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BHP Olympic Dam tailings storage facilities closure trials: a comprehensive approach to cover system field trial design and construction

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Abstract

The Olympic Dam (OD) mine, located in the hot desert region of South Australia, Australia, is a copper-uranium-gold-silver mine in operation since 1988. Waste (tailings) from processing activities is stored across six onsite tailings storage facilities (TSFs), of which TSF 1-3 is inactive and require studies to inform final closure design. To achieve OD mine closure objectives, TSF 1-3 is to be closed with a cover system that minimises long-term maintenance and monitoring and ensures all risks are mitigated in the long term (10,000 years). Closure of the TSFs is contingent on meeting BHP and regulatory requirements by building the closure knowledge base through field trials and testing to adequately inform the final landform. This paper is the case study of the OD mine TSF 1-3 closure trials.

Through a series of extensive technical studies, social engagements and field investigations, cover system field trials have been designed and developed to inform final closure design and construction. This collaboration of subject matter experts, engineering service providers, stakeholders and regulators over 18 months has resulted in a robust suite of field trials that includes:

- *a primary cover system field trial over 40,000 m^2 in area, with multiple layer thicknesses*
- *seven satellite cover system field trials to assess sensitivities such as vegetation, material types and performance under saturated conditions.*

The primary and satellite trials are constructed on the TSF tailings surface with locally sourced construction material. Industry standard monitoring instrumentation is installed and integrated with existing infrastructure to measure and record field parameters. Close collaboration between all stakeholders and contractors, including the Responsible Tailings Facilities Engineer and Tailings Engineer of Record, ensures risks have been identified and mitigation measures put in place prior to and during construction. Outcomes from field trials will be used to increase certainty in the design and construction of the optimised final closure landform and inform the closure plan.

Keywords: *TSF closure, closure knowledge base, closure field trials, case studies, lessons learned*

1 Introduction

The Olympic Dam mine (OD) is one of three operating mines within BHP's Copper South Australia asset (Copper SA). This copper-uranium-gold-silver mine produces process tailings that are stored in a series (currently six) of onsite paddock-style tailings storage facilities (TSFs). TSF 1-3 is inactive and has been subject to planning for a closure trial, which provides an opportunity to reflect on closure planning, knowledge

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building and the ultimate closure design of inactive TSFs through the design, construction and monitoring of in-field cover system trials.

This paper will present the background and context of the mine, closure outcomes and objectives, TSF closure trial design, layout, construction, monitoring, and the challenges and opportunities faced, and conclude with expected outcomes, timing and next steps.

2 Background

BHP Copper SA operates the OD mine, located 16 km north of the Roxby Downs township and 570 km north-northwest of Adelaide, in the Gawler Craton of South Australia, Australia (Figure 1). It is located on the traditional lands of the Kokatha people (BHP 2024a, 2024b). The current site layout in the proximity of TSF 1-3 is presented in Figure 2, highlighting the OD mine, processing plant, barrier wall, TSF 1-3 and TSF 4.

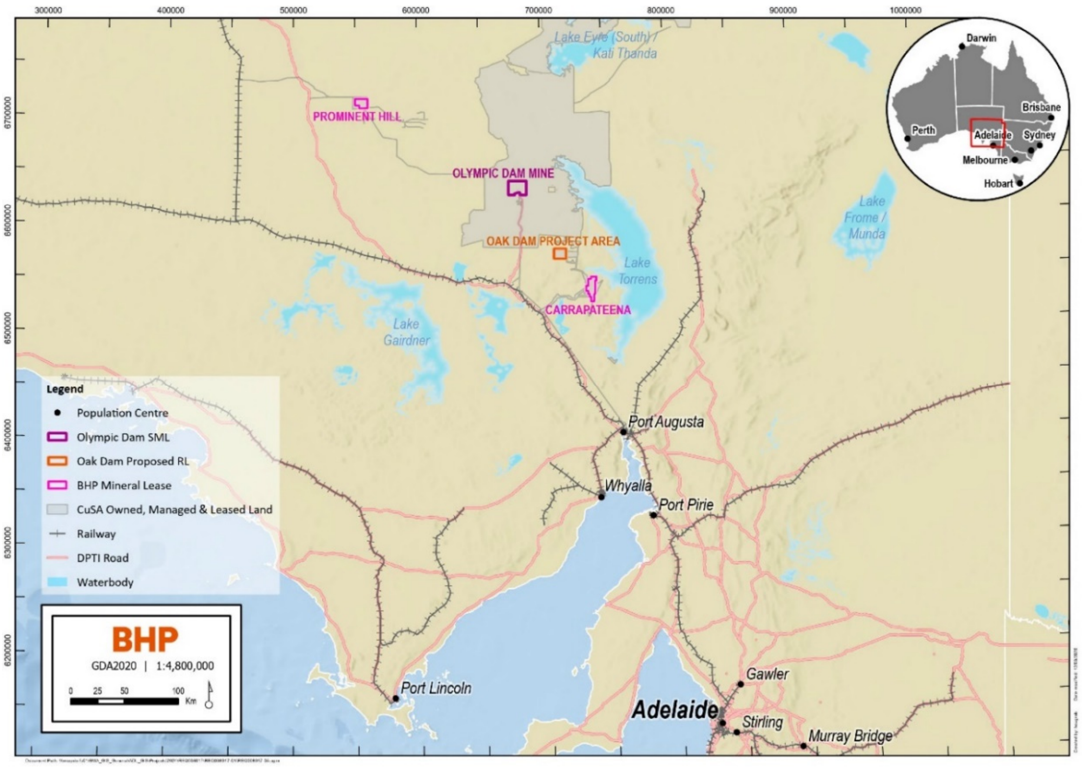

Figure 1 Location of Olympic Dam mine in South Australia

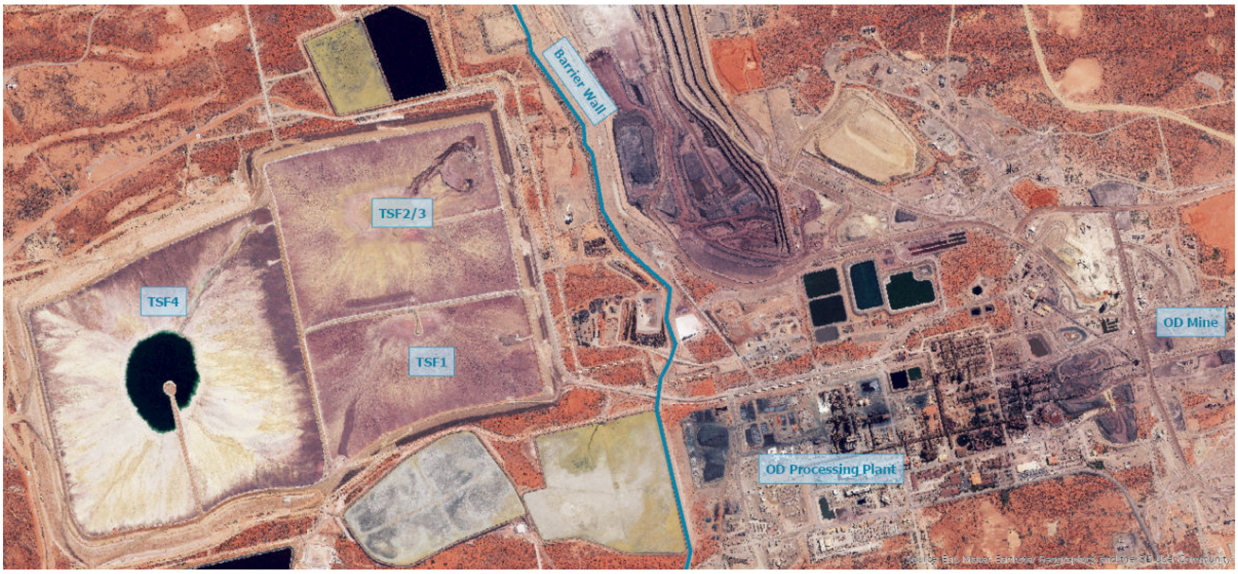

Figure 2 Plan view of the region and current configuration of Olympic Dam mine

The OD mine is in a relatively remote and sparsely populated area of South Australia. The Roxby Downs town is purpose-built to support the OD mine site. The population of Roxby Downs is very transient, with an estimated current population of 4,000 (Roxby Council c. 2024). Andamooka is a smaller community in the general area, 25 km from Olympic Dam, with a population of around 260. Port Augusta is the closest city to the OD mine at 270 km away and has a population of around 13,000. The primary industries in the region are mining, mineral exploration and pastoral activities.

2.1 Site context

The OD mine orebody was discovered in 1975 and in 1982 the Indenture Agreement between the Western Mining Corporation and BP Minerals joint venture and the South Australian Government was ratified, creating a legal framework for the development to proceed. Mine production at the facility commenced in 1988 and BHP took ownership of the mine in 2005.

The OD mine is one of the world's most significant deposits of copper, gold, silver and uranium (BHP 2024a). OD is one of three operating mines within Copper SA, producing copper cathode, gold and silver bullion, and uranium oxide concentrate. The commodities produced by Copper SA are transported by road and rail to our domestic customers and via the Adelaide and Whyalla ports to be exported to our global customers (BHP 2024a).

The OD mine is made up of operations consisting of almost 700 km of underground roads and tunnels (BHP c. 2025), surface operations and a fully integrated processing facility (from ore to metal). An automated train system hauls ore mined underground to crushing, storage and ore hoisting facilities, or ore is trucked directly to the surface via declines. OD mine has a fully integrated metallurgical complex with a grinding and concentrating circuit, a hydrometallurgical plant incorporating solvent extraction circuits for copper and uranium, a copper smelter, a copper refinery including an electro-refinery and an electrowinning-refinery, and a recovery circuit for precious metals (BHP 2024a).

Process tailings are stored in a series of TSFs, and excess process liquor that cannot be re-used in the process is evaporated in evaporation ponds. The TSFs and evaporation ponds are collectively referred to as the tailings retention system (TRS) (BHP 2023b), which incorporates all elements associated with the collection and disposal of tailings slurry and the return of tailings liquor, and includes tailings delivery, deposition and storage systems. There are currently six onsite TSFs, with TSFs 1-3 considered a single TSF based on similar life cycle stage, heights and management systems. TSF 1-3 is an above-ground facility that relies on constructed embankments to contain the tailings. The embankments are raised using the upstream method, with tailings deposited around the perimeter and a centrally located decant pond. The embankments incorporate the natural sand dunes within the TSF starter embankment and are raised using clay material mixed with tailings. The outer layer of the upstream raise consists entirely of clay to separate tailings from the outside environment and is armoured with rock for erosion protection (BHP 2024b)

TSF 1-3 ceased receiving tailings in 2011, is considered inactive and spans an area of approximately 150 ha. Closure field trials on a fraction of the total area will inform the optimised final closure design of this substantial facility (BHP 2024b).

2.2 Site characteristics

The Australian Bureau of Meteorology (BOM) has divided Australia into six main climatic zones (Australian Bureau of Meteorology 2006). OD is located within the "hot dry summer, cold winter" zone. The OD region is semi-arid, receiving an average annual rainfall of 151 mm and annual average evaporation of approximately 3,000 mm, recorded at the closest meteorological recording station (Roxby Downs Olympic Dam Aerodrome BOM Site No. 016096).

The temperature ranges from cool winters with a mean daily minima and maxima of 5°C and 18°C, respectively, to hot summers with a mean daily minima and maxima of 19°C and 37°C, respectively. Rainfall in the hot dry zone is low, unpredictable and erratic. Long sustained periods of intense rainfall are very rare, but large-intensity and short-duration storm events associated with thunderstorm activity can occur in any month.

The geology of the OD region dictates the hydrogeology. The surface geology consists of clays and calcareous materials underlain by about 50 m of limestone that varies in thickness. Below the limestone is approximately 200 m zone of quartzite, which sits atop the basement rock that contains the orebody. The groundwater aquifers exist at the interface of the limestone/quartzite and the quartzite/basement layers (BHP 2023b). Figure 3 presents a simplified geological cross-section.

Groundwater in the vicinity of the operation is of poor quality and, as defined by Environment Protection (Water Quality) Policy 2015 (Government of South Australia 2015) and Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) guidelines (ANZECC & ARMCANZ 2000), is not suitable for supporting the environmental value categories (aquatic ecosystems, recreation and aesthetics, drinking supply, primary industry). Local groundwater is also unsuitable for ore processing at OD mine (BHP 2023a). Hydro-geochemical modelling predicts that after closure, groundwater flow rates would be extremely slow due to the very low recharge rates and low regional hydraulic gradients. Impacted groundwater located beyond the special mining lease boundary would continue to travel outward, but distances travelled within a 10,000 year period are predicted to be less than 15 km (BHP 2023b).

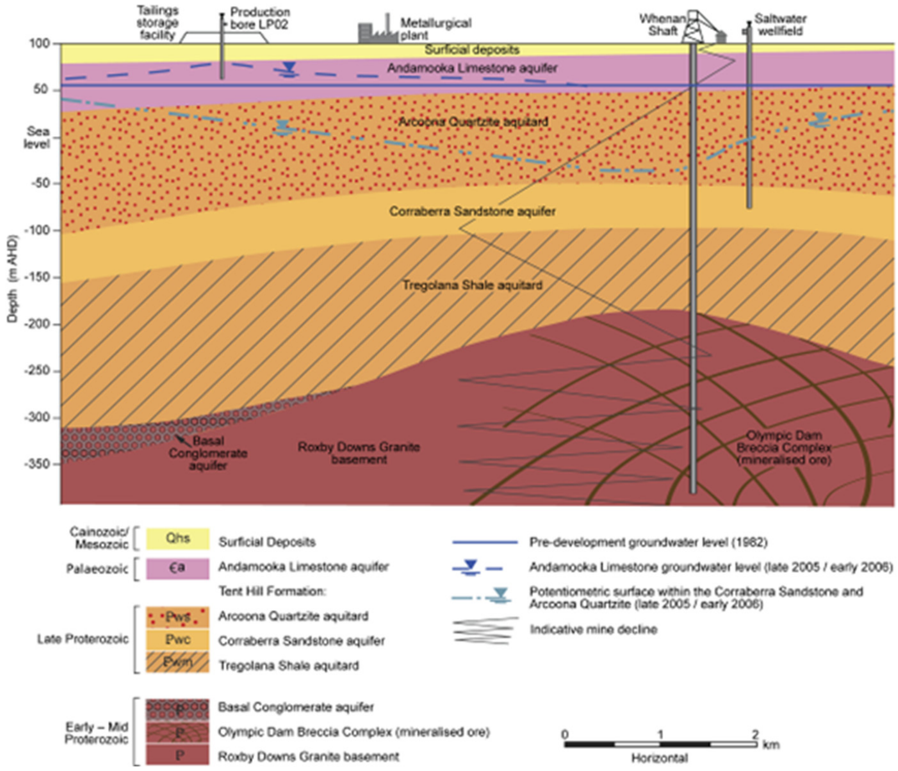

Figure 3 Simplified geological cross-section beneath the existing operations

3 Closure outcomes, objectives and design criteria

As defined in the Olympic Dam Closure Management and Rehabilitation Plan (CMRP) (BHP 2023b), the overarching closure outcome statement for OD mine is to create a safe, stable and self-sustaining landscape that is consistent with key stakeholder-agreed social and environmental values and aligned with creating optimal business value. The optimised closure outcome is relinquishment back to vacant Crown land, with potential for restricted grazing or restricted public and fauna access, depending on the proposed land use.

The closure outcome for TSF1-3 is aligned with the site, aiming to achieve a facility that is safe, stable and able to sustain the post-mine land use of vacant Crown land with restricted public and fauna access. The closure design principles and objectives associated with the TRS are presented in Table 1.

Table 1 Summarised closure design principles and closure objectives

Aspect	Design principle/closure objective
Design life/stability	Landform integrity to be maintained in perpetuity (10,000 year design life), acceptable rate of net infiltration (stability, seepage) Geotechnical and geochemical stability to reduce the need for long-term maintenance
Design storm	Tailings storage surface containment – probable maximum precipitation (PMP) or 1:10,000 annual exceedance probability if PMP data is not reliable
Radiation	No adverse impacts to public health or ecological communities as a result of radioactive waste within final landforms Radiation dose to the public < 1 mSv/year above natural background Deposition of closed site originated U238 less than 25 Bq/m2/y at non-human biota assessment sites

Aspect	Design principle/closure objective
Surface water	No unacceptable impairment of surface water quality
Groundwater	Tailings storage facilities (TSF) seepage will not cause unacceptable off-lease impact, compromise future land uses or have a significant adverse impact on vegetation No unplanned impairment of surface water or groundwater to the extent that it materially impacts third-party users or groundwater-dependent ecosystems
Seismicity	Post-closure TSF slopes stable for maximum design earthquake 1:10,000 years under all load conditions
Erosion	Erosion rate on TSF slopes will maintain the cover integrity commensurate with agreed future land use
Air	Air quality equal to or better than surrounding land use, no adverse impact to public health or ecological communities as a result of particulate or radioactive emissions from final landforms
Safety	Public and wildlife access appropriate to final landform/use of each domain
Vegetation	No impact to landform integrity or creation of a radiation pathway due to vegetation on the final landform

3.1 Radiation

Consistent with the radiation design principles, the TSF cover needs to attenuate radiation levels and radon emission from the TSF surface. As per the CMRP and the International Atomic Energy Agency (IAEA) Standard (IAEA 2018), this is currently 1 mSv/year above background levels. The project conducted a baseline radiation survey on the TSF 2 surface during the study. After the trials were constructed, the project once again took radiation readings to understand the performance of the cover trials in attenuating the radiation levels. In addition, a features, events and processes (FEPs) process was completed to chart out scenarios for radiation exposure post mine closure which will inform the safe limits of radiation. These scenarios would be used to validate the effectiveness of the cover system in attenuating the post-closure radiation impact from the tailing dams over 10,000 years.

3.2 Stakeholder engagement

Effective stakeholder engagement is a critical component of successful mine closure planning, where knowledge is gathered to inform mine closure processes and goals. Effective stakeholder engagement increases the likelihood that mine closure outcomes will be beneficial, for both the operator and the broader community. Working with stakeholders throughout the project life cycle assists in reflecting the needs of stakeholders in the rehabilitation objectives for the site.

Local community and regulatory stakeholder engagement specific to the closure outcomes, objectives and criteria of the proposed TSF closure was conducted to ensure all interests and concerns were understood, and that stakeholders are informed of relevant activities and progress. The proposed TSF1-3 closure trial methodology and design were endorsed, and support was received for the approach of multiple, smaller-scale satellite trials.

4 Tailings storage facilities closure trials design

Through a series of extensive technical studies, field investigations and social engagements, cover system field trials were designed and developed to capture variables that will inform final closure design and construction. These activities included:

- material characterisation to provide a greater understanding of the physical and geochemical properties of materials identified for use in the field trials and the tailings material upon which the trials were constructed
- vegetation assessment to provide an analogue of local vegetation communities and assess the likelihood of vegetation establishment and growth
- numerical modelling and design optimisation to provide increased confidence in three key areas – cover system design and performance, rock armour embankment erosion and TSF stability
- wind erosion assessment to provide a greater understanding of the impact of the most erosive force at OD, wind, using the Revised Wind Erosion Equation
- monitoring instrumentation assessment and selection to assess and select the most appropriate instrumentation, the number and placement of these instruments, and the method of data collection, including integration with existing technologies, for monitoring the field trials
- issue for tender and issue for construction to provide documentation required to engage contractors and service providers to execute construction
- stakeholder engagement to inform, listen to and align all stakeholders.

This collaboration of subject matter experts, engineering service providers, stakeholders and regulators over 18 months resulted in a robust suite of field trials that includes:

- a primary cover system field trial over 40,000 m^2 in area, with multiple layer thicknesses
- seven satellite cover system field trials to assess sensitivities such as vegetation, material types and performance under saturated conditions.

4.1 Primary trial

The key objective of the primary cover system field trial is to assess the effectiveness of borrow material of varying thickness on reducing net percolation, radon gas emissions and the migration of salts. The large area of the field trial (4 ha) serves several functions: it permits the use of an eddy covariance system (ECS) to measure actual evapotranspiration; it directs, collects and measures surface water run-off; and it allows assessment of surface erosion (wind and water).

The primary field trial uses a store and release cover system (designed for the temporary storage of infiltrated rainwater for later release to the atmosphere through evapotranspiration) and water-shedding, with three distinct zones, each similar in shape and area, with nominal layer thicknesses of 0.50, 1.00 and 1.50 m (Figure 4).

The trial is constructed from borrow material with a perimeter bund (berm) to eliminate edge effects and provide a safety barrier. The trial design contains and directs surface water to a run-off monitoring station at the northern extent of the trial. This area is lined with a geomembrane that provides an impermeable surface to minimise loss of run-off as infiltrated water.

Six monitoring stations are established on the trial sites, two for each distinct area. The trial also features an ECS, meteorological station and rainfall tipping bucket. A light vehicle access track constructed on the eastern side of the trial site is used for monitoring and maintenance during the trial period. The trial will be used to measure cover system performance on a large scale (water balance, wind erosion, vegetation, settlement).

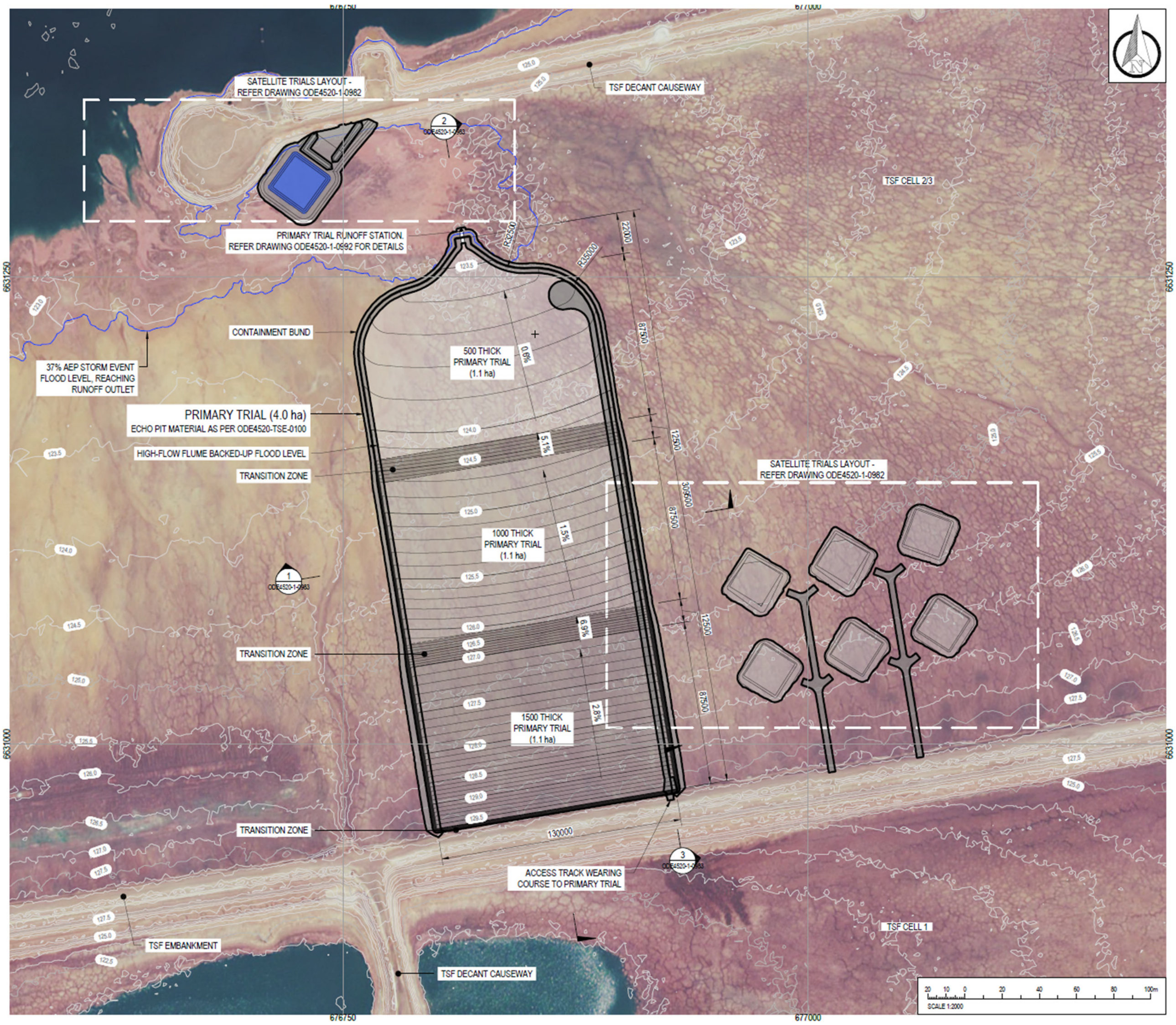

Figure 4 Extent of field trials showing the primary trial site (centre) and satellite trial sites (right and top)

4.2 Satellite trials

The key objective of the satellite cover system field trials is to provide a range of outcomes to increase our closure knowledge. The satellite field trials each have a thickness of 1.00 m and are located to the north and east of the primary field trial. A single monitoring station is installed in the centre of each trial plot. The satellite field trials are complementary to the primary field trial and will provide data on cover system performance to be used in sensitivity analysis for vegetation, material types and performance under saturated conditions.

4.2.1 Satellite trials (vegetated)

The key objective of the vegetated trials is to assess the likelihood of vegetation to establish and grow on the cover system materials.

There are three satellite field trials approximately 400 m^2 in area, with a perimeter buffer to reduce edge effects. The three satellite trials have different treatment variables applied to them so various rehabilitation and/or revegetation treatments can be assessed (Table 2). Each of the treatment variables has a purpose in either informing final closure objectives or informing best practice methods for rehabilitating the final TSF landform following completion of the field trials.

Table 2 Field trial vegetation configurations

Treatment variables	Primary trial	Satellite trial 1	Satellite trial 2	Satellite trial 3
Vegetation establishment	Yes	Yes	Yes	Yes
Topsoil application	–	–	–	Yes
Irrigation (initial)	–	–	Yes	Yes
Weed control	Yes	Yes	Yes	Yes

Native vegetation, including *Chenopod* shrubland species, are to be established across the trial plots.

Vegetation assessments will be conducted on an annual basis to remove weeds and record vegetation cover, vegetation species, observational data on vegetation health, observational data on fauna species and habitat features.

4.2.2 Satellite trials (material types)

The key objective of the satellite trials with differing material types is to assess the performance of locally sourced borrow materials for use in cover systems construction and, more broadly, closure.

There are three satellite field trials of the store and release type, each approximately 400 m^2 in area, with a perimeter buffer to reduce edge effects. The three satellite trials have materials from different borrow sources and varying properties, such as particle size distribution (PSD). The trials will also assess the ability of the borrow materials to mitigate the migration of radon gas from the underlying tailings material. Figure 5 displays the layout of the satellite trials.

Figure 5 Extent of satellite field trials (east of primary trial)

4.2.3 Satellite trial (water-holding)

The key objective of the water-holding satellite trial is to assess the upward migration of salts from the tailings under saturated conditions.

There is one water-holding satellite trial, located north of the primary trial, that will be repeatedly flooded with potable water to create ponded water on the surface within the confines of a 20 × 20 m barrier wall (Figure 6). Each ponded water event will require the application of approximately 240 m^3 of water, with four ponded water events created each year of the trial monitoring period.

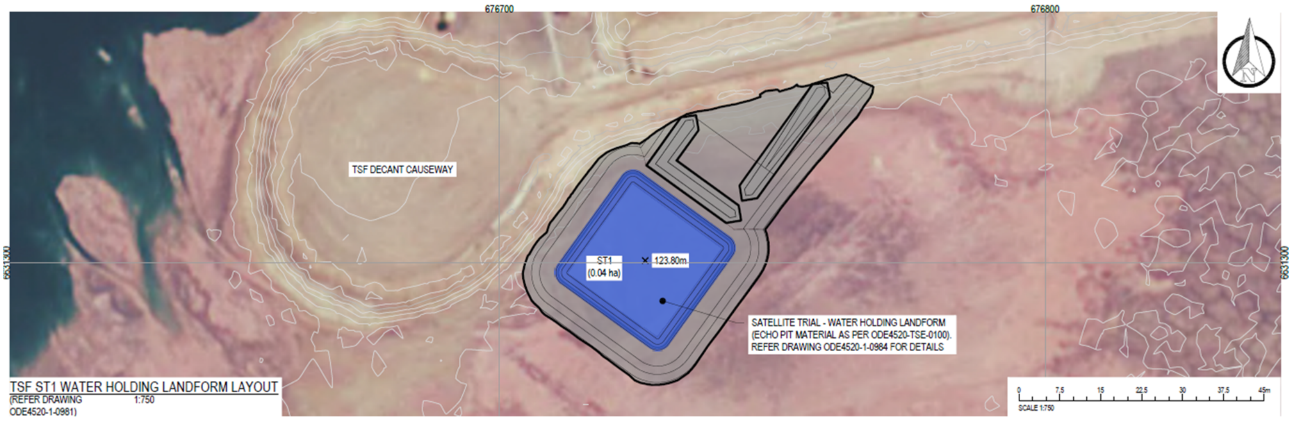

Figure 6 Extent of water-holding satellite field trial (north of primary trial)

The flooding events are designed to simulate a significant storm event (approximately 10-year storm or greater in rainfall magnitude) that would result in a decant-area pond and document the extent of upward migration of tailings salts into the cover system. The estimated water per ponded water event (240 m^3) is the equivalent of the water necessary to saturate the 1 m cover system and initially create a 0.3 m deep pond on the surface of the field trial. To ensure integrity, the trial site is bounded along the perimeter by an embankment and geomembrane designed to eliminate the lateral movement and loss of water (Figure 7).

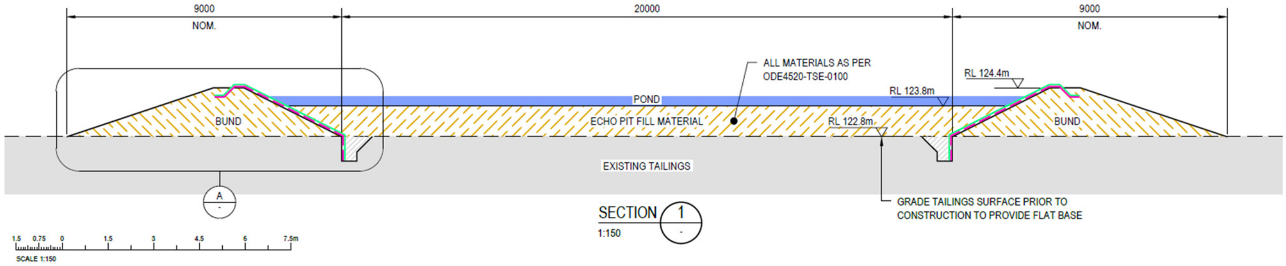

Figure 7 Cross-section view of a water-holding satellite field trial showing the geomembrane and retaining wall

4.3 Embankment erosion trials

To provide a comprehensive TSF closure assessment, the cover system trials are supported by embankment erosion field trials. There are three trial plots running perpendicular to the embankment crest, each 15 m wide and approximately 65 m long. The trials use the existing TSF embankment slopes and in situ material, and are monitored for movement with lidar measurements and for local precipitation with a rainfall gauge.

4.4 Instrumentation and monitoring program

Cover system field trial performance is monitored using instrumentation installed above, within and below the field trials. Instrumentation on the primary field trial includes six soil monitoring stations, one run-off monitoring station, one climate station and one ECS actual evapotranspiration station. Each of the satellite trials also has a soil monitoring station. Soil monitoring stations include sensors to measure volumetric water content, matric suction and water level pressure. These sensors are buried at regular intervals to capture measurements throughout the cover layer thickness and in the near-surface tailings. Therefore, the number of sensors varies with the thickness of the cover system field trial (Figure 8).

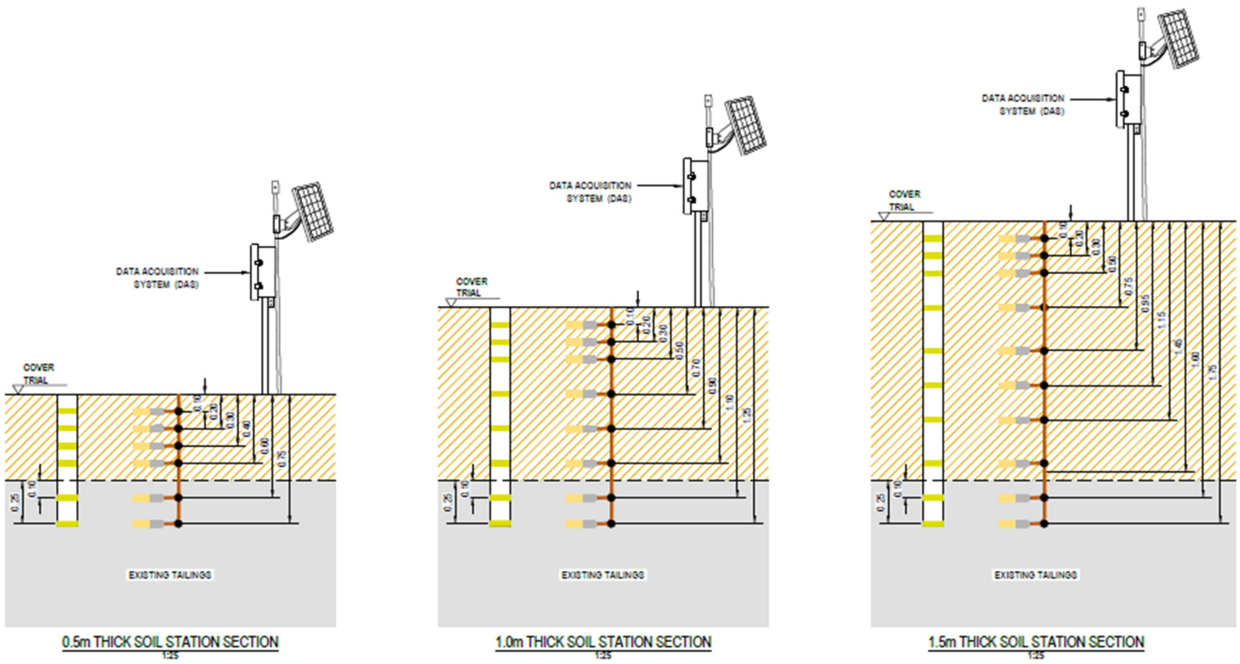

Figure 8 Cross-section view of a monitoring instrumentation installation

Sensors at each monitoring station regularly log data and are connected to a data acquisition system that is powered by a battery charged by solar panels. Each system is connected to the existing wireless network, currently used at OD mine for vibrating wire piezometers, with data able to be accessed remotely.

Data collected from the range of instruments over the monitoring period will be used to calculate net percolation using the water balance method.

5 Construction methodology and challenges

The trials' construction planning began during the study phase with the involvement of a suitable site construction contractor to support it under early contractor involvement (ECI) services, following which a tender package was prepared and contractors were invited to submit tenders. The sections below outline the steps taken to enable streamlined construction of the trials.

5.1 Early contractor involvement

The project engaged an established site earthworks contractor to provide ECI services. Scope for the ECI services included activities such as constructability review of the trials, construction risk assessment, and selection of borrow material locations and haul routes. The tailings operations and dams teams were engaged during this process to gain valuable feedback. This included discussing synergies on the use of cover material which resulted in the project selecting overburden from existing borrow sites used by the operations team for business-as-usual activities. Material samples were acquired using a site contractor and sent to the laboratory for analysis i.e. PSD. Water requirements were assessed during the ECI services, and the site water team was subsequently engaged to understand and agree on potable water requirements during and post construction of the trials.

5.2 Tailings Engineer of Record and Responsible Tailings Facilities Engineer governance

As part of BHP's commitment to ANCOLD and GISTM standards for managing tailings facilities, the RTFE and Tailings Engineer of Record (EoR) were engaged throughout the design and construction of the trials to ensure risks were identified and mitigation measures put in place prior to and during construction. In addition, the EoR conducted independent design reviews of the trials at completion of 60 and 90% of the design, and was engaged to review the trials' constructability, maintenance and monitoring plan, and to provide quality assurance during construction.

5.3 Construction contractor tender

To construct the trials, an invitation to tender was sent out to suitable earthworks contractors at the end of the design phase. Submissions were evaluated through a set of criteria which gave weightage to cost, onsite experience, relevant expertise and safety performance. In addition, consideration was given to contractors who had an existing presence onsite whereby synergies between various project works could be leveraged (i.e. mobilisation costs, resource sharing, office space).

5.4 Construction of supporting infrastructure

Through ECI work and preferred contractor selection, construction of supporting infrastructure was assessed. Upgrades to the existing ramp and crest of the inactive TSF were suggested to enable the use of an existing heavy vehicle fleet onsite. The contractor designed the upgrades, in addition to selecting materials for construction and methodology.

5.5 Construction of trials

For trials construction, overburden was extracted from existing borrow pits utilised by tailings operations and hauled to TSF 1-3 using existing haul routes. Samples were taken from the hauled material for geotechnical assessment. Material was spread in layers of 0.5 m until the desired thickness of each layer was achieved (Figure 9). Similarly, satellite trials were constructed as per the technical specifications and the design drawings developed. The water-holding satellite trial was constructed with a perimeter embankment and geomembrane liners to prevent lateral movement of the water. After construction of the trials, trenches were dug out at the prescribed locations for instrumentation installation. The engineering service provider was engaged to conduct quality assurance activities on the construction of the trials to ensure compliance to the design and technical specifications.

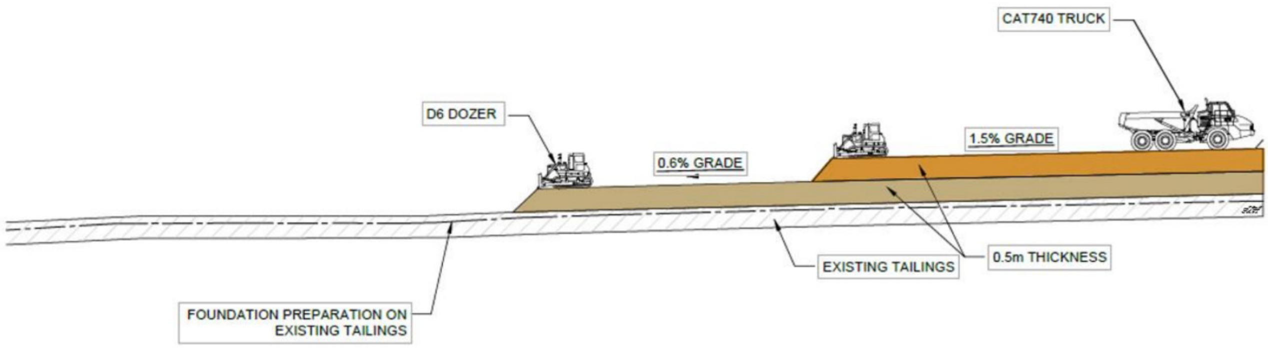

Figure 9 Trials construction methodology

5.6 Instrumentation

Cover trials require instrumentation to monitor their performance. The instrument package, which covered selection, procurement, configuration, delivery, installation and commissioning, was managed by the same contractor to ensure end-to-end accountability. Instruments were configured offsite and delivered to site. After construction of the trial plots, instrumentation was installed at the prescribed locations along with associated data acquisition and transmission infrastructure. This instrumentation was then integrated with the existing tailings monitoring infrastructure.

5.7 Vegetation

Through the study it was determined that some of the cover trials would be vegetated. An ecological contractor was engaged to assess the native flora and collect a selection of flora seeds from the locality, targeting species with capacity for rapid and low growth form. This contractor was then brought to site to seed the cover trials. Hand seeding was selected as the preferred method to seed, primarily due to the small size of the cover trial plots at a rate of approximately 20 kg/ha. After seeding, the trials surface was graded and followed up with watering as required.

5.8 Maintenance and monitoring

Cover trials are intended to be maintained and monitored for 3–5 years and will inform the final closure of TSF 1-3 at BHP’s OD mine. These activities are performed by the site tailings operations, technical tailings and environment teams. To set up the operational teams, the project developed an operational readiness plan that included developing dedicated maintenance plans and work instructions for the maintenance and monitoring activities. In addition, operational teams were trained to collect and review the monitoring data on a regular basis and engage a suitable engineering contractor to conduct annual reviews to ensure trials performed as intended.

6 Conclusion

This paper presents the case study of the design and construction of tailings storage facility (TSF) 1-3’s closure cover system field trials at Olympic Dam, South Australia. OD’s TSF 1-3 closure trials represent a key closure knowledge building step towards achieving a safe, stable and self-sustaining post-mining landscape consistent with key stakeholder-agreed social and environmental values, and aligned with creating optimal business value.

Through extensive planning, rigorous technical studies and proactive stakeholder engagement, BHP has designed and constructed a comprehensive suite of field trials to inform the final closure design of TSF 1-3, and of TSFs more generally across the site.

The TSF 1-3 trials, consisting of a 4-ha primary and seven 0.04-ha satellite trial sites, are designed to inform key closure objectives such as radiation attenuation, net infiltration, seepage, erosion control and vegetation establishment while also considering the unique site characteristics of the semi-arid environment. Construction of the cover trials and installation and commissioning of the monitoring equipment was completed in June 2025, with a multi-year monitoring period planned.

The proactive approach to early contractor involvement, the engagement of the Engineer of Record, and the detailed instrumentation and monitoring program present best practices for achieving a cover that will provide long-term environmental stewardship. By systematically assessing cover system performance and material types, and demonstrating desired closure objectives, the TSF 1-3 trials expect to generate real-time, in-field monitoring data to inform and optimise the final closure design. Data received through the trial monitoring period will be tracked, analysed for trends and compared to completion criteria, as well as communicated to stakeholders to facilitate effective and collaborative closure planning.

Closure objectives and completion criteria will be optimised through the monitoring period, with results and proposed closure designs documented in future iterations of the OD Closure Management and Rehabilitation Plan. Outcomes of the performance monitoring will directly inform the final closure design of TSF 1-3 and demonstrate a sustainable and responsible approach to progressive mine closure that aligns with stakeholder expectations, ultimately contributing to a positive legacy for the region.

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References

Australian Bureau of Meteorology 2006, *Climate Classification Maps*, viewed 12 March 2025, http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=tmp_zones#info

Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

BHP 2023a, *Olympic Dam IMS Element 8 - Environmental Management Program*, viewed 25 March 2025, https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/PEPR5684429.pdf

BHP 2023b, *Olympic Dam Mine Closure Management and Rehabilitation Plan*, viewed 3 July 2025, https://pid.sarig.sa.gov.au/document/mesac30628

BHP 2024a, *Annual Report*, viewed 3 July 2025, https://www.bhp.com/-/media/documents/investors/annual-reports/2024/240827_bhpannualreport2024.pdf

BHP 2024b, *Global Industry Standard on Tailings Management Public Disclosure*, viewed 12 March 2025, https://www.bhp.com/-/media/documents/media/reports-and-presentations/2023/230804_bhpgistmconformancestatementandpublicdisclosure.pdf

BHP ca. 2025, *Olympic Dam, South Australia*, viewed 12 March 2025, https://www.bhp.com/what-we-do/global-locations/australia/south-australia/south-australia-olympic-dam

Government of South Australia 2015, *Environment Protection (Water Quality) Policy 2015*, Adelaide.

IAEA 2018, *Prospective Radiological Environmental Impact Assessment for Facilities and Activities (GSG-10)*, Vienna.

Roxby Council ca. 2024, *About Roxby Downs*, viewed 12 March 2025, https://www.roxbydowns.sa.gov.au/lifestyleandsport/visitor-information/about-roxby-downs