-pit TSF is about 700m east of Laleham TSF. There are several vegetated spoil dumps around the southern side of the TSF, with Sirius Creek at the southern side of those, about 35m from Laleham TSF. Prior to mining, the dominant land use was low intensity grazing. Regulated vegetation is mapped on the sandstone ridge and an area to the south-west of the TSF, described as endangered acacia dominated open forest and of-concern eucalypt open forest respectively.

For the final landform, it is planned to re-handle spoil from some of the smaller nearby dumps to cover the TSF and create a broad mound abutting the natural sandstone ridge draining south to Sirius Creek.

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian Rangal Coal Measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). Flow path simulation included in SLR (2024) may be relevant to the in-pit part of the TSF and indicated that if any seepage reached the groundwater system it would flow toward R74 void. Surface geology mapped for the footprint of Laleham TSF is Emerald Formation Tertiary sediment, with Rangal Formation sub-cropping south of Sirius Creek. Over the forty years since tailings were first deposited in-pit, there have been no reports of shallow seepage from the TSF being detected in Sirius Creek.

6.3 Cover Design

6.3.1 Specific Hazards

The planned final landform is a mounded shape that will not pond water, so there is no risk of spill to surface water (hazard c in Table 4-1). The TSF did not greatly alter natural surface drainage because it followed the pre-existing ground-slope direction (hazard f). As noted in the previous section, there is the possibility of shallow seepage out of the TSF and into Sirius Creek, although there is not a clear hydrogeologic connection. If seepage did occur, the rate would decrease over time since tailings deposition has ceased, and a cover system designed to minimize deep infiltration would also reduce long-term seepage. Any deep seepage from the TSF would follow the excavated ground surface into Ramp 74 void (another TSF) and therefore would not measurably reach regional groundwaters (hazard a).

As a TSF with some aboveground containment, embankments are required to structurally contain low strength tailings, and so embankment failure is a credible scenario (hazard i). However, the cover can only influence embankment stability indirectly and in a limited way – by avoiding

accumulation of water and consequent pore pressure increase – and so this hazard is separately addressed through detailed design for overall decommissioning of the TSF.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

6.3.2 Concept Cover Design

The tailings surfaces (in-pit and out-of-pit) were covered with 1m minimum depth of spoil about thirty years ago. There are historically rehabilitated spoil dumps nearby and future mining is planned within that area of the minesite. Given this context, the preferred cover type is a thick layer of general spoil, including the material that is already in place. Final surface gradients, topsoil thickness and vegetation will be consistent with other spoil landforms rehabilitated to the same post-mining land use.

Tailings consolidation settlement varies with tailings depth and water content profile (or conversely, density profile) and with cover thickness. Considering that tailings deposition ceased so long ago, it is likely that a significant amount of settlement has already occurred. However, the additional weight of cover spoil will trigger a new stage of consolidation that theoretically might take decades to complete (although consolidation follows a logarithmic timeframe which means that most of the settlement happens in the early years). For detailed cover design, the rate of consolidation and total and differential settlement will need to be estimated and allowed for, typically by adjusting the cover thickness to compensate.

6.3.3 Design Details

The high level design objective for rehabilitation of Laleham TSF is to create a landform that permanently contains tailing solids, limits any release of solutes to levels that will not cause environmental harm, and can support managed grazing within a wider grazing enterprise. In addition to providing a cover function, the spoil also needs to create the required landform topography. Consequently, the following specifies a minimum spoil thickness, but in some areas the actual thickness will be greater, to create a surface that sheds rainfall runoff without ponding but also without causing excessive erosion.

- 5m thickness of spoil (including that already placed), dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform. This may be achieved by selective placement or by chemically treating the top metre of spoil to reduce sodicity;
- Topsoil and erosion management practices consistent with those on other rehabilitated spoil areas.

Tailings consolidation settlement will vary with tailings depth and water content profile (or conversely, density profile) and with spoil thickness, and is expected to occur over a long timeframe – potentially decades. Conceptually, this settlement can be accommodated by making the relevant layers of the cover thicker in the areas where greater settlement is predicted so that mounded interfaces and surfaces will remain mounded after the settlement has occurred.

6.3.4 Construction Methodology

The greatest challenge in constructing a cover over soft fine waste is usually in placing an initial layer that can support construction equipment without breaking through the crusted surface itself. In the case of Laleham TSF, that first layer is already in place; however, its thickness and condition is not known in detail. Consequently, further strength profiling is recommended to support detailed design of the cover system and selection of construction equipment with appropriate ground pressure configurations.

All vegetation and the topsoil/root matter should be removed before fresh spoil placement commences. Spoil placement may then proceed as determined to suit strength conditions; however, considering the inherent variability across the TSF, the construction methodology may be further modified based on monitoring as work proceeds.

Because the proposed cover system is essentially simple bulk spoil fill, no specific testing is required for QC/QA during construction except to confirm minimum cover thickness. After completion of bulk earthworks, the landform may be left for a period while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile. The area would then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures.

7. R72 WSF

7.1 Description

R72 is an inactive tailings and coarse rejects storage facility with the waste mainly below ground, but rainfall and runoff are intermittently stored over tailings behind an aboveground embankment. It is located just north of the loadout rail line into South Blackwater.

Ramp 72 was mined sometime before 1985. Tailings were discharged to the pit from the early 1990's until December 2001; at some stage during that period, a 4m high embankment was constructed at the top (western end) of the ramp to contain the decant pond as the tailings level rose slightly above natural ground level and decant drained to that end of the ramp. Mixed CHPP waste was dumped into the southern end of the pit, over the tailings, from about 2005 until it reached a couple of metres below pre-mining ground level. In 2010, the embankment was raised 6m to better contain rainfall runoff from the pit and surrounding catchment.

The pit section of the WSF is about 950m long and 150m wide, while the ramp section is about 650m long with a width opening from 50m at the top of the ramp to 160m where it joins the pit. Depth of tailings ranges from a couple of metres at the top of the ramp to about 40m in-pit, and the mixed rejects in the southern end are about 16m thick over the tailings.

7.2 Surrounding Environment

The WSF is bound by the rail line at the south, a mine access/haul road at the west, other mine voids at the north and presently, highwall spoil at the east. As noted, at closure there will be a new residual void further east, with an in-pit spoil dump in between. The southern rail loop is about 1km to the south-west with old mine building and the SCPP at the eastern side of the loop. It is

understood that most of that infrastructure will be removed prior to closure. In this part of the mine, the pre-mining ground surface and its watercourses drained from east to west, and a natural drainage line flows from the top of the ramp into Sirius Creek about 4km downstream to the south-west. That drainage line is mapped as regulated vegetation (endangered regional ecosystem comprising remnant acacia dominated woodland to open forest on gilgai clay plains). Prior to mining, the land use was mainly low intensity grazing, and this continues in areas outside the area of mine disturbance.

The final landform for the mine involves burying R72 under a new spoil dump generated from mining down-dip (east) of the previous pit. The depth of spoil over CHPP waste will range from at least 5m at the top of the ramp to more than 100m at the current highwall. The final void from new mining will be about 1.2km east of R72 WSF.

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian Rangal Coal Measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). Flow path simulation included in that report indicated that the TSF would remain a groundwater sink, and therefore tailings-contacted water would not flow out into the broader groundwater system. Surface geology mapped for the footprint of R72 WSF is cemented Tertiary sediment (duricrust) on deeply weathered regolith. The planned future mining will remove Tertiary and Permian overburden down to coal floor; consequently, any seepage from R72 would be eastward through in-pit spoil to that subsequent final void.

7.3 Cover Design

7.3.1 Specific Hazards

The proposed final landform over R72 WSF is sloping ground that will not pond water, so there is no risk of spill to surface water (hazard c in Table 4-1). No watercourse or defined drainage feature is directly impacted by the WSF; the rehabilitated landform will locally increase the catchment draining to a gully that flows into Sirius Creek but it will not interfere with the watercourse alignment (hazard f). There is a slight possibility of seepage through the western embankment and into the gully, however this (hazard b) was addressed in the embankment design. If seepage has occurred, the rate will decrease after the decant pond is removed. A cover system designed to minimize deep infiltration would also reduce long-term seepage. As was also noted in the preceding report section, any deep seepage from the WSF would likely follow the excavated ground surface into a final void and therefore would not measurably reach regional groundwaters (hazard a).

As the WSF contains tailings stored aboveground, the embankment is required to structurally contain low strength tailings in the long-term, and so embankment failure is a credible scenario (hazard i). However, the hazard of embankment failure will be separately addressed through detailed design for decommissioning of the overall TSF structure.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

7.3.2 Concept Cover Design

Given the location of R72 WSF within a large spoil landform, a thick cover of general spoil material is proposed to achieve cover performance objectives. At concept design level, gravelly spoil or coarse rejects will be spread over the exposed tailings surface to provide an initial support layer, then a thicker layer of general spoil will be placed over that. Final surface gradients, topsoil thickness and vegetation will be consistent with other spoil landforms rehabilitated to the same post-mining land use.

Tailings consolidation settlement varies with tailings depth and water content profile (or conversely, density profile) and with cover thickness. Consolidation actually occurs throughout the life of the facility and beyond, and it is likely that a significant amount of settlement has already occurred. However, the additional weight of spoil will trigger a new stage of consolidation. Consolidation theory indicates that the process might take decades to complete (although consolidation follows a logarithmic timeframe which means that most of the settlement happens in the early years). For detailed cover design, the rate of consolidation and total and differential settlement will need to be estimated and allowed for, typically by adjusting the spoil thickness to compensate.

7.3.3 Design Details

The high-level objective for rehabilitation of R72 WSF is to incorporate it in a larger spoil landform such that the whole area has consistent topography and land use capabilities. The thickness of spoil required to achieve this varies markedly across the facility. The following, therefore, are proposed minimum layer thicknesses, to be refined in the detailed design:

- 1.5m thickness of coarse rejects or gravelly spoil – for example, spoil from fresh non-carbonaceous sandstone-siltstone overburden and/or interburden - over the exposed tailings;
- Spoil, 3.5m thick at the top of the ramp, 5m thick over coarse rejects and as required over the remainder of the WSF, dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform (spoil may be chemically ameliorated to achieve this); and
- Topsoil and erosion management practices consistent with those on the adjoining rehabilitated spoil areas.

The magnitude and rate of consolidation settlement depend on composition (size grading), existing pre-consolidation, and the disposition of drainage paths, all of which will vary throughout the tailings deposit. Consequently, estimates are not included in the conceptual cover design; instead, settlement will be assessed and allowed for as part of detailed design and especially by adaptive design revision during the construction phase.

7.3.4 Construction Methodology

As described in Section 5.3.4, the first layer over tailings is the most difficult to construct because it needs to balance the conflicting effects of supporting construction equipment and loading the tailings. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints. For this reason, the ramp section must be dewatered continuously and allowed to desiccate for several years before in situ strength profiles are measured and used to undertake geomechanical design of the construction sequence. This will typically involve bearing capacity

and/or stability analysis to determine combinations of thickness of the first layer of cover material and construction plant ground pressures that do not overload tailings strength profiles across the WSF. Even then, considering the inherent variability in tailings due to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as the initial layer is placed. If the surface cannot be strengthened sufficiently within an acceptable timeframe, special construction support such as geogrid may be required.

Once the first layer has been placed, it may be possible to proceed using normal spoil dumping practices to complete the bulk shape of the final landform. The actual dumping strategy should be confirmed by further geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not compromise the final surface drainage plan.

Because the proposed cover system is essentially simple bulk spoil fill, no specific testing is required for QC/QA during construction, except to confirm minimum cover thickness. After completion of bulk earthworks, the landform may be left for a period while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile. The area would then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures.

8. R74 TSF

8.1 Description

R74 is an inactive in-pit tailings storage facility with no aboveground storage. The pit was mined sometime before 2001. The northern half of the pit is aligned roughly north-west to south-east while the southern part is nearly north to south. The northern endwall is about 1.8km south-west of the SCPP, with various mine small mine-affected water dams and Laleham TSF in between.

From December 2001 until 2008, tailings were discharged from the northern endwall and allowed to beach down toward the southern end. Based on the site geological model, the tailings surface is below the base of weathering except at the location of the pre-mining alignment of Sirius Creek, and it is more than 10m below spill level. Since tailings deposition ceased, the pit has at times been used to store excess mine-affected water, apparently without infrastructure to recover the water.

R74 TSF is about 1.9km long from northern to southern endwall and has a footprint of about 41Ha. Based on limited historic survey, it is estimated that the depth of tailings varies from about 24m in the south to 32m in the north. The beach angle of the tailings is about 0.6%.

8.2 Surrounding Environment

R74 TSF is not close to any third party infrastructure. A power line easement to the SCPP passes about 0.4km north of the northern endwall, but the only other nearby infrastructure are mine access roads. Prior to mining, Sirius Creek flowed east-to-west across the southern area of the pit, and a diversion was constructed around the southern endwall. An upgraded creek diversion

and associated flood protection structures have been designed but the alignment near R74 will not change greatly. In keeping with creek-flow direction, unmined ground east of the highwall slopes gently toward the pit. Spoil west of the pit lowwall has undergone rehabilitation. Prior to mining, the dominant regional land use was low intensity grazing but a significant area of land east of the highwall is uncleared woodland mapped as MSES regulated vegetation (Category B – endangered) comprising sub-dominant shrubby open forest. A smaller area about 1km south of the TSF (on the other side of Sirius Creek is mapped as high ecological significance wetlands comprising dominant endangered open forest.

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian coal measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). Flow path simulation included in that report indicated that the TSF would remain a groundwater sink, and therefore tailings-contacted water would not flow out into the broader groundwater system. The site geological model shows typically 10-20m depth of Tertiary/ Quaternary soil and rock overlying weathered Permian rock with unweathered Permian Rangal Coal Measures generally 20-25m below pre-mining ground level. The exception is at the original channel of Sirius Creek, where the depth of weathering increases to about 35m.

As noted in Section 10.1, the tailings surface is more that 10m below surrounding ground level and more than 5 million cubic metres of spoil would be required to completely backfill the void. Considering geological changes, proximity to Sirius Creek and the presence of regulated endangered vegetation about a kilometre east of the current highwall, no further mining is planned in the vicinity. The spoil that was produced from R74 pit has been rehabilitated up to the lowwall and so re-handling from that source would have a negative environmental outcome. Consequently, the final landform design for R74 TSF is a residual void that is a NUMA approved under existing Land Outcome Documents. This imposes different requirements on cover design, as discussed in the following sections.

8.3 Cover Design

8.3.1 Specific Hazards and Concept Cover Design

As an in-pit TSF with no aboveground storage, there is no mechanism for embankment failure (hazard i). In addition, because the void will be a NUMA, hazards d and e, regarding uptake of contaminants by vegetation, are not relevant. Consequently, the most important specific hazards relate to seepage or spill of tailings-contacted water (hazards a, b, and c). Iterative final landform design, hydrogeological modelling and void water balance modelling (SLR, 2024 and WSP, 2024) have shown that by constructing a thick single-layer spoil cover from the northern end down to about 650m from the southern endwall, a water cover always at least 1m deep will establish over the remaining (southern) section and the void will remain a long-term groundwater sink with no risk of overflow to surface waters.

Tailings consolidation settlement (hazard g) will vary with tailings depth and water content profile (or conversely, density profile) and with spoil cover thickness, and is expected to occur over a long timeframe – potentially decades. Conceptually, this settlement can be accommodated by making the cover thicker in the areas where greater settlement is predicted so that surface drainage is maintained after the settlement has occurred. Settlement under the permanent water cover will not affect cover performance.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

8.3.2 Design Details

As a NUMA, the over-arching objective for closure of R74 TSF is to create a stable landform that permanently contains tailing solids and limits any release of solutes to levels that will not cause environmental harm. The following are preliminary specifications for the combined spoil and water covers:

- 5m minimum thickness of spoil will be placed over the tailings, from the northern end of the TSF to nominally 650m north of the southern endwall. The spoil layer will be battered down at an angle assumed to be 1:3 for planning purposes but to be determined by stability analyses at detailed design;

- A pit lake will be established south from the spoil batter to act as a permanent water cover with a minimum depth of 1m over the tailings that are not covered by spoil.

The magnitude and rate of consolidation settlement depend on composition (size grading), existing pre-consolidation, and the disposition of drainage paths, all of which vary within the three-dimensional tailings deposit. Consequently, estimates are not included in the conceptual cover design; instead, settlement will be assessed and allowed for as part of detailed design and especially by adaptive design revision during the construction phase.

8.3.3 Construction Methodology

As described in Section 5.3.4, the first layer over tailings is the most difficult to construct because it needs to balance the conflicting effects of supporting construction equipment and loading the tailings. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints. For this reason, mine-affected water stored in the void must be pumped down to allow the tailings north of about 600m from the southern endwall to desiccate for several years before in situ strength profiles are measured and used to undertake geomechanical design of the construction sequence. This will typically involve bearing capacity and/or stability analysis to determine combinations of thickness of the first layer of cover material and construction plant ground pressures that do not overload tailings strength profiles across the TSF. Even then, considering the inherent variability in tailings due historic to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as an initial layer of spoil is placed.

Once a first layer has been placed, it may be possible to place the remaining thickness of spoil cover in one pass. The actual dumping strategy should be confirmed by further geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not prevent the final surface from draining freely to the water cover at the northern end.

Because the proposed northern cover is essentially simple bulk spoil fill, no specific testing is required for QC/QA during construction, except to confirm minimum cover thickness. After completion of bulk earthworks, the landform may be left for a period while further consolidation

settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile.

The water cover at the southern end is expected to establish readily once dewatering ceases. If this does not occur within a desired timeframe, for example if closure occurred during drought conditions, water could be pumped onto the tailings until conditions equilibrated.

9. BOTTOM DAM TSF & ROM3 AREA WSF

9.1 Description

The ROM3 Area coarse rejects dump is located against an east-facing natural slope about 0.7k south of the SCPP. The dump batter is at angle of repose and about 38m high; the flat top ranges up to 120m wide and the total footprint is 5.5Ha.

Bottom Dam abuts the eastern toe of the dump, about half-way along. It is bound by sloping ground at the north, a 6m high earthfill embankment at the east, and a spoil dump at the south. The footprint of Bottom Dam TSF is 3.2Ha Geotechnical drilling suggests that the storage is up to 15m deep and founded within the regolith, that is, above fresh Permian coal measures.

Bottom Dam was originally a process water storage forming part of the SCPP water management system. It received overflow from No.1 Dam (upslope to the north) and into flowed though a culvert to Duck Pond at the east, on the other side of a mine road. The dam also incidentally received coal fines and other sediment washed in from No.1 Dam and the rejects dump but it was not designated as a TSF until sometime after 2012.

The tailings surface is close to the embankment crest level and is fairly flat except for a small sump around the culvert to Duck Pond. Scrubby mid-storey has established over more than half of the tailings surface. Recent geotechnical investigation showed a desiccated surface crust typically 1-2m thick.

9.2 Surrounding Environment

The combined WSF is in the middle of the old South Blackwater Mine industrial area, with ROM3 Area and the CHPP on natural high ground to the west and north respectively, other mine dams immediately east and Laleham TSF further east again, a spoil dump immediately to the south and natural ground draining to Sirius Creek about to the south-east. Prior to mining the dominant land use on the mining lease was low intensity grazing, with significant areas of uncleared woodland. Some of the latter remain in the vicinity of ROM3 Area/Bottom Dam and are mapped as Category B regulated vegetation (endangered and of-concern eucalyptus woodland to open forest).

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian Rangal Coal Measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). Similar to NCPP TSF, flow path simulation included in SLR (2024) does not reflect the risk of seepage to the groundwater system. Surface geology mapped for the footprint of the combined WSF is Emerald Formation Tertiary weathered siltstone and claystone; the ridge to the west and north has Tertiary duricrust, and Sirius Creek runs through

regolith of Permian Burngrove formation. That is, the WSF is unlikely to have direct hydrogeologic connection with Sirius Creek.

For the final landform, it is planned to push the rejects down over the tailings to create a slope abutting the Tertiary ridge with runoff draining freely to the south and south-east.

9.3 Cover Design

9.3.1 Specific Hazards

The planned final landform is a sloping shape that will not pond water, so there is no risk of spill to surface water (hazard c in Table 4-1). The rejects dump and TSF did not greatly alter natural surface drainage because they broadly followed the pre-existing ground-slope direction (hazard f). As noted in the previous section, shallow seepage out of the TSF and into Sirius Creek is unlikely because there is not a clear hydrogeologic connection. Deep seepage from the TSF might flow toward Sirius Creek as indicated by the flow path simulations (SLR, 2024), however it is unlikely (hazard a).

As a TSF with some aboveground containment, embankments are required to structurally contain low strength tailings, and so embankment failure is a credible scenario (hazard i). However, the cover can only influence embankment stability indirectly and in a limited way – by avoiding accumulation of water and consequent pore pressure increase – and so this hazard will be separately addressed through detailed design for overall decommissioning of the TSF.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

9.3.2 Concept Cover Design

The present batter of the rejects dump is steep and eroded and requires significant re-shaping to create an acceptable final landform. Bottom Dam TSF has been colonised by shrubby vegetation but has formed a shallow surface depression that would intermittently pond and potentially overflow. Hence, it is planned to push the rejects down over the TSF to flatten the slope and fill the depression. There is a spoil dump immediately south of Bottom Dam but the spoil characteristics are unknown; the same applies to the next closest potential sources of cover material. Given this context, the preferred cover type is a thick layer of general spoil. Final surface gradients, topsoil thickness and vegetation will be consistent with other spoil landforms rehabilitated to the same post-mining land use.

Tailings consolidation settlement varies with tailings depth and water content profile (or conversely, density profile) and with cover thickness. Considering that tailings deposition ceased so long ago, it is likely that a significant amount of settlement has already occurred. However, the additional weight of cover spoil will trigger a new stage of consolidation that theoretically might take decades to complete (although consolidation follows a logarithmic timeframe which means that most of the settlement happens in the early years). For detailed cover design, the rate of consolidation and total and differential settlement will need to be estimated and allowed for, typically by adjusting the cover thickness to compensate.

9.3.3 Design Details

The high level design objective for rehabilitation of Bottom Dam TSF and ROM3 Area WSF is to create a landform that permanently contains tailing solids, limits any release of solutes to levels that will not cause environmental harm, and can support managed grazing within a wider grazing enterprise. The coarse rejects will be pushed over Bottom Dam to create the bulk landform topography, so in this case the spoil will only be required to provide cover function – limiting the movement of solutes both downward and upward. The following specifies a minimum spoil thickness, but in some areas the actual thickness may be greater, to create a surface that sheds rainfall runoff causing excessive erosion.

- 5m thickness of spoil, dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform. This may be achieved by selective placement or by chemically treating the top metre of spoil to reduce sodicity;
- Topsoil and erosion management practices consistent with those on other rehabilitated spoil areas.

Tailings consolidation settlement will vary with tailings depth and water content profile (or conversely, density profile) and with spoil thickness, and is expected to occur over a long timeframe – potentially decades. Conceptually, this settlement can be accommodated by making the relevant layers of the cover thicker in the areas where greater settlement is predicted so that mounded interfaces and surfaces will remain mounded after the settlement has occurred.

9.3.4 Construction Methodology

As described in Section 5.3.4, the first layer over tailings is the most difficult to construct because it needs to balance the conflicting effects of supporting construction equipment and loading the tailings. On Bottom Dam TSF, that first layer will be coarse rejects rather than spoil; this is an advantage because the rejects are both lighter and stronger. However, the strength and thickness of the tailings surface crust will still be critical to being able to meet both construction constraints. The in situ strength profiles recently measured may be sufficient to undertake geomechanical design of the construction sequence. This will typically involve bearing capacity and/or stability analysis to determine combinations of thickness of the first layer of rejects and construction plant ground pressures that do not overload tailings strength profiles across the TSF. Even then, considering the inherent variability in tailings due to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as the initial layer is placed. If the surface cannot be strengthened sufficiently within an acceptable timeframe, special construction support such as geogrid may be required.

Once the first layer has been placed, it may be possible to complete the coarse rejects re-handling and subsequent spoil cover placement using normal earthworks practices. However, the actual dumping strategy should be confirmed by further geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not compromise the final surface drainage plan.

Because the proposed cover system is essentially simple bulk spoil fill, no specific testing is required for QC/QA during construction except to confirm minimum cover thickness. After completion of bulk earthworks, the landform may be left for a period while further consolidation

settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile. The area would then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures.

10. BONNIE DOON TSF

10.1 Description

Boonie Doon is an active in-pit TSF located at the northern end of current mining. It comprises four straight pit sections connected by two ramps (R10 and R12).

The lowest part of the mined pit floor was RL 119m. Tailings deposition commenced in December 2023 and will continue until the tailings reach RL 160m just north of R10, beaching down from about RL 179m at the southern end. The maximum tailings elevation was reduced from the level specified in the design plan, both to keep the operating tailings and decant pond levels below the base of weathering exposed in the highwall (ranging from RL 172m to RL 185m), and to ensure that the storage facility remains a sink relative to possible groundwater aquifers in the Tertiary and Quaternary sediments.

The TSF is 2.7km north-south and has a footprint of about 42Ha. When filled, the depth of tailings will range from about 25m in the north to 60m at the southern end. The location of tailings discharge and the decant pond may change throughout the operational life but by closure, the tailings surface will drain toward the north with beach slope in the order of 1-1.5%.

10.2 Surrounding Environment

The northern end of the TSF is about 1.5km south of the Capricorn Highway and 5km south-west of the town of Blackwater. The two pit ramps run about 1km down from the main mine access road at the west and the mine's rail line is at the western side of the road. Sagittarius Creek is located about 3.7km east of the TSF highwalls and flows northward. Several unnamed gullies (that are defined drainage features under the Water Act 2000) collect overland flow from the area east the TSF and feed it into the creek. Prior to mining the dominant land use was low intensity grazing and this continues outside the area of mine disturbance. Regulated vegetation (Category R – GBR riverine) is mapped along the upslope ends of some of those drainage features but there are no other Matters of State Environmental Significance near the TSF.

In and around the mine area, groundwater occurs mainly in the coal seams in the Permian Rangal Coal Measures and potentially in poorly consolidated Tertiary sediments. Quaternary alluvium is limited to some current drainage features and watercourses and investigations to date suggest that any groundwater is ephemeral and associated with creek flows, rather than representing a sustained water table (SLR, 2024). Surface geology mapped for the footprint of Boonie Doon shows most of the highwall edging into Triassic Rewan Formation overburden that overlies the mined Permian Rangal Formation. The exception is at the northern end, where Quaternary alluvium comprising sheetwash and flood-out sheets is mapped. Hence Bonnie Doon TSF, like all pits mined at Blackwater, intersects the unmined portions of coal seam aquifers; however, this TSF could also contact shallow local aquifer(s) in the surface alluvium, if the tailings and decant pond level were not restricted to avoid it.

Because of the constraints on maximum tailings level described in Section 10.1, the final tailings surface will be 20-40m below surrounding ground level. Within the current life-of-mine plan, there will not be mining close to Bonnie Doon when the TSF is undergoing closure so no close-haul spoil will be produced at the time. Much of the spoil that was produced by mining Bonnie Doon is already under rehabilitation, so re-handling enough of that spoil to fill the TSF to ground level would be high cost and have negative environmental impact. Consequently, the final landform design for Bonnie Doon TSF is a residual void that is a NUMA approved under existing Land Outcome Documents. This imposes different requirements on cover design, as discussed in the following sections.

10.3 Cover Design

10.3.1 Specific Hazards and Concept Cover Design

As an in-pit TSF with no aboveground storage, there is no mechanism for embankment failure (hazard i in Table 4-1). In addition, because the void will be a NUMA, hazards d and e, regarding uptake of contaminants by vegetation, are not relevant. Consequently, the most important specific hazards relate to seepage or spill of tailings-contacted water (hazards a, b, and c). Iterative final landform design, hydrogeological modelling and void water balance modelling (SLR, 2024 and WSP, 2024) have shown limiting the tailings level to RL 160m at the end of R10, and constructing a thick single-layer spoil cover south of R10 will maintain the void as a long-term groundwater sink, avoid seepage into any shallow alluvial aquifers, and avoid overflow to surface waters. This configuration will also provide a permanent water cover, at least 1m deep, over tailings north of R10.

Tailings consolidation settlement (hazard g) will vary with tailings depth and water content profile (or conversely, density profile) and with spoil cover thickness, and is expected to occur over a long timeframe – potentially decades. Conceptually, this settlement can be accommodated by making the cover thicker in the areas where greater settlement is predicted so that surface drainage is maintained after the settlement has occurred. Settlement under the permanent water cover will not affect cover performance.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

10.3.2 Design Details

As a NUMA, the over-arching objective for closure of Bonnie Doon TSF is to create a stable landform that permanently contains tailing solids and limits any release of solutes to levels that will not cause environmental harm. The following are preliminary specifications for the combined spoil and water covers:

- The final tailings elevations in the TSF will be RL 160m at the end of R10, with the surface sloping down to the north and up to the south;

- 5m minimum thickness of spoil will be placed over the tailings, from the southern end of the TSF to nominally 150m south of the endwall at R10. The spoil layer will be battered down at an angle assumed to be 1:3 for planning purposes but to be determined by stability analyses at detailed design;

- A pit lake will be established north from the spoil batter to act as a permanent water cover with a minimum depth of 1m over the tailings that are not covered by spoil.

The magnitude and rate of consolidation settlement depend on composition (size grading), existing pre-consolidation, and the disposition of drainage paths, all of which vary within the three-dimensional tailings deposit. Consequently, estimates are not included in the conceptual cover design; instead, settlement will be assessed and allowed for as part of detailed design and especially by adaptive design revision during the construction phase.

10.3.3 Construction Methodology

As described in Section 5.3.4, the first layer over tailings is the most difficult to construct because it needs to balance the conflicting effects of supporting construction equipment and loading the tailings. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints. For this reason, after the tailings reach final design level, the decant pond must be pumped down continuously to allow the tailings south of the endwall at R10 to desiccate for several years before in situ strength profiles are measured and used to undertake geomechanical design of the construction sequence. This will typically involve bearing capacity and/or stability analysis to determine combinations of thickness of the first layer of cover material and construction plant ground pressures that do not overload tailings strength profiles across the TSF. Even then, considering the inherent variability in tailings due to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as an initial layer of spoil is placed.

Once a first layer has been placed, it may be possible to place the remaining thickness of spoil cover in one pass. The actual dumping strategy should be confirmed by further geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not prevent the final surface from draining freely to the water cover at the northern end.

Because the proposed southern cover is essentially simple bulk spoil fill, no specific testing is required for QC/QA during construction, except to confirm minimum cover thickness. After completion of bulk earthworks, the landform may be left for a period while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface may be trimmed to final design profile.

The water cover at the northern end is expected to establish readily once dewatering ceases. If this does not occur within a desired timeframe, for example if closure occurred during drought conditions, water could be pumped onto the tailings until conditions equilibrated.

11. RAMP 36 REJECTS DUMP

11.1 Description

Ramp 36 Rejects Dump is a long narrow WSF located south-east of the NCPP TSF, on the southern side of Deep Creek and the western side of the main haul road. It has a footprint of

72Ha, with a high mound at the southern end reaching about 30m above surrounding ground levels. The batters in that area are at angle-of-repose.

It is understood that the WSF received coarse rejects over the period from 1967 to 2007 and that rejects were also removed from the WSF at times, to use in construction of wall lifts on the NCPP TSF.

11.2 Surrounding Environment

The is a small sediment pond at the northern end of the WSF, about 30m from the culvert where Deep Creek flows under the haul Road. At the east and south, it appears that runoff is directed into the haul road side drains. Taurus Creek flows under the haul road about 2km to the south.

Current mining pits are about 1.6km east of the haul road; partly rehabilitated spoil dumps at the back of the pits drain west toward the haul road. Under the Life-of-Mine Plan, the final Deep Creek Void will be about 0.9km further east from the present location.

Prior to mining and outside the area of mine disturbance, the dominant land use has been low intensity grazing, except in Amaroo State Forest more than 3km west and up-slope of the WSF. An are of regulated vegetation (sub-dominant of-concern regional ecosystem comprising remnant acacia dominated open forest, woodland and shrublands) is mapped south-east of the WSF; regulated vegetation (riverine) is mapped along Deep Creek and Taurus Creek and their tributaries. Deep Creek and Taurus Creek are watercourses defined by the Water Act 2000.

The final landform design for Ramp 36 is a stand-alone elevated landform with about the same footprint as the current facility. Some coarse rejects will be moved within that area to flatten slopes down to the same gradients being applied to spoil dumps.

11.3 Cover Design

11.3.1 Specific Hazards

Coarse rejects are geotechnically competent and do not need physical containment, so hazards g, i, and l in Table 4-1 are not relevant. In addition, the waste was dry-placed and contains much less water than tailings, so the risk of deep seepage to groundwater is much reduced (hazard a).

The proposed final landform is a mounded shape that will not pond water, so there is no risk of spill to surface water (hazard c). The WSF did not alter surface drainage except in its immediate vicinity - runoff draining east and west is presently captured but after rehabilitation it will follow normal drainage paths north and south to Deep Creek and Taurus Creek respectively (hazard f). Shallow seepage out of the WSF, in particular to Deep Creek, is feasible (hazard b) so minimising infiltration below the rooting zone will be a focus of detailed cover design.

Other relevant potential hazards will be addressed by the general controls outlined in Table 4-1.

11.3.2 Concept Cover Design

Because coarse rejects do not require containing embankments, Ramp 36 WSF can be re-shaped and covered essentially within its existing footprint (unlike NCPP TSF). In this context, a thick layer of general spoil is proposed for rehabilitation, with spoil sourced from future mining of the Deep Creek Pits. Final surface gradients, topsoil thickness and vegetation will be consistent with other spoil landforms rehabilitated to the same post-mining land use.

11.3.3 Design Details

The high level design objective for rehabilitation of Ramp 36 WSF is to create a landform that limits any release of solutes to levels that will not cause environmental harm, and can support managed grazing within a wider grazing enterprise. Coarse rejects presently in the emplacement will be re-handled to create a rough landform shape such that the required cover layer thickness will be fairly uniform, with details as follow:

- 5m thickness of spoil, dumped and spread in such a way that dispersive spoil with high fines content is not placed in the outer 1m of the landform. This may be achieved by selective placement or by chemically treating the top metre of spoil to reduce sodicity;
- Topsoil and erosion management practices consistent with those on other rehabilitated spoil areas.

Coarse rejects do not experience consolidation settlement. Due to the uncompacted nature of the waste, there may be some settlement due to the weight of the cover layer but most of this will occur as the cover is constructed and does not need to be specifically addressed in design.

11.3.4 Construction Methodology

Given the geotechnical competence of coarse rejects, construction of the thick spoil cover will be straight forward, typically comprising a simple dump and spread operation. Because the thick spoil is essentially simple bulk fill, no specific testing is required for QC/QA during construction except to confirm minimum cover thickness.

After completion of bulk earthworks, it would be advisable to leave the landform for a period to allow any residual settlement to occur. When topographic monitoring suggests that minimal further movement is likely, the area would then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures. The vegetation species mix should be consistent with the post-mining land use of managed grazing.

12. FUTURE WORK

The cover systems described herein are conceptual designs based on information available at August 2024.

As emphasised in the sections discussing construction methodology, construction design for the TSF covers cannot be finalised until in situ strength profiles are measured and this should be done as short a time as possible before cover works commence.

Spoil that may be suitable for the various cover layers should be identified as mined and/or in spoil dumps close to each TSF. Ideally, spoil should have been aged in dump for at least a couple of years to observe slaking and other degradation before samples for classification testing including silt/clay fraction and plasticity. In situ infiltration tests to confirm construction materials and methodology may be undertaken after suitable spoils have been identified and must be completed before the design is finalised.

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