BHP

Annual Environmental Protection and Management Program Report

Olympic Dam

1 July 2017 – 30 June 2018

Distribution

External Distribution	
Organisation	Contact Person
Department for Energy and Mining (DEM)	Director Mining Regulation Manager, Mining Compliance and Regulation
Department of Environment and Water (DEW)	Chief Executive Team Leader, Conservation and Mining Senior Hydrogeologist
Environment Protection Authority South Australia (EPA)	Director Operations Manager Radiation Protection
Great Artesian Basin Coordinating Committee	Chair
South Australian Arid Lands Natural Resources Management Board	Presiding Member

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Department	Contact Person
BHP Billiton	Asset President Olympic Dam General Manager Mine Olympic Dam General Manager Surface Olympic Dam General Manager Integrated Operations Head of Corporate Affairs Olympic Dam Head of HSE Olympic Dam Manager Legal Olympic Dam Superintendent Environment Analysis & Improvement Olympic Dam Head of Environment Analysis & Improvement Manager Environment Analysis & Improvement

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INTRODUCTION

Purpose and scope

This annual environmental protection and management program report (annual EPMP report) presents data relating to the environmental management of the BHP Olympic Dam operations for the period 1 July 2017 to 30 June 2018 (FY18).

The objectives are to:

- Meet the requirements of clause 11 of the Olympic Dam and Stuart Shelf Indenture (the Indenture) and condition 18 of the major development approval (10th October 2011).
- Report performance against environmental outcomes, compliance criteria and leading indicators presented in the 2017 Environmental Protection and Management Program (EPMP).
- Report performance against targets and continuous improvement actions also contained in the 2017 EPMP.
- Document the results of the deliverables presented in the monitoring programs (MPs) of the 2017 EPMP.

The 2017 EPMP was submitted to the Indenture Minister in October 2017 and subsequently approved.

Report structure

A description of the EPMP structure against which reporting is based is given below.

The reporting against outcomes is achieved through a hierarchy of data reporting (deliverables) and statements of compliance leading to an assessment of whether or not the environmental outcome has been met. The main chapters in the report are aligned to the key environmental aspect ID's contained within the EPMP.

The reporting hierarchy then takes the following form:

- Deliverables from the various MPs are included in the most relevant chapter, and a presentation of data and discussion of results is provided.
- The results of the deliverables contribute to the compliance statement for the compliance criteria under which they are reported (and in some cases to other compliance criteria, in which case appropriate cross-referencing is provided).
- These compliance criteria then provide a statement of achievement of the environmental outcome.

Performance against targets and continuous improvement actions is reported separately but still within the relevant ID chapter.

Table 1 contains a summary of each Environmental Management Program (EM Program) ID. This provides an overview of the outcomes and has the following elements:

- the environmental outcome to be achieved
- a 'traffic light' style indicator to indicate whether the outcome has been achieved.
- a statement that summarises whether or not the environmental outcome was achieved, and why.

EPMP STRUCTURE

Background

The structure of the EPMP report is closely aligned with the structure of the BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) 2017 EPMP, and in particular the EM Program contained within that document. The EPMP consists of a number of documents which form a portion of the Environmental Management System (EMS) requirements. A brief summary of each document within the EPMP is shown in Table 1.

Table 1: EPMP Structure

Document	Content summary
EMM	General overview of the EPMP. Purpose and scope. Regulatory framework. Background information about Olympic Dam and the expansion. Overview of the structure and requirements of the Environmental Management System. Glossary of defined terms. Cross-referencing of EPMP content to approval conditions and the requirements of the Mining Code.
EM Program	Addresses potentially significant environmental aspects and impacts, identified through analysis and prioritisation of environmental risks, legal obligations and community concerns. Documents the processes, systems and actions used to manage the prioritised aspects and impacts.
MP(s)	Address assessment and performance of the EM Program's outcomes, compliance criteria and targets, control mechanisms and legal and other requirements.
Actions, Targets and Major Changes	Captures continuous improvement opportunities and development opportunities identified that can assist in meeting compliance criteria and environmental outcomes and improving ODC's environmental performance, environmental improvement targets and the action plan to achieve such targets.
Mine Closure and Rehabilitation Plan	A plan for closure and rehabilitation of the mine, including the environmental outcomes expected to be achieved indefinitely, and options for progressive rehabilitation.

The EM Program documents the processes, systems and actions used to manage prioritised aspects and impacts, including the incorporation of:

- the environmental values that may be impacted, and the key risks to those values;
- the environmental outcomes that BHP aims to achieve;
- clear, specific and measurable compliance criteria that demonstrate achievement of the outcome(s);
- leading indicator(s) criteria, providing early warning of trends that indicate a compliance criteria may not be met;
- the management and operational controls in place to deal with the environmental risk (aspects and impacts), including any regulatory conditions; and
- contingency options to be used in the event that identified risks are realised.

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EXECUTIVE SUMMARY

Overview

The FY18 Annual EPMP Report demonstrates compliance and environmental improvements against the 2017 Environmental Protection and Management Program (EPMP).

Data from monitoring programs is presented as evidence against compliance criteria under the Environmental Management Program (EM Program) IDs.

Considerable progress against environmental outcomes and compliance criteria in the 2017 EMP and actions and targets was made during the reporting period.

Major Achievements

Following is a list of major achievements for the reporting period:

- A trial of seven Cat Grooming Traps was facilitated by ODC in FY18. The trial took place over a five week period in February – March 2018 and sprayed a total of 39 cats, with an overall success rate of 51 %. ODC is currently investigating the applicability of deploying units as a cat management technique at Olympic Dam and other BHP assets.
- There has been a trend of reduced radioactive process spills over the past seven years. During FY18, there were 13 radioactive process material spills across site, which occurred at the SX, hydromet; concentrate and TRS areas. The number of radioactive process material spills shows a decreasing trend since FY11 from ~75 spills down to ~13 spills an annum. This is attributed to planned maintenance and work management through 1SAP.
- An investigation was conducted to determine how point source SO_2 emissions from the Olympic Dam Mine site main stack influenced ambient SO_2 levels in the surrounding region; and if these ambient SO_2 levels impact plant diversity in the area and sulphur uptake in plant leaves. 24 sites between ~0.03 and 25km from the main stack were studied. The study determined that the ambient SO_2 in the Olympic Dam region is very low and generally below 0.0001 ppm over the monitored period. This is mainly due to the fact that the Olympic Dam Mine recovers/captures approximately 99 % SO_2 to produce sulphuric acid and provides good dispersion of the small amount of residual SO_2. Although monitored vegetation sites demonstrated differences in diversity no significant relationship between plant diversity and leaf sulphur content was observed.

  Existing research suggests that if there is an increase of ambient SO_2 levels above 0.007 ppm but below 0.046 ppm there could be either positive or negative effects on plant communities in the Olympic Dam region. Ongoing operations and possible expansions at Olympic Dam are highly unlikely to increase ambient SO_2 levels to such an extent. This is due to the design of the gas cleaning equipment that captures approximately 99% of the generated SO_2, and good dispersion of the small amount of residual SO_2 which results in compliance with Environment Protection (Air Quality) Policy 2016 ground level concentrations for SO_2.
- The new monitoring system of salt deposition monitoring with sampling jars located on the edges of the SML has been operational for a full reporting year. Background salt deposition monitoring results recorded for the monitoring period are below the background limit of 20mg/m^2/day. The data collected supports the technical assessment undertaken to justify the change to the monitoring program and demonstrates that the majority of saline emission deposition is within a 250m radius of each raise bore. This is due to improved design requirements for the raise bores which require 20m splash ponds with surrounding barricades/walls.
- Following the approval and construction of the Contaminated Waste Disposal Facility (CWDF) a project was initiated to decommission the temporary contaminated waste facilities and clean, prepare, test and dispose of the waste as per the approved CWDF Waste Management Plan. The project ensured implementation of cleaning and recycling strategies in order to minimise contaminated waste. The project commenced in May 2017 and was completed ~

October 2017. The project successfully processed 5979 tonnes of waste; of this amount 3007 tonnes, or ~50%, were cleaned, tested and removed off-site for recycling. The remaining 2972 tonnes was tested and prepared for disposal as per the CWDF Plan.

Compliance summary

Table 3 lists the environmental outcomes for each EM Program ID. Next to each outcome 'traffic light' style indicators have been used to allow for overview assessment of achievement of the outcome, as follows:

- ● (green) Environmental outcome achieved
- ▲ (blue) Significant progress towards achieving the Environmental outcome
- ● (red) Environmental outcome not achieved.

The approved 2017 EMP contained 22 environmental outcomes, 26 compliance criteria and 15 leading indicators. An additional 14 targets, and 23 actions, which are aspirational and support the environmental outcomes and compliance criteria against which ODC is assessed. All environmental outcomes and compliance criteria were achieved or were within prescribed limits and all targets and actions were also achieved.

No leading indicators were triggered during the period reported in the 2017 EPMP.

Table 3 provides a summary of the environmental outcomes assessed during FY18.

Table 3: FY18 Compliance Summary

ID 1 USE OF NATURAL RESOURCES	
ID 1.1 Land Disturbance and Rehabilitation	
Environmental outcome	Outcome Statement
● No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of the construction, operation and closure of Olympic Dam.	No significant adverse impacts to populations of listed species as a result of the construction and operation of Olympic Dam occurred. No closure activities were undertaken during FY18. One species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and four species listed under the *National Parks and Wildlife Act 1972* (NPW Act), were observed interacting with the TRS during FY18.
ID 1.2 Aquifer Level Drawdown	
Environmental outcome	Outcome Statement
● No significant adverse impacts to existing third-party users' right to access water from within the GAB wellfield Designated Areas for the proper development or management of the existing use of the lands as a result of ODC activities.	Drawdown and percentage wellhead pressure loss at pastoral bores remains less than the predicted long-term impact as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016), and significantly less than the maximum drawdown area defined within the 10 m contour. Environmental flow rates at GAB springs remained above predicted long term impacts as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016).
● No significant adverse impacts to the availability and quality of groundwater to existing Stuart Shelf third-party users as a result of groundwater drawdown associated with ODC activities.	No significant impact to groundwater for existing Stuart Shelf third-party users has occurred. Regional groundwater levels are stable.
● No significant adverse impact on groundwater-dependent listed species or ecological	Drawdown remains less than the predicted long-term impact and was within compliance criteria limits for FY18. Environmental flow rates at GAB springs remained above predicted long term impacts as presented in the EIS (Kinhill Engineers 1997,

communities as a result of groundwater drawdown associated with ODC activities.	updated Golder Associates 2016). Monitoring showed no indication of a significant adverse impact on groundwater-dependent listed species or ecological communities.

ID 2 STORAGE, TRANSPORT AND HANDLING OF HAZARDOUS MATERIALS

ID 2.1 Chemical and Hydrocarbon Spills

Environmental outcome	Outcome Statement
● No significant site contamination of soils, surface water or groundwater, as a result of the transport, storage or handling of hazardous substances associated with ODC's activities.	No significant site contamination of soils, surface water or groundwater occurred in undisturbed areas in FY18. All spills were appropriately contained and cleaned up as soon as practicable. Active monitoring and management of legacy hydrocarbon sites was continued during FY18.

ID 2.2 Process Material Spills

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of radioactive process material spills from ODC's activities.	BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from operational activities and radioactive emissions, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1mSv/y limit. During FY18 there were no radioactive process material spills outside operational areas. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken by ODC
● No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive process material spills from ODC's activities.	No significant impacts to populations of listed species or ecological communities were recorded as a result of operational activities, including the effects from any radioactive process material spills. Impacts to listed species and ecological communities are avoided by ensuring that there is no uncontrolled loss of radioactive material to the natural environment. As there was no loss of radioactive material to undisturbed environment in FY18, no impact to populations of listed species or ecological communities occurred.

ID 3 OPERATION OF INDUSTRIAL SYSTEMS

ID 3.1 Particulate Emissions

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of particulate emissions from ODC's activities.	No adverse impacts to public health as a result of particulate emissions from operations conducted by ODC occurred during FY18. Condition 49(a) of the Major Development Approval prescribes ground level criteria for dust concentrations. Measured ground level dust concentrations derived from operations at Olympic Dam and recorded at sensitive receptor sites were below compliance criteria for PM_{10} dust at all times during FY18.

ID 3.2 Sulphur dioxide emissions

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of sulphur dioxide emissions from ODC's activities.	There were no adverse impacts to public health as a result of sulphur dioxide (SO_2) emissions from ODC's activities during FY18. National Environmental Protection Measure (NEPM) levels for ambient air quality are based on protection of human health. Roxby Downs and Olympic Village ambient SO_2 analyser results for the reporting period showed no exceedance of the NEPM for ambient air quality SO_2 at either Olympic Village or Roxby Downs Township.

ID 3.3 Saline aerosol emissions

Environmental outcome	Outcome Statement
● No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of ODC's activities.	No significant adverse impact to populations of listed species from saline aerosol emissions was observed during FY18. Observations made during environmental inspections and supported by data collected during various flora and fauna monitoring programs, did not find any significant adverse impacts to listed species.

ID 3.4 Radioactive emissions

Environmental outcome	Outcome Statement
● No adverse impacts to public health as a result of radioactive emissions from ODC's activities.	BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from operational activities to less than a small fraction of the 1mSv/yr public dose limit prescribed by the International Commission on Radiological Protection (ICRP). As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at ODC.
● No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive emissions from ODC's activities.	There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODC's activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota assessment sites is used as an indicator of the potential exposure of listed species to radioactive emissions. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

ID 3.5 Greenhouse gas emissions

Environmental outcome	Outcome Statement
● Contribute to stabilising global atmospheric greenhouse gas concentrations to minimise environmental impacts associated with climate change.	BHP's climate change strategy focuses on reducing our operational greenhouse gas (GHG) emissions, investing in low emissions technologies, promoting product stewardship, managing climate-related risk and opportunity and working with others to enhance the global policy and market response. As a BHP group asset, ODC operates under the BHP group strategy.

ID 4 GENERATION OF INDUSTRIAL WASTES

ID 4.1 Embankment stability of TSF

Environmental outcome	Outcome Statement
● No significant TSF embankment failure.	During FY18 the Tailings Storage Facilities (TSFs) were managed in accordance with the TRS Operations, Maintenance and Surveillance Manual (BHP Olympic Dam 2017d) and the Tailings Management Plan (BHP Olympic Dam 2017e) and no embankment failures of any magnitude occurred.

ID 4.2 Tailings seepage

Environmental outcome	Outcome Statement
No significant adverse impact on vegetation as a result of seepage from the TSF.	No significant adverse impact to vegetation as a result of seepage from the TSF has occurred. Eighty metres AHD (20 m below ground level) is considered as the level below which groundwater cannot interact with the root zone of plants in the Olympic Dam region. Groundwater levels in the vicinity of the TSF remain below 80 mAHD.
No compromise of current and future land uses on the Special Mining Lease (SML) or adjoining areas as a result of seepage from the TSF.	No compromise of current and future land uses on the SML or adjoining areas has occurred. Groundwater levels in the vicinity of the TSF remain below 80 mAHD and sampling indicates that seepage is being attenuated.
No compromise of the environmental values of groundwater outside the SML as a result of seepage from the TSF.	No compromise of the environmental values of groundwater outside the SML has occurred. Sampling indicates that seepage is being attenuated within the SML, and groundwater levels of bores along the SML are consistent with other regional bores. Seepage modelling has been updated to demonstrate that there are no expected future offsite impacts.

ID 4.3 Fauna interaction with Tailings Retention System

Environmental outcome	Outcome Statement
No significant adverse impacts to listed species (South Australian, Commonwealth) as a result of interactions with the Olympic Dam TRS	No significant adverse impacts to listed species as a result of interactions with the Olympic Dam Tailings Retention System (TRS) have occurred. One species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and four species listed under the *National Parks and Wildlife Act 1972* (NPW Act), were observed interacting with the TRS during FY18.

ID 4.4 Solid waste disposal

Environmental outcome	Outcome Statement
No significant adverse impacts as a result of management of solid waste.	The Resource Recovery Centre (RRC) effectively manages solid waste as per the EPA approved Landfill Environmental Management Plan 2016 (LEMP). No evidence of material environmental harm was identified through routine auditing or based on the reporting of materials disposed of to the landfill. No significant adverse impacts resulted from the management of solid waste at Olympic Dam during FY18.

ID 4.5 Radioactive waste

Environmental outcome	Outcome Statement
No adverse impacts to public health as a result of radioactive waste from ODC's activities.	BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from radioactive waste, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1 mSv/yr limit. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at Olympic Dam.
No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive waste from ODC's activities.	There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODC's activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota assessment sites is used as an indicator of the potential exposure of listed species to radioactive waste. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

ID 5 INTERACTION WITH COMMUNITIES

ID 5.1 Community interaction

Environmental outcome	Outcome Statement
● Residents in Roxby Downs, Andamooka and Woomera trust ODC to act in their best interests.	Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is a trusted organisation within its local communities. In addition to this, ODC provides employment to local and regional communities.

Note: Individual monitoring programs are referred to in this document with a two letter abbreviation as follows: Fauna – FA; Flora – FL; Great Artesian Basin – GA; Groundwater – GW; Environmental Radiation – ER; Airborne Emissions – AE; Energy Use and Greenhouse Gas (GHG) Emissions – EG; Waste – WA; Surface water – SW; Social Effects – SE

1 Use of natural resources

1.1 Land disturbance and rehabilitation

1.1.1 Environmental Outcome

No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of the construction, operation and closure of Olympic Dam.

No significant adverse impacts to populations of listed species as a result of the construction and operation of Olympic Dam occurred. No closure activities were undertaken in FY18.

One species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and four species listed under the *National Parks and Wildlife Act 1972* (NPW Act), were observed interacting with the TRS during FY18.

1.1.2 Compliance criteria

No significant impact to the size of an important population of a community of native species dependent on natural discharge of groundwater from the Great Artesian Basin, including *Eriocaulon carsonii. NOTE: Significant impact is as defined in the Significant Impact Guidelines and greater than predicted in the EIS.*

Potential impacts to communities of native species dependent on natural discharge of groundwater from the Great Artesian Basin (GAB) are discussed in Chapter 1.2 on Aquifer Level Drawdown. Within the region studied, populations of *Eriocaulon carsonii* were restricted to 18 spring vents in the Hermit Hill, North East and Lake Eyre springs complexes in FY18. It was absent from two springs (HHS074 and HHS122) where it was recorded in FY17. However, it was recorded on two springs where it had been observed previously (HHS119 and HNWlawn), but not in FY17. The average abundance of *Eriocaulon carsonii* observed in FY18 (9±2) was slightly higher than FY17 (7±2). Overall, 89 of the 104 springs monitored could be sampled for invertebrates (due to the availability of standing water). In FY18, target invertebrate species were observed on most springs. While the percentage occurrence for all target species is highly variable, no trends were observed over time for most springs. Therefore, it is concluded that no significant impact to the size of an important population of Category 1a flora species has occurred in FY18.

No loss of an important population of Plains Rat (*Pseudomys australis*).

No loss of an important population of Plains Rat occurred as a result of land disturbed by ODC activities. No known preferred habitat was cleared during FY18. Vegetation clearance was primarily restricted to the SML with small amounts of disturbance occurring in the near vicinity.

Clearing of vegetation not to exceed the total area of 17,269 hectares as indicated in the EIS (DEIS and SEIS).

Clearing of vegetation as indicated in the 2009 EIS did not exceed the total area of 17,269 ha (BHP Olympic Dam 2009). As at 30 June 2018 a total of 768 ha of land was cleared subject to an offset. The amount reported in FY18 was less than FY17 as the method for reporting data was improved so that land was potentially not double counted. The offset provisions indicated in the 2009 EIS do not apply to land approved for clearing under previous EIS approvals prior to 2003. This is discussed in further detail in Section 1.1.6.

1.1.3 Deliverables (FA 2.1)

An annual report of monitoring and control actions undertaken within the SML and surrounding areas.

During FY18, a total of 343 traps were set with an average of 29 traps set per month. Over this period, a total of 72 cats were caught. Therefore, the overall trap success rate was 21%. The overall trap success rate was greater than last financial year. Areas of focus included Roxby Downs Village, Olympic Dam Village, the Resource Recovery Centre and office buildings on the SML.

ODC remains committed to control efforts for cats and monitors the presence of other feral animals. In FY18, ODC facilitated a trial of seven automated Cat Grooming Traps (hereafter Felixer) on the northern boundary of the SML over a five week period. In total, 39 cats were sprayed by the Felixers and several of these cats had previously walked past Felixers without activating them for various reasons (Read 2018). The overall success rate was 51%. Although evidence from the pen and radiocollared cat trials at Arid Recovery indicates that most sprayed cats die peacefully, the lack of decline in cat detections throughout the trial suggests a large and mobile feral cat population (Read 2018).

The deployment of Felixers was conducted according to APVMA permit 80962 and Adelaide University AEC permit S-2015-223, both issued to John Read of Ecological Horizons.

Throughout FY18, three wild dogs were observed opportunistically south of the dog fence in the vicinity of Olympic Dam and Roxby Downs. ODC remains committed to work in conjunction with the South Australian Natural Resources South Australian Arid Lands Management Board (NRM SAAL) to opportunistically control wild dog numbers (see SA Arid Lands Wild Dog Management Plan 2015).

In FY16, ODC together with Arid Recovery re-established an historical spotlight transect program that monitors the density of rabbits, cats, foxes and kangaroos in the Olympic Dam region. ODC worked with the Department of Primary Industries South Australia (PIRSA) to facilitate the release of a Korean strain of rabbit haemorrhagic disease virus (RHDV) known as K5 in the Roxby region in March FY16 (Figure 1). From July 2016 to April 2018, a significant decline in rabbit numbers has been observed at the Andamooka transect ($F_{1,14} = 6.388$, $p = 0.024$; $R^2 = 0.313$), but not at the Roxby Downs transect ($F_{1,14} = 4.365$, $p = 0.055$; $R^2 = 0.238$; Figure 1). Considering the close proximity of the release site to the Roxby Downs transect, it is viable that the release of the K5 virus is not responsible for the decline in rabbit numbers at the Andamooka transect. Rather it's more probable that a reduction in available resources as a consequence of low rainfall in the region may have resulted in fewer rabbit sightings.

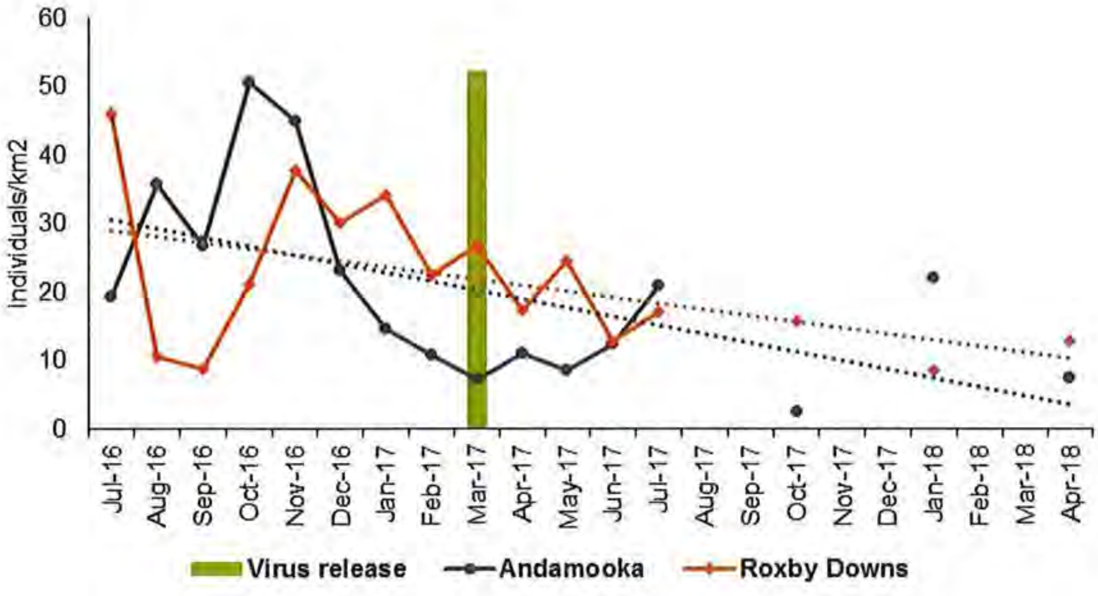


Figure 1: The density of rabbits observed pre- and post- K5 virus release.

An assessment of the abundance of specific feral and abundant species within the region.

Quarterly spotlight counts of two transects within the Olympic Dam region showed that rabbits exist in the highest density compared to other introduced species (i.e., foxes, cats and wild dogs) and abundant natives species (i.e., kangaroos) during FY18 (Figure 2). However, rabbit numbers remain below pre-RHDV1 release in 1995 (Pedler et al. 2016). Kangaroos were the next most abundant species, followed by cats, foxes and wild dogs (Figure 2). Due to the cautious nature of wild dogs, it is recognised that the spotlight transect method may not be the best for capturing wild dog abundance data.

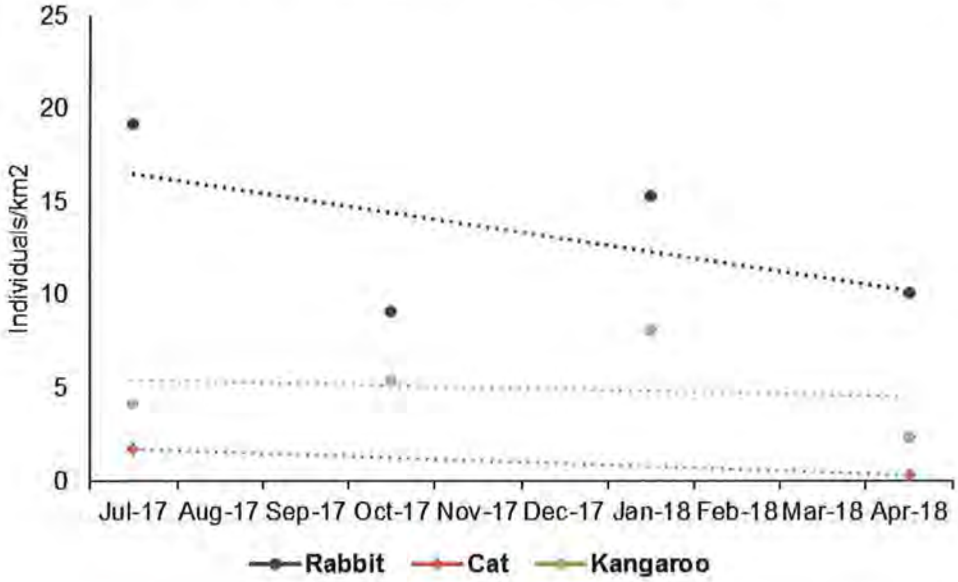


Figure 2: Density of rabbits, cats and kangaroos observed in the Olympic Dam region in FY18.

1.1.4 Deliverables (FL 2.3)

Define and map the current distribution of extreme and high risk weed species within the Olympic Dam region, Roxby Downs Municipality, the expanded SML and Gosse Springs SEB areas.

Identification of whether measures are required to control declared weeds and plant pathogens in the operations area.

Routine and opportunistic observations were undertaken throughout the reporting period. A total of 13 pest plant species were recorded during FY18, comprising of nine declared species (Table 4). Moreover, an additional 33 pest plant species are known to persist in the SML/Municipal lease region (i.e., infestations recorded FY14 to FY18 that are known to still be active). Control efforts for a number of these species were undertaken throughout FY18. No self-sustaining population of previously un-recorded species of declared pest plants were observed. Despite this, it was determined that control measures were still required for the continued management of pest plants.

A baseline weed assessment undertaken within the Gosse Springs SEB area during FY16 recorded no declared species and two species, Common sow thistle and Ruby dock, listed as 'significant' by the South Australian Arid Lands Natural Resources Management Region. No pest plant species were recorded in FY18. The FY18 distribution of declared and other high risk pest plant species is shown in Figure 3 - Figure 5. In many cases a single GPS location may reference a large infestation area, and as such distribution of weeds such as Ruby Dock, Salvation Jane, Caltrop and Blackberry nightshade may be more extensive than appears on the map below.

Table 4: A list of declared and other high risk weed species observed in the SML, Municipal lease region during FY18.

Declared weed species	High risk weed species
African Boxthorn	Blackberry nightshade
Athel pine	Couch grass
Buffel grass	Onion weed
Caltrop	Paddy melon
Fountain grass	Potato weed
Gazania	Prickly lettuce
Innocent weed	Ruby dock
Prickly pear	Saffron thistle
Salvation Jane	Stemless thistle
	White cedar
	Wild oats

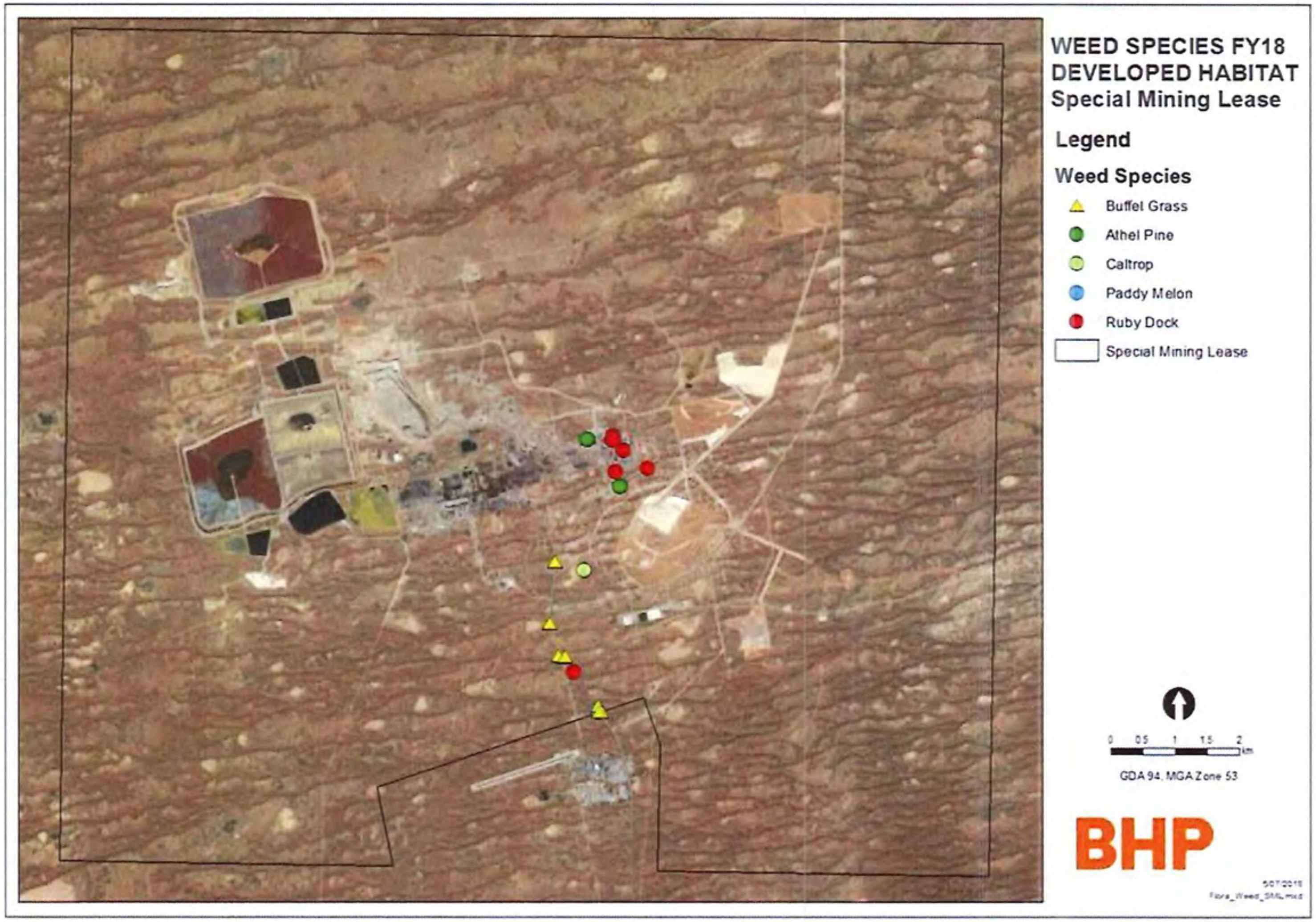


Figure 3: Locations of Declared and high risk weed species on the SML in FY18

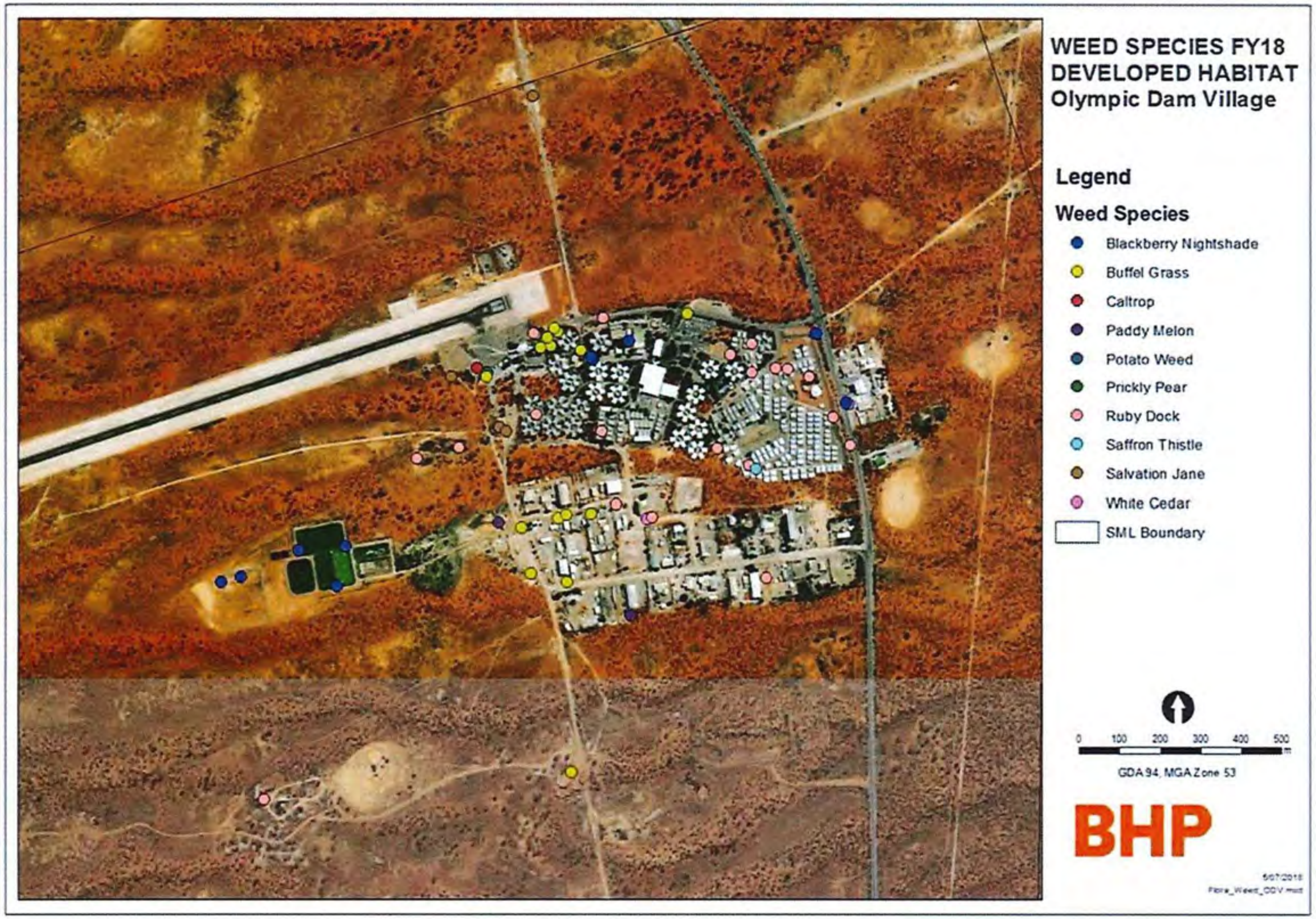


Figure 4: Locations of Declared and high risk weed species at Olympic Dam Village (within the Municipal Lease) in FY18

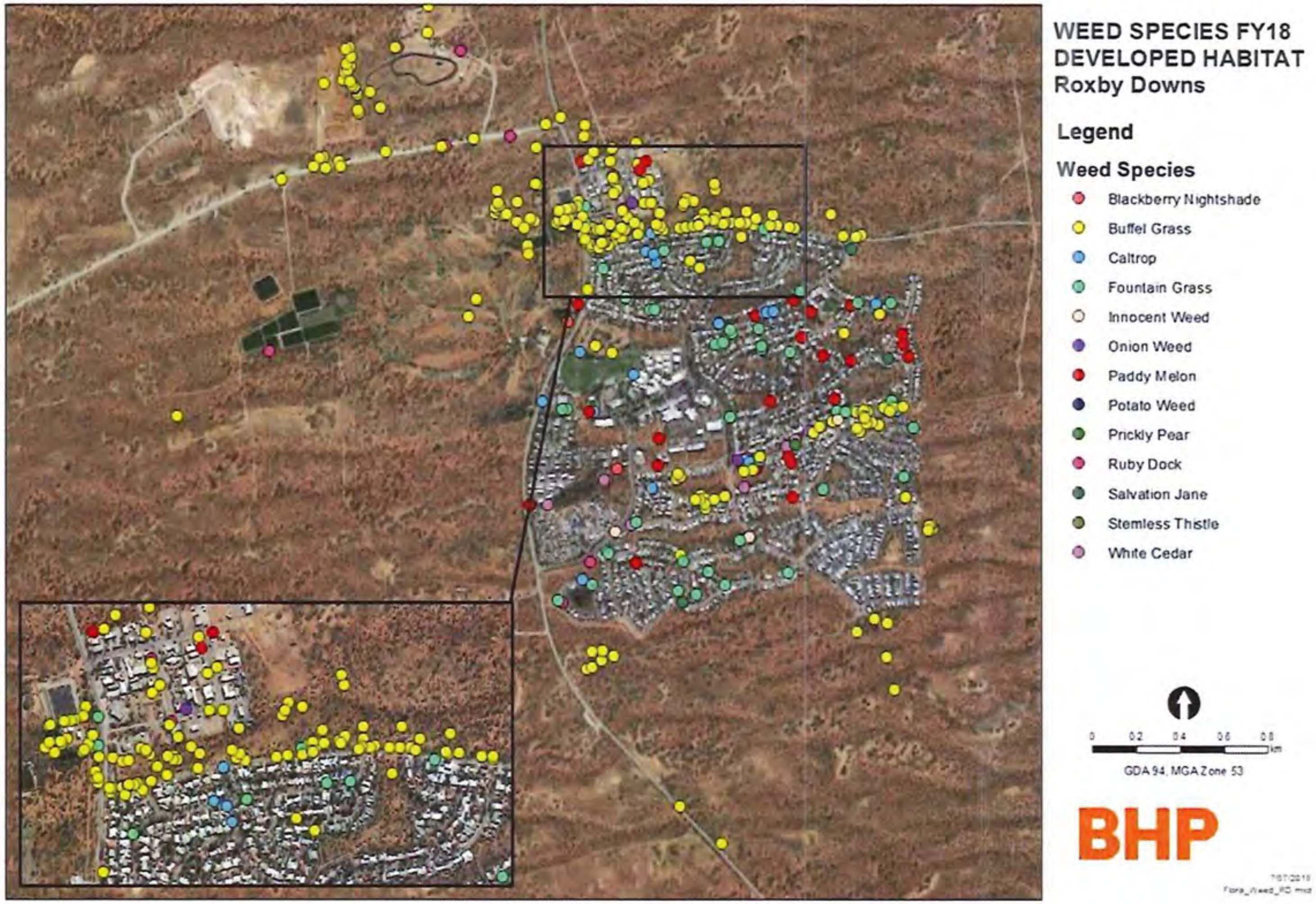


Figure 5: Locations of Declared and high risk weed species in the Roxby Downs urban area (in the Municipal Lease) in FY18.

1.1.5 Deliverables (FL 2.4)

A map of the known locations of 'At-risk' species within the impact area of the Olympic Dam operation.

A statement of impacts to, and measures undertaken to avoid 'At-risk' species.

'At-risk' species include species known to occur in the region that are either listed as Threatened or greater under state, national and/or international legislation or considered regionally or locally significant and have the potential to be adversely impacted by operations. This includes species that have a wider distribution within the state, interstate or overseas and are therefore not considered to be critically dependent on existing populations within the potential impact area (Figure 6 and Figure 7).

No known 'At-risk' flora species were impacted by disturbance activities during FY18. Efforts are made wherever possible to avoid these species during the Environmental Disturbance Permit (EDP) process.

A map of known locations and important habitats for 'At-risk' fauna species is shown in Figure 7. These data are maintained and updated as required, to assist in the EDP process.

No additional management activities were required for 'At-risk' species during FY18.

Figure 6: Potential and confirmed habitats of 'At-risk' flora species.

Figure 7: 'At-risk' fauna species potential and confirmed habitats.

1.1.6 Deliverables (FL 2.4)

A map of the direct disturbance impact footprint of ODC's Olympic Dam activities.

A statement of comparison between the impact footprint of ODC's Olympic Dam activities (i.e. within and outside the SML) and the offset areas under SEB processes, to track progress towards a life of mine ratio of 8 ha set aside for each hectare disturbed.

In 2010 the Gosse Springs Native Vegetation Management Plan was approved to establish a Significant Environmental Benefit (SEB) offset area of 10,963 ha. All land disturbance that is subject to an environmental offset under legislation is tracked though the EDP procedure and allocated an appropriate SEB offset ratio.

Total offset areas are then subtracted from the total SEB offset area that have been approved by the Native Vegetation Council, and a remaining SEB offset is reported in Table 5.

Spatial analysis techniques were utilised on geo-referenced orthoimagery for FY18. During this reporting period, satellite imagery of the vast majority of the SML was captured on a quarterly basis (captured in September 2017, December 2017, March 2018 and June 2018), offering an accurate account of the timing of land disturbance. Disturbances identified as occurring between these dates were digitised and are represented in Figure 8. The total area of disturbance that occurred during FY18 is 241.1 ha (Table 5).

The majority of disturbance for FY18 is attributed to works associated with the Tailings Retention System.

As at 30 June 2018 a total area of 758.8 ha of land requiring offset had been cleared resulting in an SEB offset of 6,470.9 ha, with an average offset ratio greater than 8.6. A balance of 4,492.1 ha remained in the Gosse Springs SEB offset area.

The total area of disturbance related to Olympic Dam activities is currently 4,826.9 ha. This figure is inclusive of rehabilitation areas and Roxby Downs town facilities, water pipelines and other associated infrastructure.

Table 5: Areas of Disturbance and SEB Offset Areas as at June 2018.

	FY18 (ha)	Total Area (ha)	SEB offset (ha)	Average SEB Ratio
Gosse Springs Offset Area	-	-	10,963	-
Maximum Area Permitted to be Cleared as Indicated in the EIS	-	17,269	-	-
Land disturbed subject to an SEB offset*	16.6	758.8	6,470.9	8.6
Land disturbed not subject to an SEB offset*	224.6	4,068.1	-	-
Total Land Cleared**	241.1	4,826.9	-	-
SEB Balance Remaining in Reserve ***	-	-	4,492.1	-

* This figure includes areas where permission was granted to clear under the SEB offset policy prior to the approval of the EIS in 2011. It is based on a conservative calculation where the higher offset value of any permit issued over the area is used, which can result in small co-mission errors.

** This figure includes all land cleared to date as a part of ODC activities under previous EIS approvals.

***Slight variations will occur from year to year due to continuous improvement of the mapping layer.

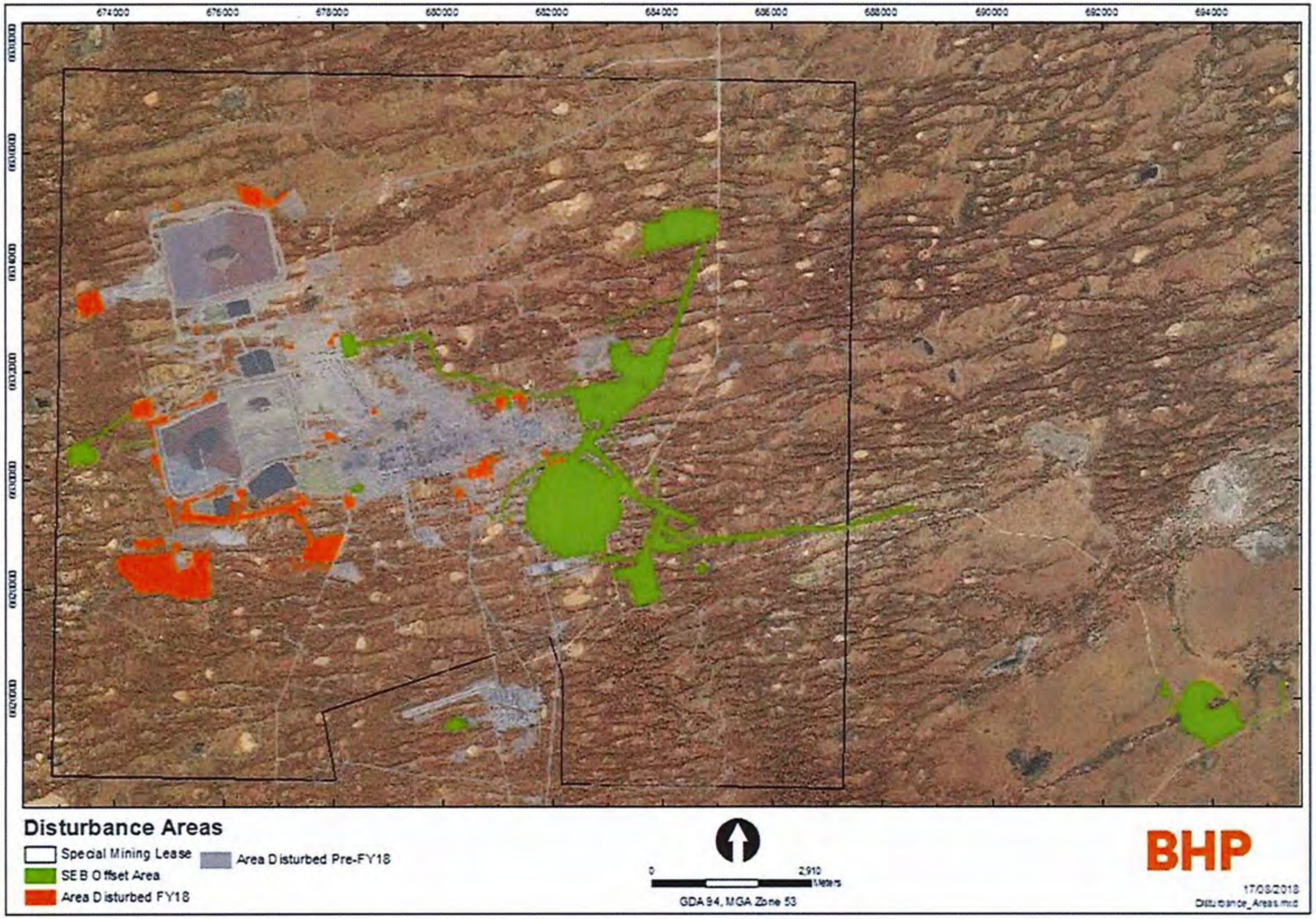


Figure 8: Areas of disturbance as at June 2018 (SML).

1.1.7 Deliverables (FL 2.5)

A summary of actions achieved from the SEB implementation plans within the fiscal year through the Annual EPMP Report.

An annual report to the government on SEB management outcomes through the Annual EPMP Report.

Shapefiles of the SEB areas for inclusion in relevant departmental databases.

Prior to FY18, a number of actions were undertaken by ODC within the Gosse Springs SEB area. The Heritage Agreement was ratified by the Lands Titles Office, formalising this tenure aspect over the Gosse Springs SEB area. A new fence was also installed along the eastern boundary of the Gosse Springs SEB area and three dedicated parking areas have been constructed within the SEB area encouraging visitors to park prior to approaching the spring vent.

ODC commissioned a baseline vegetation survey of the Gosse Springs SEB area to record species cover and abundance using landscape representative quadrats. The baseline survey also targeted known threatened species locations and land systems to aid in the identification of priority management areas. The baseline survey also recorded the location of introduced species to guide weed management processes. The weed species locations have been added to ODC's weed management database and the Gosse SEB area has been included into the latest ODC Weed Management Work Instruction. A targeted survey for pest plant species within the SEB area was undertaken in September 2015. This data improves upon the broader assessment undertaken in an earlier vegetation survey and will be used to prioritise pest plant management within the SEB area.

During FY18:

- Monitoring of the cover and abundance of vegetation on the mound springs within the SEB area continued in FY18 and now forms part of the vegetation monitoring programme for Olympic Dam.
- Routine inspections were undertaken of car parks at Gosse, McLachlan and Fred Springs and SEB tracks.
- The SEB area was monitored for pest plants and animals. Horses were removed from Gosse Springs and tracked back to Stuart Creek Station.

A shapefile of the Gosse Springs SEB area has been provided to the Geographical Information System (GIS) Administrator – Native Vegetation and Biodiversity Management Unit of the South Australian Government. No further SEB areas have been implemented. The shapefiles of existing and proposed SEB offset areas are available in a standard GIS format that can be made available for other departmental databases as required.

1.1.8 Leading Indicators

- None applicable.

1.1.9 Targets

- None applicable.

1.1.10 Action plan FY18

Align pest plant and animal control with SAAL NRM objectives.

ODC has worked with the SAAL NRM Board to align our pest plant and animal control efforts with SAAL NRM regional objectives. As a result, ODC is working towards expanding its influence to pastoral lease holders in regards to pest plant and animal management (BHP Olympic Dam 2017a).

Develop pest plant and animal management (monitoring and control) effort guidelines.

During FY18, the Pest Animal Monitoring and Control Work Instruction (BHP Olympic Dam 2018b) was updated in an annual process to ensure continuous improvement of our processes. The Work Instruction encompasses an effort-based approach for feral cat management and targets problematic areas such as Roxby Downs Village, Olympic Village and the Resource Recovery Centre. Adherence to the strategy is measured through 1SAP to ensure that management targets are met.

Continue to implement actions and identify progressive rehabilitation opportunities in the site Rehabilitation Strategy.

Several actions associated with the cessation of Olympic Dam expansion pre-commitment works continued throughout FY18. The Rehabilitation Strategy actions associated with these works are described in Table 6. Regular photo point monitoring has shown that in some areas where specific stabilisation measures were adopted, an increase in vegetation coverage has occurred. See Figure 9 to Figure 12 as examples. Areas where compaction and saline water was used to minimise passive dust generation have showed signs of natural re-vegetation.

The open pit area is now surrounded by works associated with the underground expansion of the Southern Mine Area. Therefore, no further rehabilitation plans are in place for areas associated with pre-commitment works. Access to the pit itself and the immediate surrounding areas remains restricted.

Due to the underground mining method used at Olympic Dam, large scale rehabilitation works were not required during FY18. The EDP process requires temporary disturbances (i.e. excavation for pipe maintenance and cable installations) to be remediated through topsoil replacement and scarification to promote natural re-vegetation.

Planning for demolition of redundant equipment will continue in FY19, with demolition of the Old Gold Room due to commence early FY19.

Table 6: Rehabilitation Strategy actions undertaken in FY18.

Rehabilitation Strategy Action	Comment
Set up photo monitoring points for the area cleared for the proposed contractor's village on Andamooka Station to visually monitor soil stability.	Six monitoring sites were established in May 2012 and continue to be monitored on a biannual basis through photo points. The area continues to show progressive re-establishment of local plant species (Figure 9 to Figure 12).
Regular inspection of proposed contractor's village area for erosion.	The site of the proposed contractor's village is inspected during biannual photo point monitoring and other time-in-field excursions. Minor erosion from high rainfall events is visible within the Hiltaba area but does not warrant corrective action.

Review closure risks and assumptions through annual workshop.

The FY18 Annual Closure and Rehabilitation Plan review included a Closure Planning Workshop in March 2018. This workshop was held with the relevant internal stakeholders.

The following were implemented to update the Closure Estimates for the Current and Life of Asset Disturbances and associated Closure Risk Register:

- The mine closure date remained constant at FY2086;
- The Life of Asset 2020 (LoA20) Optimised Base Plan will update any changes.

Figure 9: Photo point ENV 492 at Hiltaba taken May 2013.

Figure 10: Photo Point ENV 492 at Hiltaba taken March 2018 showing natural re-vegetation is occurring.

Figure 11: Photo Point ENV 490 at Hiltaba taken May 2013.

Figure 12: Photo Point ENV490 at Hiltaba taken March 2018.

1.2 Aquifer level drawdown

1.2.1 Environmental Outcome

No significant adverse impacts to existing third-party users' right to access water from within the GAB wellfield Designated Areas for the proper development or management of the existing use of the lands as a result of ODC activities.

Drawdown and percentage wellhead pressure loss at pastoral bores remains less than the predicted long-term impact as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016), and significantly less than the maximum drawdown area defined within the 10 m contour.

No significant adverse impacts to the availability and quality of groundwater to existing Stuart Shelf third-party users as a result of groundwater drawdown associated with ODC activities.

No significant impact to groundwater for existing Stuart Shelf third-party users has occurred. Activity associated with the open pit and RSF have ceased, and the Motherwell wellfield has not been constructed, substantially reducing any potential for groundwater impact. Regional groundwater levels are stable.

No significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities.

Drawdown remains less than the predicted long-term impact and was within compliance criteria limits for FY18. Environmental flow rates at GAB springs remained above predicted long term impacts as presented in the EIS (Kinhill Engineers 1997, updated Golder Associates 2016). Monitoring showed no indication of a significant adverse impact on groundwater-dependent listed species or ecological communities as a result of groundwater drawdown associated with ODC activities.

1.2.2 Compliance criteria

A 4 m drawdown limit at the point on the designated area for Wellfield A that is mid-way between GAB8 and HH2 based on the 12-month moving average (GA 2.5).

At the end of FY18 average drawdown between GAB8 and HH2 was 1.3 m (BHP Olympic Dam 2018c).

A 4 m drawdown limit for Wellfield B at the point between monitoring bores S1 and S2 (measured as the average drawdown of the two bores) and based on the 12-month moving average (GA 2.5).

At the end of FY18, the average drawdown between S1 and S2 was 0.2 m (BHP Olympic Dam 2018c).

A drawdown footprint for Wellfield B, measured as the area contained within the 10 m drawdown contour, that is less than or equal to 4,450 km^2 (GA 2.5).

At the end of FY18, the area contained within the 10 m drawdown contour line was 2,382 km^2 (BHP Olympic Dam 2018c).

No material change in the availability and quality of groundwater at existing bores in the Stuart Shelf area operated by third-party users.

Monitored water levels and quality in the Stuart Shelf area are consistent with historical levels, and do not indicate any change in the availability of groundwater at existing bores (see sections 1.2.8 and 1.2.9).

1.2.3 Leading Indicators

No leading indicator trigger values were reached. Drawdown trends at monitoring bore S1 (for Wellfield A) remain well below threshold values, as does the drawdown footprint area for Wellfield B. Flow and water quality parameters at GAB springs, and drawdown trends at GAB pastoral bores, are stable and remain within the predictions of the 1997 EIS. Water quality in the Stuart Shelf area remains unaffected.

1.2.4 Deliverables (FL 2.2)

An evaluation of the composition of vegetated wetlands within the GAB springs.

In total, 30 flora species were observed, not including Atriplex (HDB004 and LMS001) and Frankenia (HDB004 and HOW009) that could not be identified down to a species level. The greatest number of species observed on one spring was 10 (HHS157, HHS161 and LGS003), while the least number of plants observed on one spring was zero (WWS013).

The abundance of plant species observed was plotted against the occupancy, where occupancy is calculated as the percent of springs on which a species occurred and abundance is the percent of quadrats, for each spring, on which a species occurred, averaged over all springs (Figure 13). Similar to FY16 and FY17 monitoring results, *Cyperus laevigatus* and *Phragmites australis* were the most abundant species followed by *Fimbrostylis dichotoma*, *Sporobolus virginicus* and *Baumea juncea*. Trianthema sp. was also identified separately to *Spergularia rubra* in 2015 and hence Trianthema is now moderately abundant comparative to other species observed. *Eriocaulon carsonii* was also moderately abundant, however, springs with *Eriocaulon carsonii* are targeted in this survey.

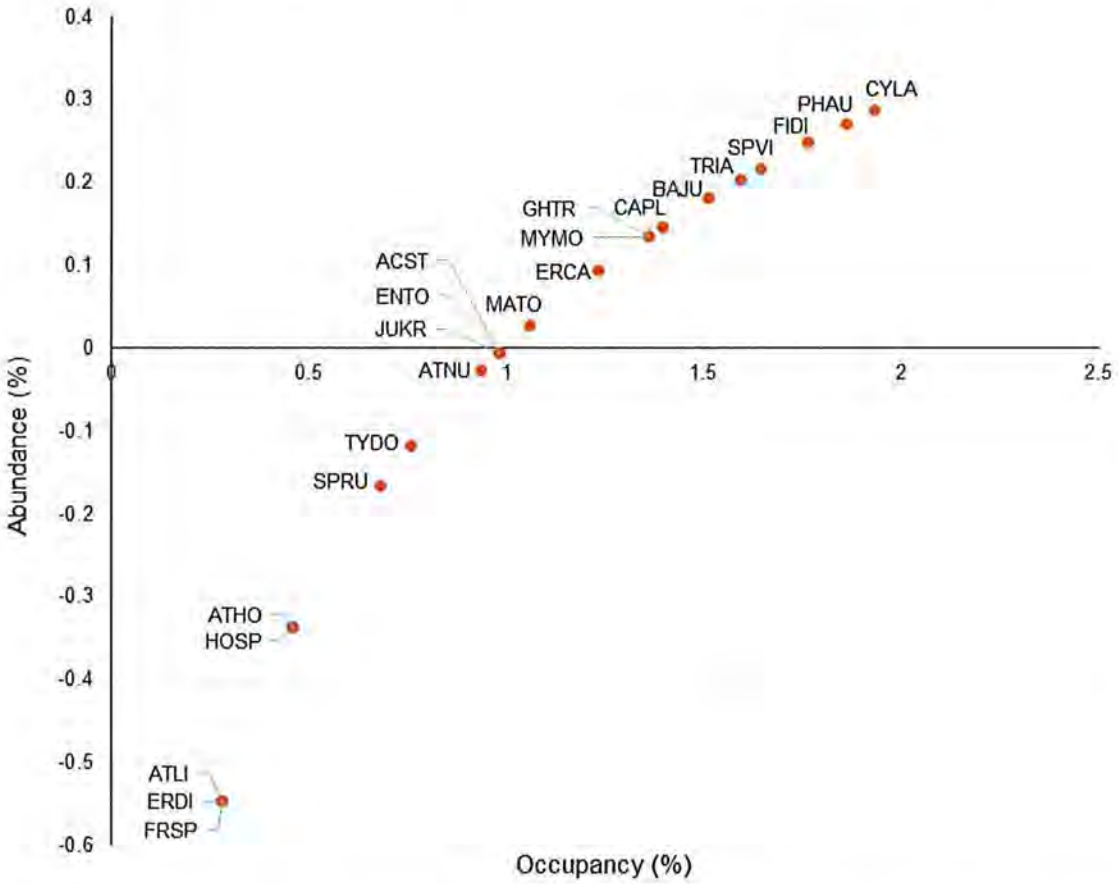


Figure 13: Distribution of 21 of the most abundant species recorded on all GAB springs monitored as a log function of the percent of springs occupied (x-axis) and the mean quadrat percent frequency (y-axis). The four letter codes refer to species names.

Using the Bray-Curtis dissimilarity metric, springs with a species composition greater than 50 % similarity were grouped together. Spring WWS013 was excluded from the analysis as it had no flora species present (FY16-FY18). Monitoring results from FY18 identified 9 dendrogram groups (Figure 14), unlike the FY16 analysis, which identified 10 dendrogram groups and the FY17 analysis, which identified 12 dendrogram groups.

Similar to previous monitoring years, HHS125 constituted its own group (i.e., Group 2) characterised by a relatively high frequency of *Juncus kraussi* and *Sporobolus virginicus*. Similar to FY17 data, LGS003 also constituted its own group (i.e., Group 1) characterised by relatively high frequencies of *Calocephalus platycephalus* and *Spergularia rubra*. The largest group, Group 3, was characterised by relatively high frequencies of *Phragmites australis* and *Baumea juncea*. This result was similar to previous monitoring years (FY16-17). Group 4 included only HHS160, which was characterised by a relatively high frequency of *Sporobolus virginicus,* Trianthema sp. and *Phragmites australis*. Monitoring results of HHS160 were relatively similar between FY16 and FY18. Therefore, slight differences recorded in other spring groups have resulted in it being placed in a separate group. Group 5 was characterised by a relatively high frequency of *Phragmites australis*. Group 6 was characterised by a relatively high frequency of *Cyperus laevigatus* and *Fimbrostylis dichotoma*. It was also the only group which consisted of both *Phragmites australis* and *Typha domingensis*. Group 7 was characterised by a relatively high frequency of *Typha domingensis* and *Cyperus laevigatus*. Group 8 was characterised by relatively high frequencies of *Calocephalus platycephalus* and *Cyperus laevigatus*. Finally, Group 9 was characterised by relatively high frequencies of *Cyperus laevigatus*.

In addition, *Eriocaulon carsonii* occurred in relatively low frequencies in only two groups, Group 3 and 6, both of which were dominated by *Phragmites australis* and *Cyperus laevigatus*, respectively. Both groups were found to have the greatest average percentage of standing water present, 83 % and 95 %, respectively. The remaining groups had less than 68 % of springs with standing water present. Therefore, the species composition of particular species, including *Eriocaulon carsonii*, may be reliant of the presence of standing water. The occurrence of *Eriocaulon carsonii* is explored further below.

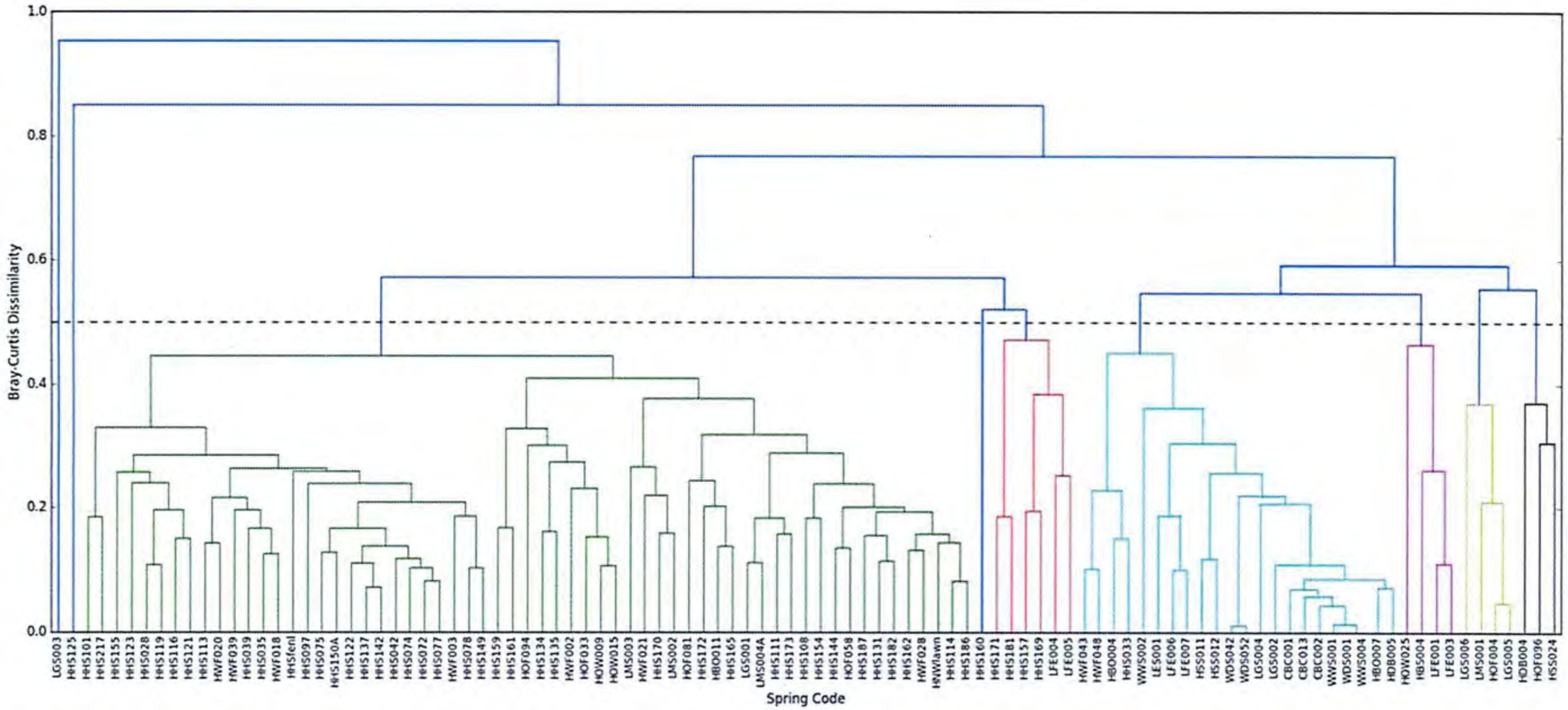


Figure 14: Springs grouped according to species composition (>50 % similarity) using hierarchal clustering. Springs groups are labelled from 1-9 from left to right.

A comparison of the abundance and distribution of *Eriocaulon carsonii*, per impact zone, with previously reported values, to determine impacts to the GAB springs.

Within the region studied, populations of *Eriocaulon carsonii* were restricted to 18 spring vents in the Hermit Hill, North East and Lake Eyre springs complexes in FY18. *Eriocaulon carsonii* occurred on the Hermit (13 springs), Gosse (2), West Finniss (1), North West (1) and Sulphuric (1) spring groups *Eriocaulon carsonii* was uncommon and limited in abundance where it did occur. It ranged in percentage abundance on any one spring vent on which it occurred from 2.4 – 45 %. *Eriocaulon carsonii* occurred on both spring mounds and spring tails.

Eriocaulon carsonii was recorded again on HNWlawn after not being recorded in FY17. It is likely that *Eriocaulon carsonii* was present in FY17, however, due to the large size of the spring and the unknown location of *Eriocaulon carsonii* to the FY17 observers (Alice Taysom (ODC) and Gilbert Whyte (GHD)) it was missed. As a result, the number of quadrats for HNWlawn was reviewed and increased to 100.

Using a nonparametric ANOVA for dependent samples, the average abundance of the 26 springs identified as suitable *Eriocaulon carsonii* habitat from FY15-18 has shown that there has been no significant impact to the size of an important population of *Eriocaulon carsonii* ($F_{2,26} = 7.435$, $p = 0.024$; Figure 15). Therefore, it is concluded that no significant impact to the size of an important population of *Eriocaulon carsonii* has occurred in FY18.

Table 7: Comparison of *E. carsonii* results in FY15 – FY18.

Spring group	Spring vent	Units monitored in FY15[2]	FY15 (cover class)	FY16 (percent abundance)	FY17 (percent abundance)	FY18 (percent abundance)
Hermit Hill	HHS028	-	-	8.7	13.5	29.7
	HHS033	-	-	1.6	2.7	5.4
	HHS035	-	-	0.0	2.8	11.1
	HHS072	M	1	1.4	0.0	0.0
	HHS074	M	1	2.7	5.1	0.0
	HHS075	M	0	1.4	0.0	0.0
	HHS077	-	-	0.0	7.7	7.7
	HHS078	-	-	5.5	20.5	11.8
	HHS114	S	1	1.7	0.0	0.0
	HHS116	M	2	1.4	8.3	8.3
	HHS119	S	2	0.0	0.0	22.2
	HHS121	-	-	0.0	2.9	17.1
	HHS122	M	2	0.0	2.8	0.0
	HHS123	-	-	6.3	30.5	8.3
	HHS131	M	1	1.8	4.7	2.4
	HHS144	S	1	0.0	0.0	0.0
	HHS150A	M/S/T	1	2.6	5.4	8.1
	HHS154	T	1	0.0	0.0	0.0
	HHS155	-	-	3.9	15.0	17.5
	HHSfenl	T	6	13.0	10.5	17.5

Spring group	Spring vent	Units monitored in FY15[2]	FY15 (cover class)	FY16 (percent abundance)	FY17 (percent abundance)	FY18 (percent abundance)
North West	HNWlawn	T	1	1.7	0.0	2.9
Old Finniss	HOF058	S	1	0.0	0.0	0.0
Sulfuric	HSS012	M	2	3.2	2.7	5.4
West Finniss	HWF043	S/T	3	9.8	11.5	9.6
Gosse	LGS002	M/T	2	12.3	18.0	8.0
	LGS004	S/T	3	18.9	26.7	45.0

Notes:

1. Because of the change in monitoring program, not all of the results are directly comparable.
2. Up until (and including) 2014, springs units were monitored separately: A spring unit is a morphological component of a spring: the vent, mound, or tail. The vent is the source of most of the water. The vent is usually set in the top or side of the mound ('m') (if the spring has a mound). The tail ('t') is an area with an outflow of water away from the vent. A spring ('s') may possess some or all of these components. For monitoring *E. carsonii* and grazing impacts, the mound and tail have generally been treated separately (no monitoring occurs on the vent). Over 2005-2014, we followed the procedure established by Kinhill Stearns (1984) and Fatchen and Fatchen (1993). However, past monitoring has been inconsistent: PPK (2002) and Badman (2004; 2005) treat an "undifferentiated spring plus any tail" as a single unit (Badman, 2005:16).
3. Up until (and including) 2014, the monitoring was targeted at finding and recording *E. carsonii*. While the 2015 monitoring included all identifiable springs where *E. carsonii* has ever been recorded, the method quantifies species abundance for all species present on the site, rather than focussing on searching for the generally very small *E. carsonii* populations.
4. Up until (and including) 2014, cover was estimated using the Domin-Krajina rank score (see Griffin and Dunlop, 2014). In 2015 and 2016, abundance was calculated directly from the percentage of quadrats on which a species occurred.

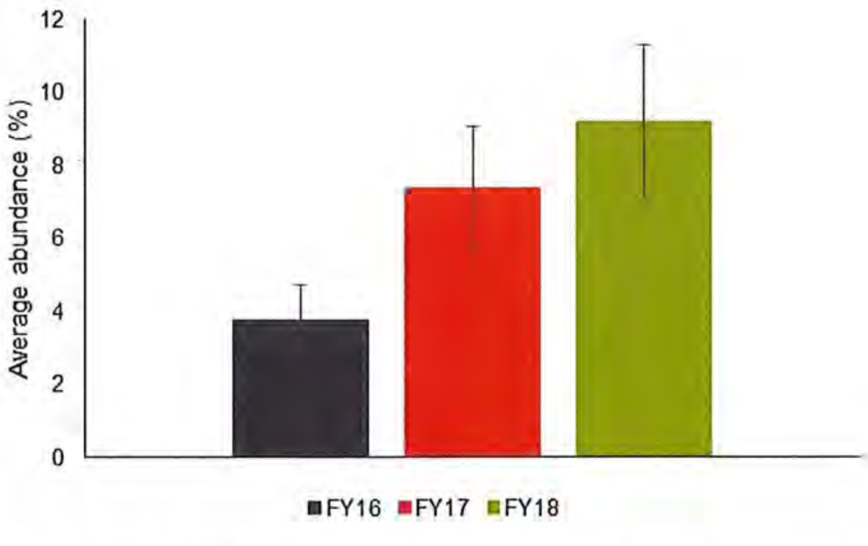


Figure 15: The abundance (mean ± SEM) of *Eriocaulon carsonii* from 2015-17 across the 26 springs identified as suitable *Eriocaulon carsonii* habitat.

Comparison of the abundance of Hydrobiid species against baseline data to quantify population change.

Overall, 89 of the 104 springs monitored could be sampled for invertebrates (due to the availability of standing water). In FY18, target invertebrate species were observed on most springs (Figure 16). The percentage occurrence of target invertebrate species was compared across spring complexes for years FY96 (baseline), FY06, FY09, FY12, FY15 and FY18, where the Coward and the Eastern spring complexes are outside of the predicted impact zone (Figure 17 – Figure 20). While the percentage occurrence for all target species is highly variable, it was not found to significantly change over time for species in the Hermit Hill and Eastern complexes (Table 8; Figure 19 – Figure 20). Three target species were found to be increasing over time in the Coward Springs complex and in the North East complex one species was found to be increasing over time, while the other (*F. accepta*) was decreasing (Table 8). While the North East complex is within the predicted impact zone, average drawdowns within the zone have decreased slightly and are less than the 5 year average (BHP Olympic Dam 2018c). Therefore, it's likely that there are other environmental factors leading to the decrease of *F. accepta* (e.g., spring pugging by large herbivores). It can be noted that Amphipods appear to be increasing in the same complex. Therefore, it is unlikely that the threatened community as a whole is decreasing as a result of impacts from the operation.

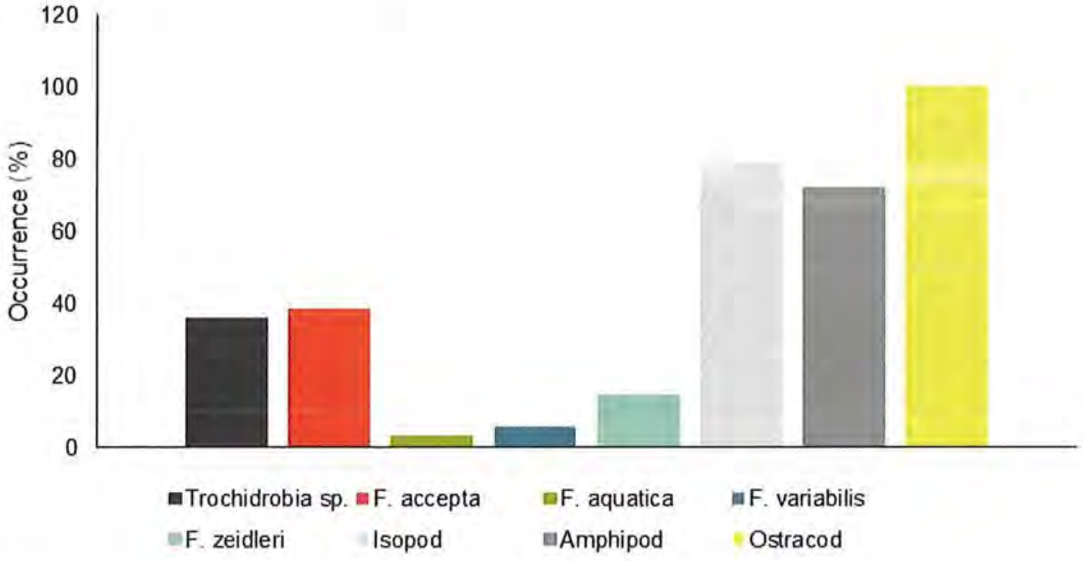


Figure 16: Percentage occurrence of target invertebrate species sampled across all springs in FY18.

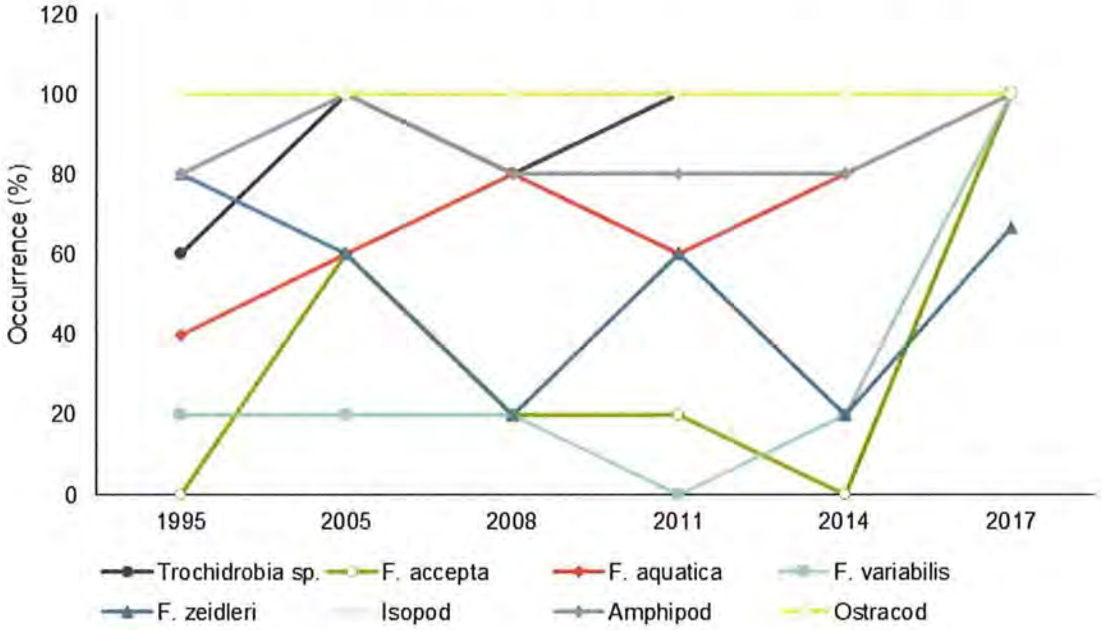


Figure 17: Percentage occurrence of target invertebrate species sampled at the Coward springs complex from FY96 – FY18. Note that inconsecutive years are evenly spaced.

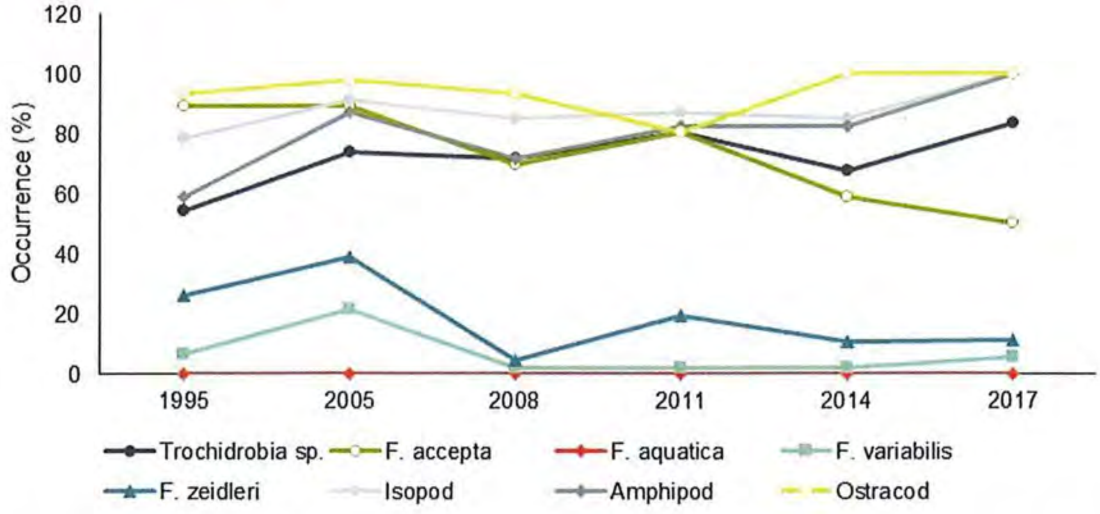


Figure 18: Percentage occurrence of target invertebrate species sampled at the North East springs complex from FY96 – FY18. Note that inconsecutive years are evenly spaced.

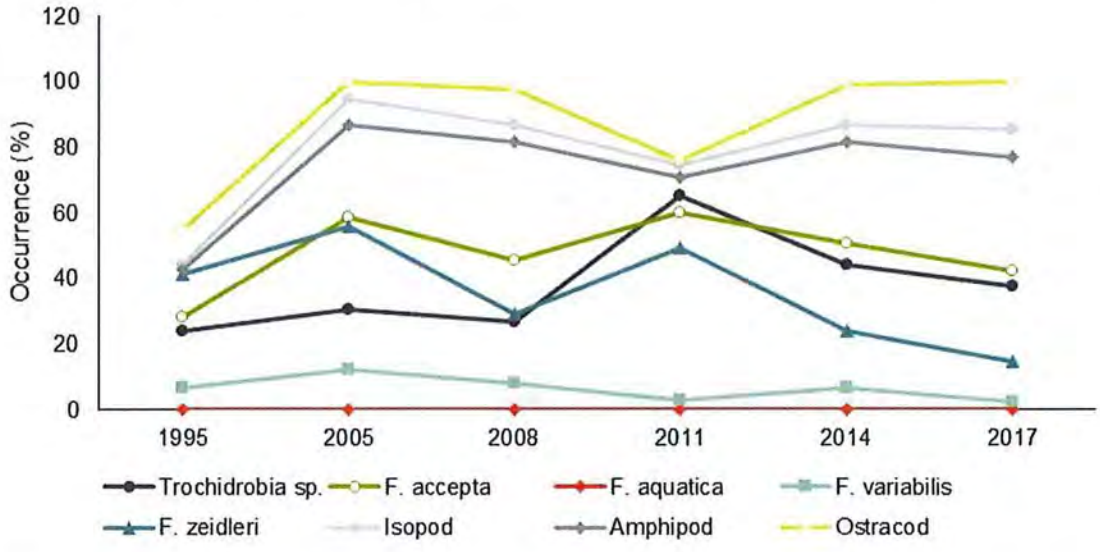


Figure 19: Percentage occurrence of target invertebrate species sampled at the Hermit Hill springs complex from FY96 – FY18. Note that inconsecutive years are evenly spaced.

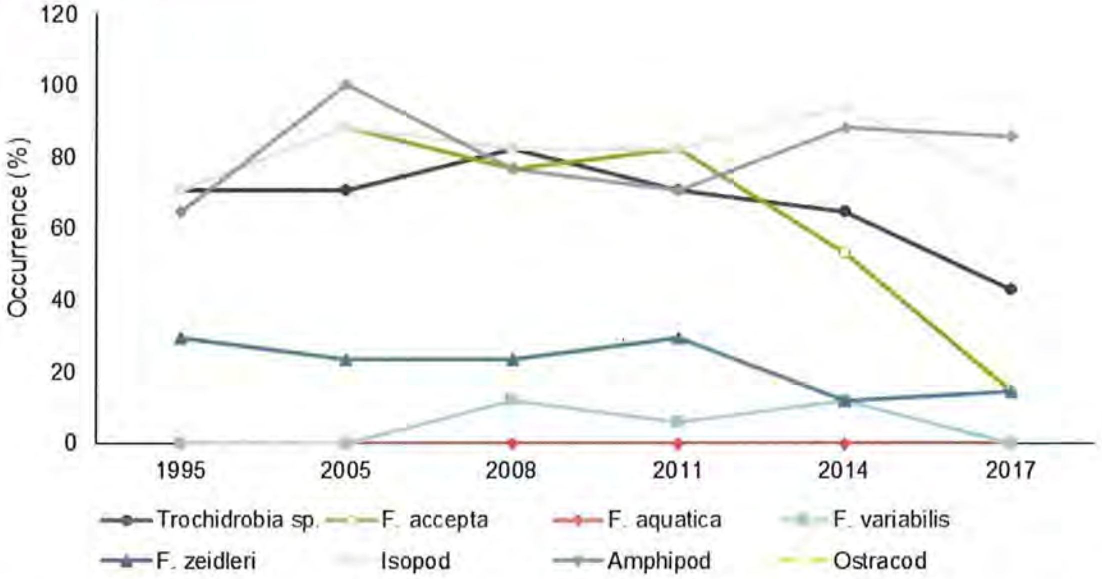


Figure 20: Percentage occurrence of target invertebrate species sampled at the Eastern springs complex from FY96 – FY18. Note that inconsecutive years are evenly spaced.

Table 8: Significance values (p-values) and slope values (R^2) for each target species in each spring complex for the years 1995, 2005, 2008, 2011, 2014 and 2017. Significant values are highlighted with bold text.

Target Species	Coward p	Coward R^2	Eastern p	Eastern R^2	Hermit Hill p	Hermit Hill R^2	North East p	North East R^2
Trochidrobia sp.	**0.042**	**0.687**	0.266	0.294	0.271	0.290	0.054	0.646
F. aquatica	**0.020**	**0.777**	-	-	-	-	-	-
F. accepta	0.352	0.217	0.226	0.338	0.323	0.241	**0.039**	**0.697**
F. zeidleri	0.395	0.185	0.106	0.519	0.234	0.329	0.260	0.300
F. variabilis	0.351	0.218	0.499	0.121	0.338	0.228	0.543	0.099
Isopod	**0.037**	**0.703**	0.559	0.092	0.116	0.500	0.115	0.377
Amphipod	0.612	0.070	0.410	0.174	0.126	0.481	**0.037**	**0.704**
Ostracod	-	-	0.735	0.032	0.097	0.539	0.772	0.023

Triennial qualitative comparison of GAB springs monitoring data incorporating GAB spring flow and GAB springs endemic invertebrate data.

Using spring flora dendrogram groups identified earlier, comparisons were made with spring flow and presence of target invertebrate species. Spring flow for flora dendrogram Group 6 was substantially higher than other dendrogram groups (Figure 21). However, there was insufficient flow data for all groups excluding Group 3 and Group 6. A non-parametric ANOVA determined that the flow rate of Group 6 was significantly higher than Group 3 ($F_{18, 11} = 3.244$, $p = 0.001$). Noting that the flow rate for Group 6 was highly variable. Higher flows of Group 6 could be attributed to the group containing the largest of the springs monitored. The spring wetland area was also significantly higher in Group 6 compared to Group 3 ($F_{60, 21} = -2.027$, $p = 0.043$; Figure 22). Therefore, spring flow could be linked to spring wetland area and moderate flora species diversity. However, high flows were not linked to the occurrence of *Eriocaulon carsonii*, which occurs in both Group 3 and Group 6. This result is expected as *Eriocaulon carsonii* generally does not occur near the vent of the spring where flow is the strongest and where measurements are taken.

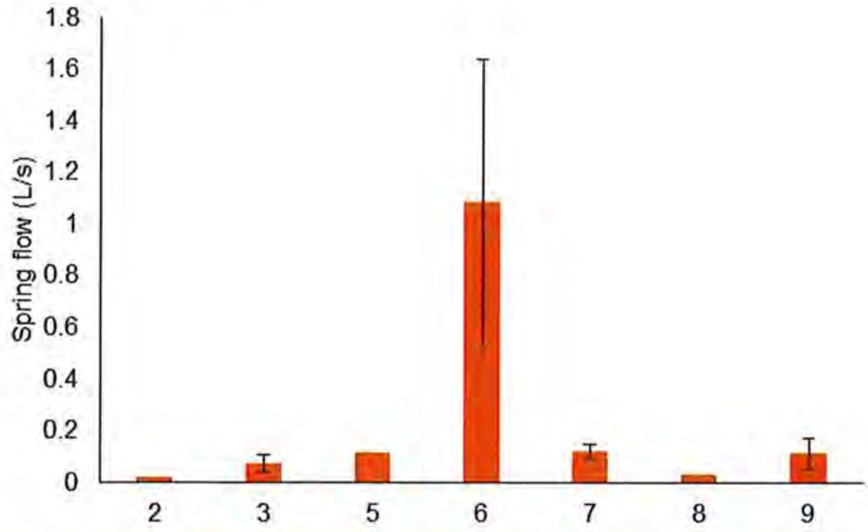


Figure 21: Spring flow (mean ± SEM) for flora dendrogram groups.

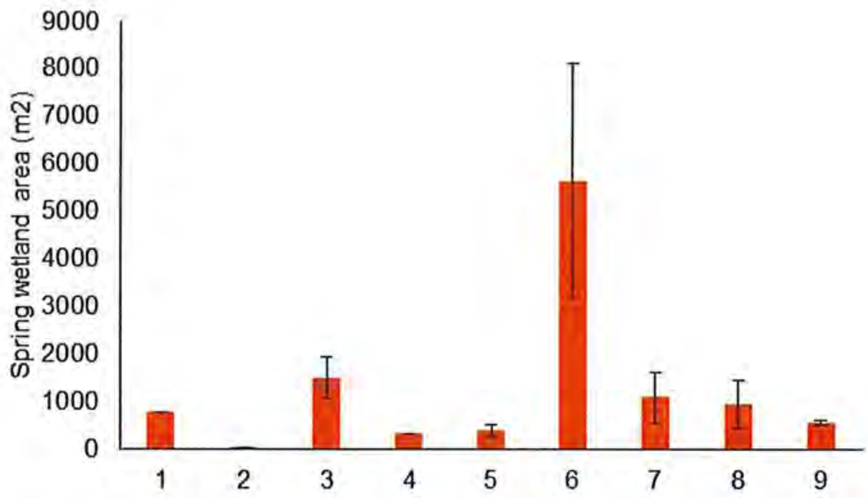


Figure 22: Spring wetland area (mean ± SEM) for flora dendrogram groups.

Similarly for flow, there was not enough data for most groups to determine whether pH of the surface water was significantly different. However, a non-parametric ANOVA determined that the pH of Group 3 was significantly higher than Group 6 ($F_{18, 11} = -2.677$, $p = 0.007$; Figure 23). Group 3 had the highest average percent abundance of *Phragmites australis* recorded. An increase in pH and a relatively high species diversity is generally not associated with an increase in *Phragmites australis* abundance (e.g., Uddin & Robinson 2017). While it is unlikely a result of ODC's operations, the result warrants further investigation. Flora species composition and pH should be monitored over time to determine the impact of any changes.

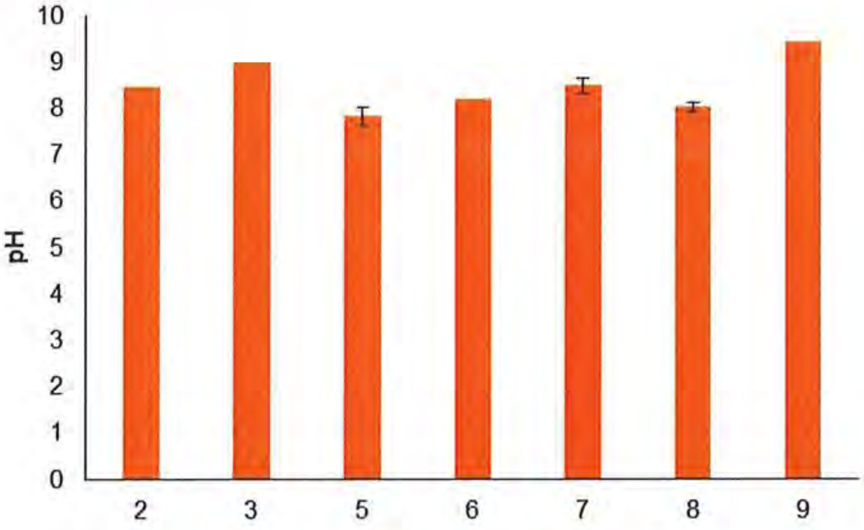


Figure 23: pH of surface water for flora dengrogram groups

Spring flora dendrogram Group 6 and Group 3 had the greatest target invertebrate species diversity with all 8 species occurring in Group 6 and 7 out of 8 species occurring in Group 3 (Figure 24). This was followed by Group 7 that had 6 out of 8 species occurring and Groups 8 and 9 that had 5 out of 8 species occurring (Figure 24). A regression across flora dendrogram groups determined that there was a positive significant relationship between flora and invertebrate species diversity ($F_{1,8} = 5.687$, $p < 0.044$; $R^2 = 0.416$). However, this result should be treated with caution due to the small sample size of most dendrogram groups and a p-value that was relatively close to the significance level (< 0.05).

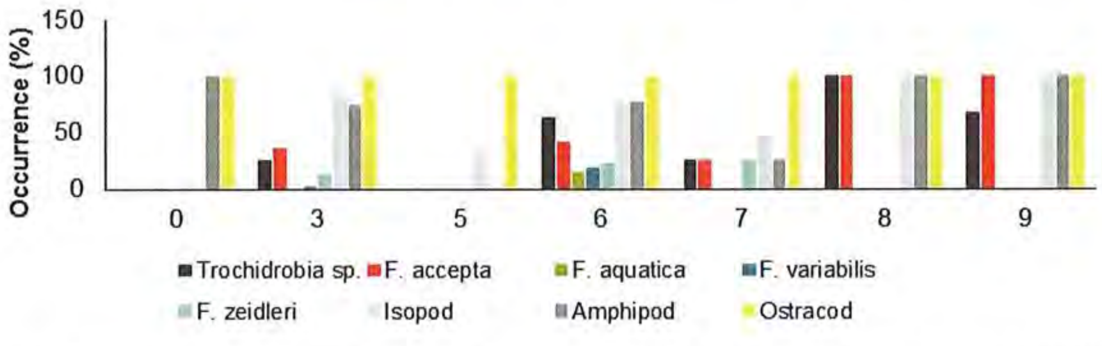


Figure 24: Percent occurrence of target invertebrate species for flora dendrogram groups, where Group 0 is WWS013.

1.2.5 Deliverables (GA 2.5)

Collated domestic and industrial water use efficiency data, to assess performance against improvement targets.

In FY18 the GAB Industrial Water Efficiency of the operation was 1.19kL/t compared to the target of 1.16 kL/t and 0.96kL/t for FY17. An increase in kL of GAB water used per tonne milled is due to the SCM17 Smelter Shutdown and decreased production efficiency during this time. Historical GAB industrial water efficiency is given in Figure 25.

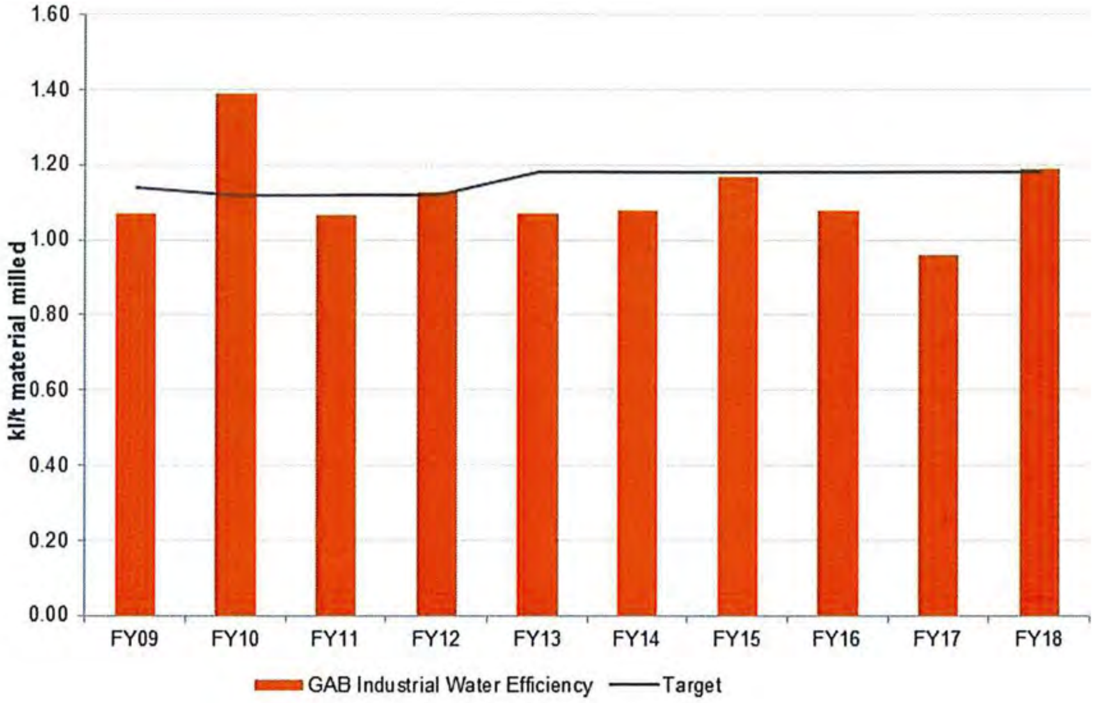


Figure 25: Historical industrial GAB water efficiency.

Domestic water use during FY18 averaged 2.3 ML/d compared to 2.2 ML/d in FY17, well below the target of 3.2 ML/d.. Historical domestic water use is given in Figure 26

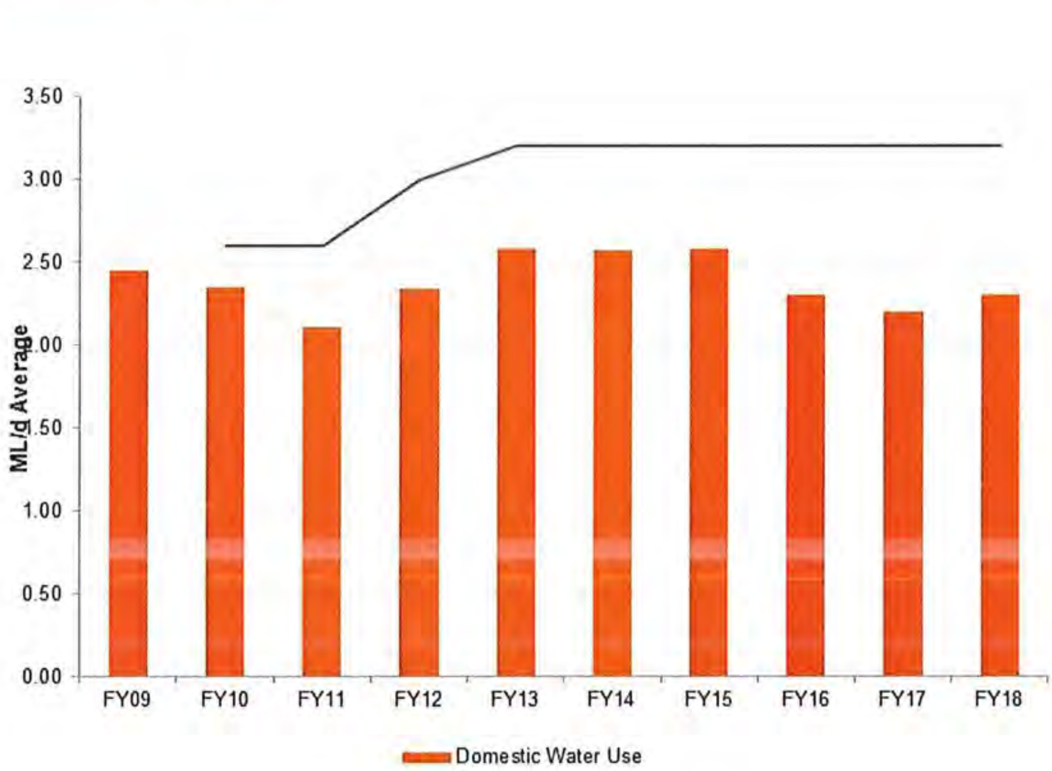


Figure 26: Historical domestic water use (note there was no target in FY09).

1.2.6 Deliverables (GA 2.5)

Ten-year water use schedule to be submitted to the Indenture Minister by 1 January annually.

The current 10-year water use schedule, as provided to the Minister for Mineral Resources Development in January 2017, is presented in Appendix 9 of the FY18 Annual Wellfields Report (BHP Olympic Dam 2018c). An updated schedule will be provided by 1 January 2019.

The current forecast shows an increase in the non-potable water requirement in the Mine and Process Plant from 2018. Water use is predicted to increase over the next decade, which is predominantly driven by the increase of production physicals. A detailed water forecast beyond 2022 is not available, however production and therefore water demand is forecast to increase.

1.2.7 Deliverables (GW 2.1)

A review of abstraction rates and trends and an assessment with respect to groundwater levels.

Saline water was abstracted from the Arcoona Quartzite throughout FY18 from the Saline Wellfield located south of the Whenan Shaft.

Some of this water from the Saline Wellfield was used in construction projects throughout the operations, whilst the remainder was discharged to the mine water disposal pond for evaporation. An average of 3.4 ML/d (Figure 27) was abstracted over the period, compared to 3.6 ML/d during the previous reporting period.

A definition and map of the underground mine water balance.

The mine water balance is a summary of the volume of water going into and out of the underground mine. It includes saline water abstracted from local bores that is added to surface storages and used around site. The balance (presented in Figure 27) is generated from a combination of measured, derived and estimated data.

An estimate of the volume of groundwater discharge to underground.

Groundwater inflow to the mine occurs at several intersections with the underground operations (Figure 27). Total natural inflow is estimated to be approximately 1.0 ML/d, the majority entering via upcast raise bores. Additional natural inflow comes into the mine via other entry points, including downcast raise bores, exploration drill holes and shafts. Much of the total inflow to the mine is transported to the surface as ore content or exhausted to the atmosphere as saline aerosols or moisture-laden air via upcast raise bores, estimated at around 0.9 ML/d.

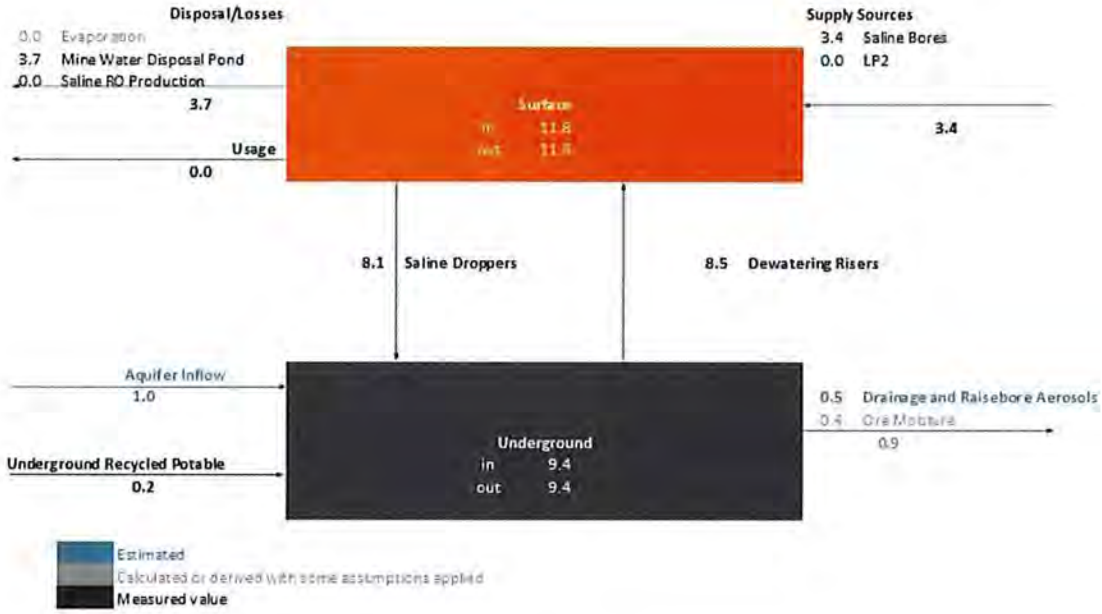


Figure 27: FY18 Saline (Mine) water balance summary (ML/d).

1.2.8 Deliverables (GW 2.2)

A review of the trends in local and regional groundwater levels and a comparison with historical groundwater levels.

A slight downward trend in local and regional groundwater levels (Figure 28) is evident over the last three years. The groundwater cross section (Figure 29) and hydrograph (Figure 30) confirm the limited changes in groundwater levels beneath the TSF between June 2017 and June 2018. Monitoring bore LT18 has been decommissioned and redrilled to the south-eastern of the original well which is reflected in the change in water level monitored.

The maximum groundwater level recorded below the TSF for the current reporting period was 67.82 mAHD at LT67. The rising trend at LT67 has been addressed with the installation of a dewatering system and changed supernatant pond control which has stabilised the water rise. Groundwater levels are not expected to exceed the agreed limit of 20 m below the ground surface (80mAHD.

Groundwater level contours in the Andamooka limestone aquifer beneath the perimeter of the TSF (Figure 31) have generally remained stable during FY18. A continued stable area above 60 mAHD in TSF 1-4 and no groundwater level above 65 mAHD has been maintained. There is a continued rise in groundwater levels beneath TSF 5 (Figure 32) which can be attributed to the ongoing use of this facility. Levels are below compliance limits of 80 mAHD however well LT67 is rising at a rate greater than expected. As noted above, a dewatering system has been installed and the supernatant management in the TSF modified which has stabilised the rise. The water level in this area will continue to be managed in FY19 to maintain compliance with agreed compliance levels.

Groundwater levels for bores in the vicinity of the underground mine (Figure 33) continue to show depressurisation of the geological units, consistent with ongoing mine depressurisation activities.

Limestone aquifer bores in the vicinity of Roxby Downs (Figure 34) demonstrate stable groundwater levels during FY18.

Historical level monitoring indicates steady groundwater levels over time with no overarching trends that would indicate material change in the availability at existing bores in the Stuart Shelf area operated by third-party users (section 1.2.3).

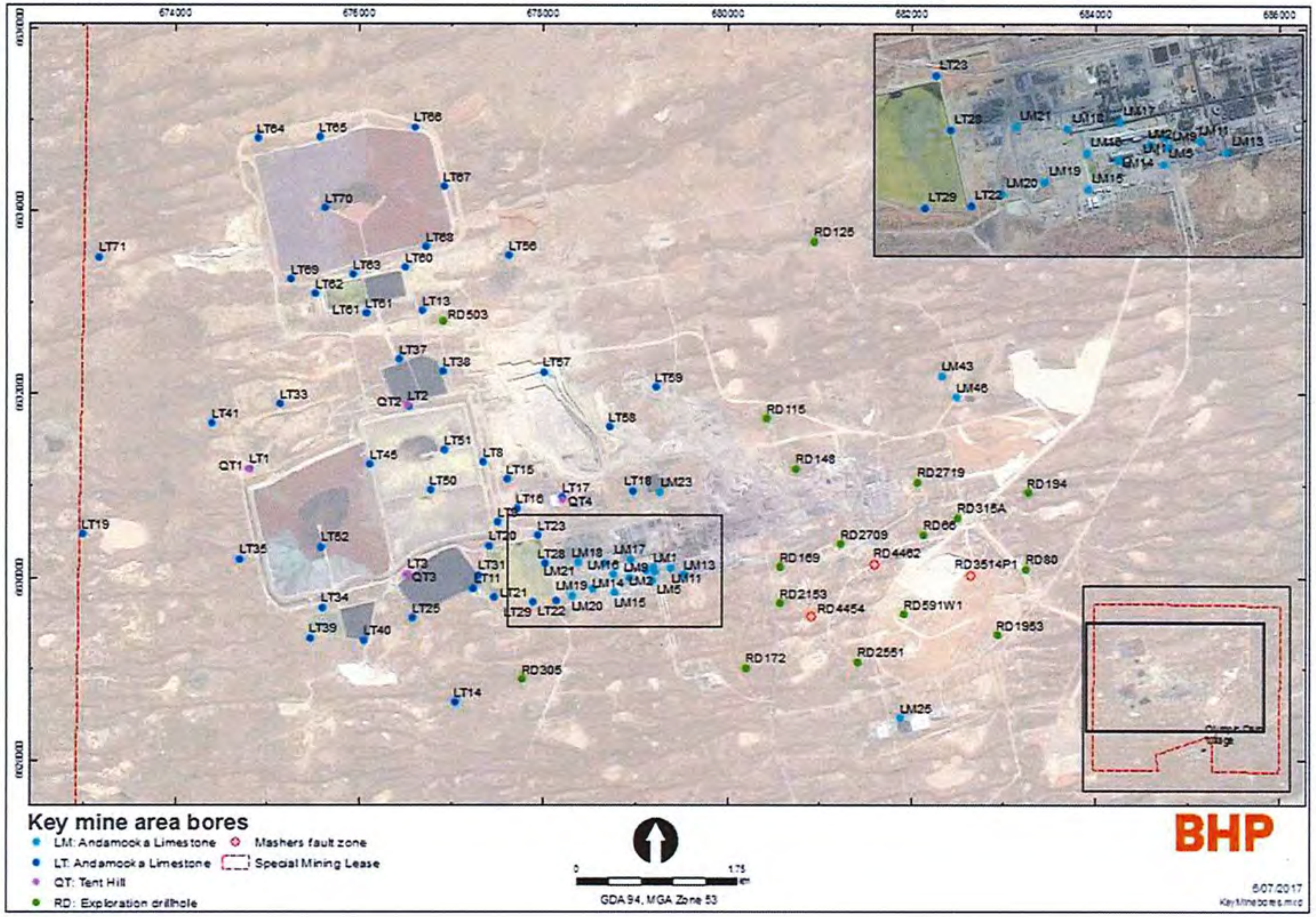


Figure 28: Location of key mine area bores.

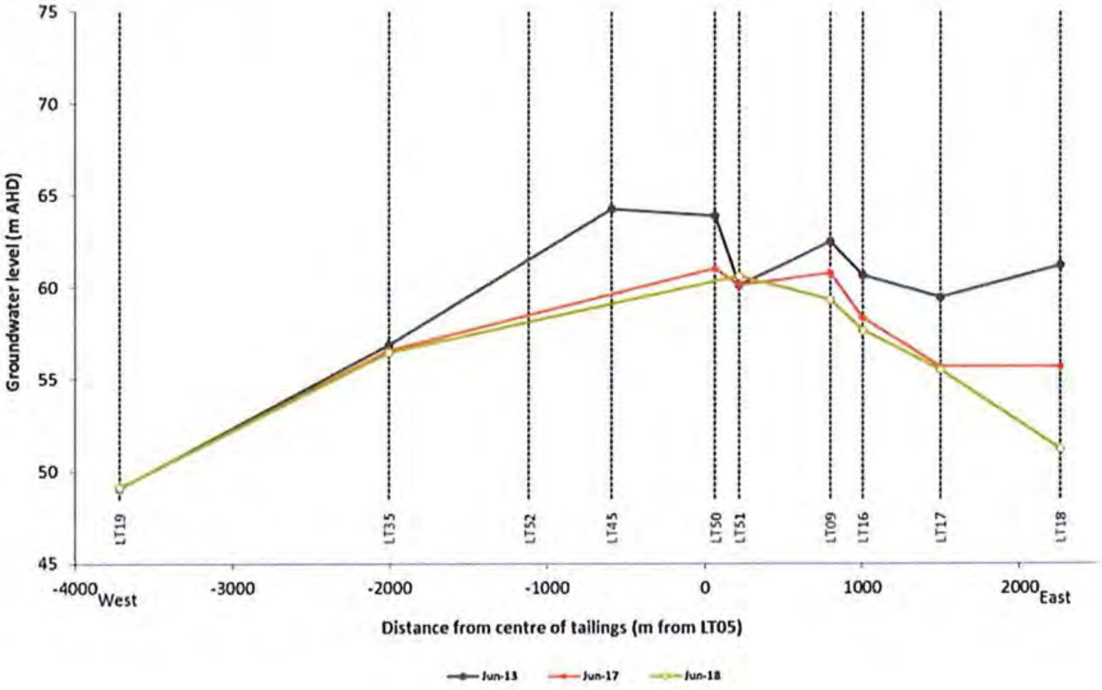


Figure 29: Change in groundwater elevation along an east-west cross-section from LT19 to LT18, through the centre of the TSF.

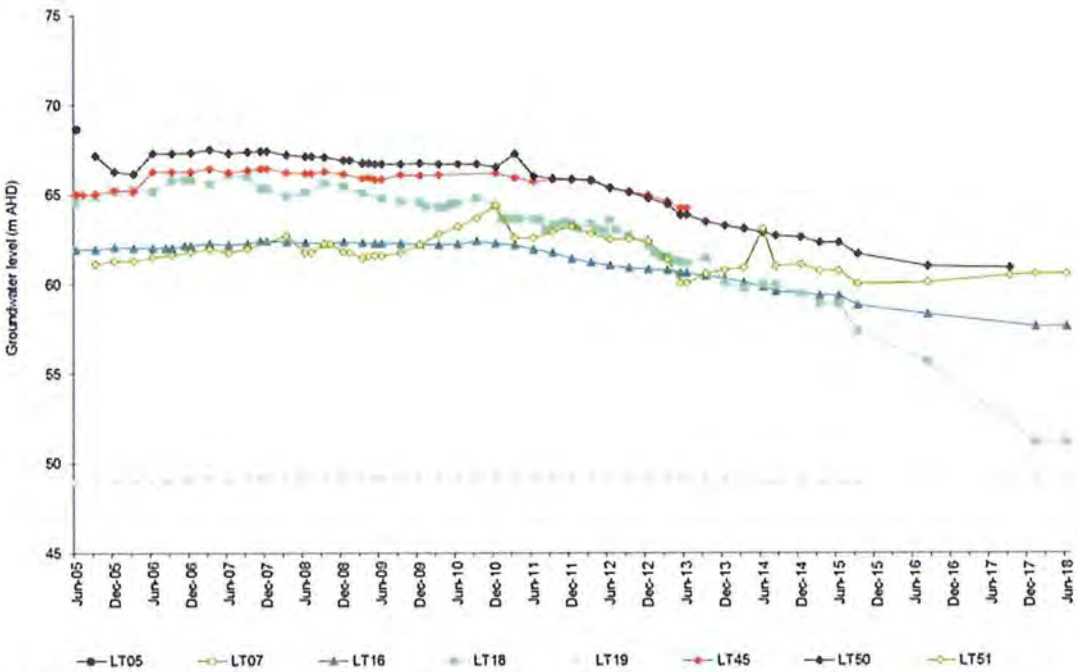
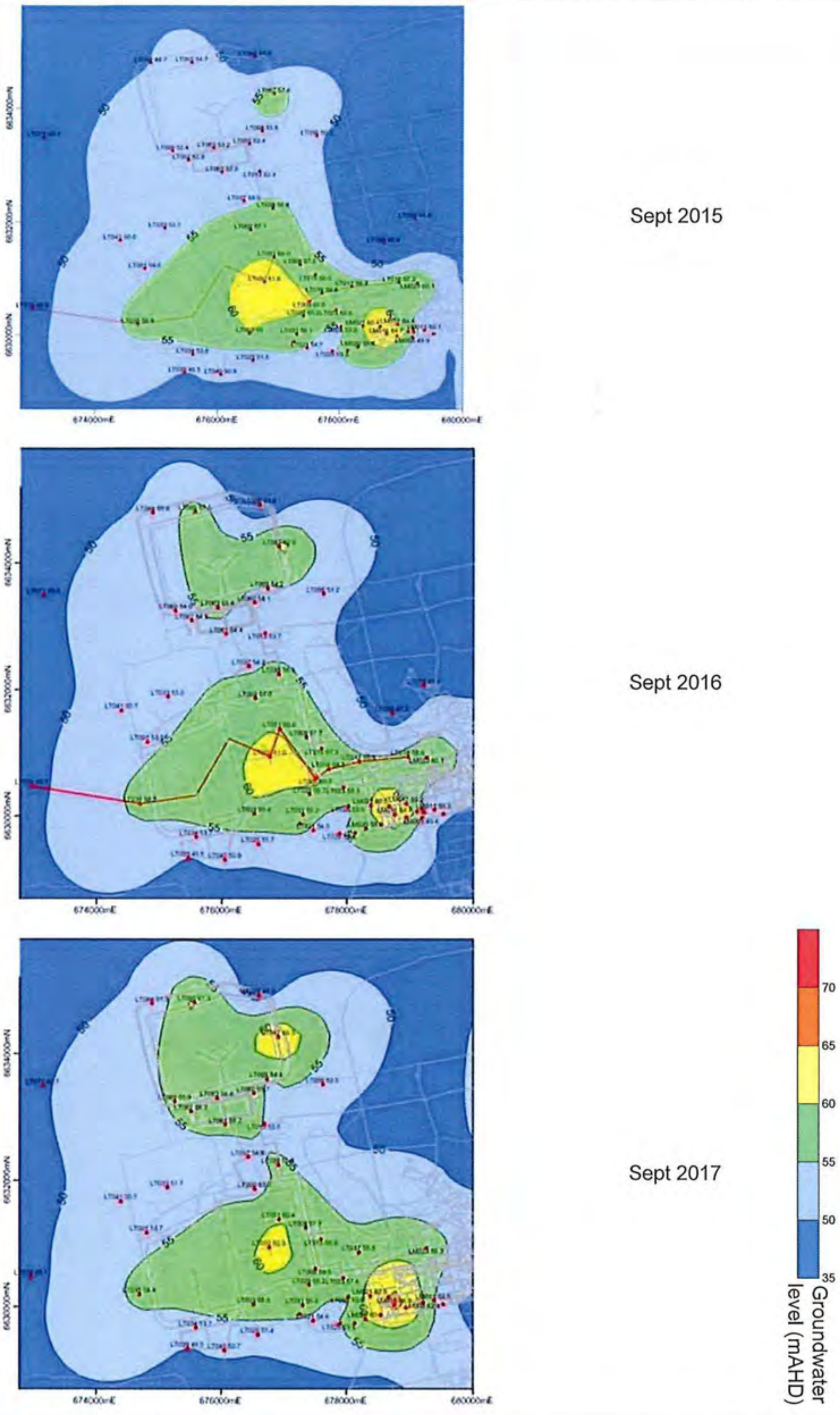


Figure 30: Groundwater levels for Andamooka Limestone bores in the vicinity of the TSF



Datum: GDA94

Projection: MGA94

Zone: 53

Figure 31: TRS area groundwater levels (mAHD) Andamooka Limestone Aquifer.

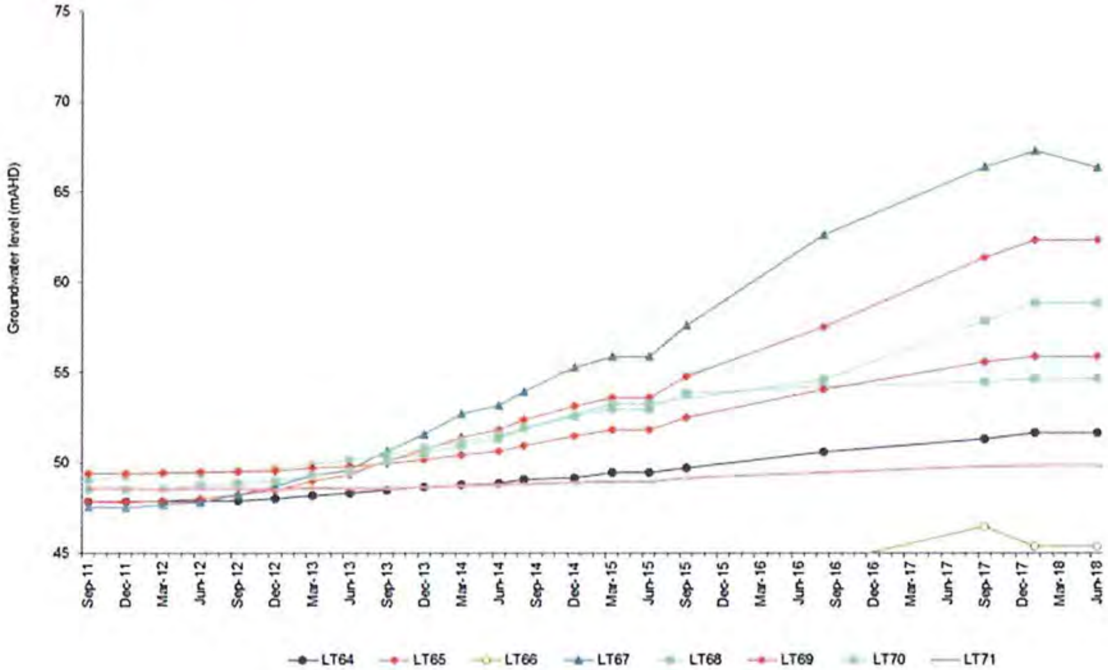


Figure 32: Groundwater levels for bores in the vicinity of TSF 5.

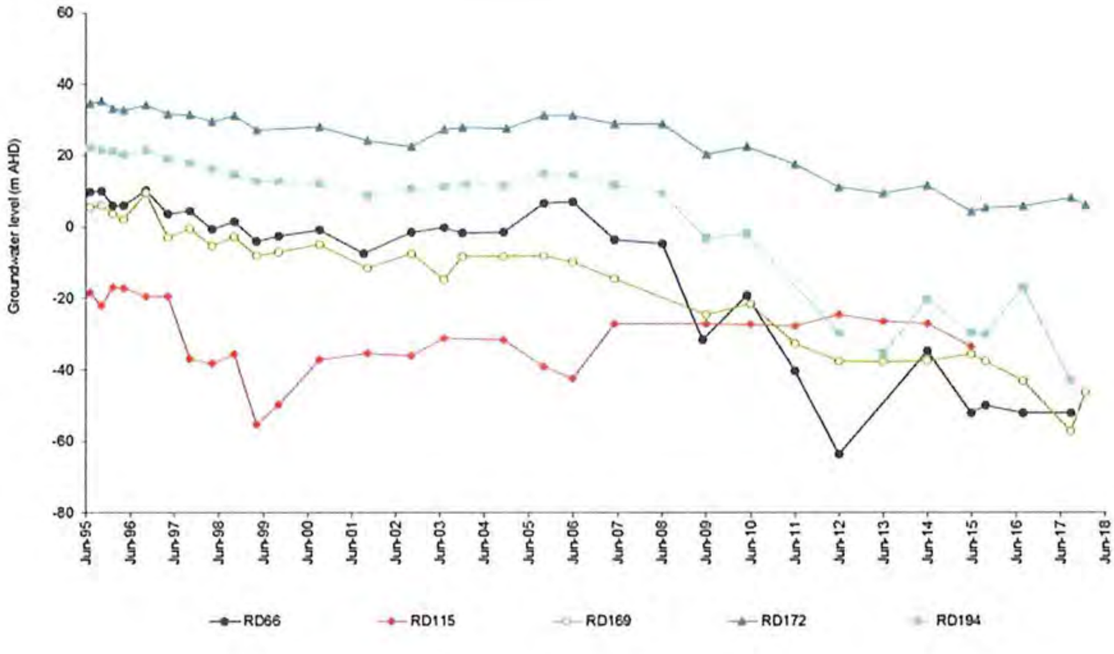


Figure 33: Groundwater levels for exploration drill holes in the vicinity of the underground mine.

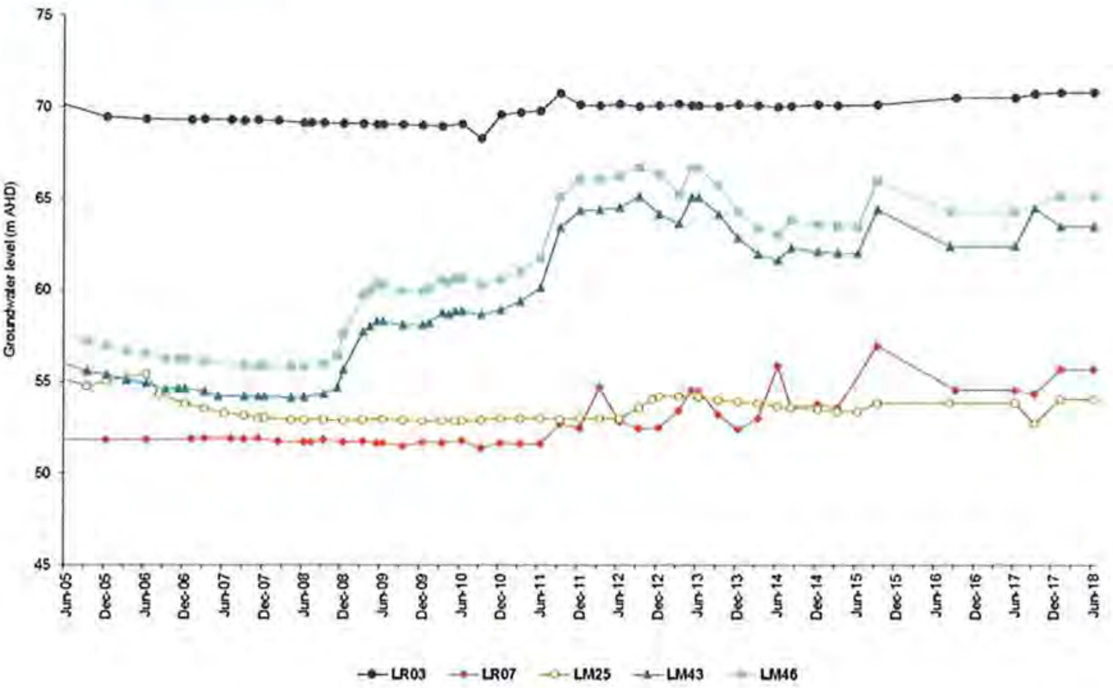


Figure 34: Groundwater levels for Andamooka Limestone bores in the vicinity of Roxby Downs (LR) and the Mine Water Pond (LM).

Data showing the tracking of trends towards leading indicators for groundwater impacts, and an alert to management when levels approach the leading indicators.

Data for groundwater level was collected, with a discussion of results in section 1.2.8. Leading indicator trigger levels were not reached (see section 0).

1.2.9 Deliverables (GW 2.3)

A review of trends in groundwater quality and a comparison to ANZECC criteria.

Groundwater in the vicinity of the Olympic Dam Operation occurs at depth and is highly saline making it unsuitable for human or livestock consumption and largely inaccessible. The local groundwater does not meet any of the beneficial use categories listed under ANZECC guidelines.

Groundwater salinity has generally remained stable and within the range that could be reasonably expected for natural variation within the aquifer. Salinity levels across site vary slightly due to input sources from various areas of the mine.

Groundwater pH ranges from 7.29 at LM43 to 7.83 in LT35, within the range of historical monitoring results.

Concentrations of copper in all groundwater monitoring bores sampled during the FY18 monitoring program were reported below ANZECC (2000) guidelines for livestock consumption of 0.4 mg/L (Figure 35).

While slightly elevated concentrations of uranium continue to be detected in the groundwater in the vicinity of evaporation pond two, uranium concentrations remain within historical limits in the majority of bores. Uranium concentrations are lower than the adopted ANZECC (2000) guidelines for livestock consumption of 0.2 mg/L in all except three bores (Figure 36).

A uranium concentration in excess of the ANZECC livestock guidelines has been detected at bores LT15 (0.454 mg/L) LT17 (0.263 mg/L) and LT25 (0.557 mg/L). LT15, LT17 and LT25 are located at the base of the tailings facility and are highly susceptible to changes in tailings pond use rates. Other bores in the area do not show elevated Uranium levels.

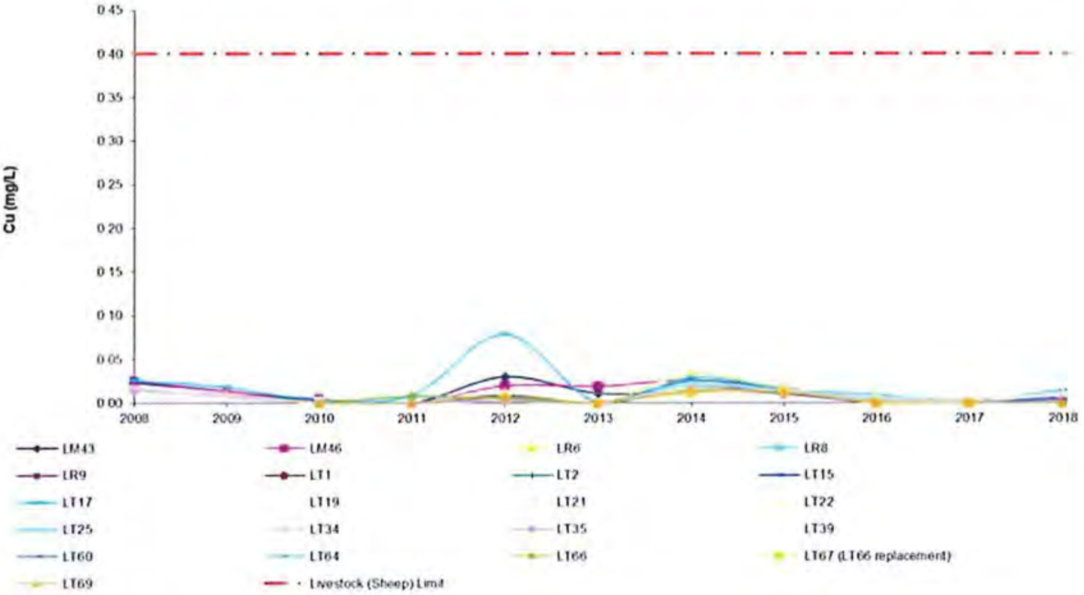


Figure 35: Olympic Dam on-site and regional groundwater monitoring bores: copper concentration.

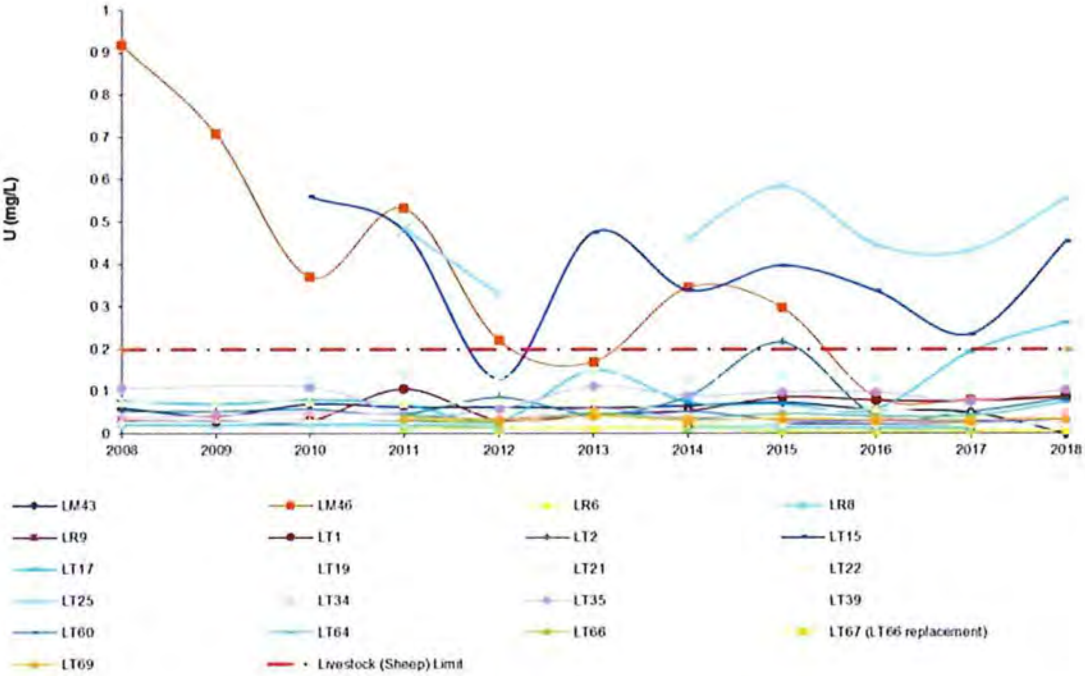


Figure 36: Olympic Dam on-site and regional groundwater monitoring bores: uranium concentration

1.2.10 Deliverables (WA 2.3)

Records of the water levels in the MWDP.

To determine any potential environmental impacts of the Mine Water Disposal Pond (MWDP), water levels were monitored via local groundwater bores. Stable groundwater levels at LM43 and LM46 were observed due to consistent water discharge rates into the pond during early FY18 (Figure 34).The groundwater level remains below the leading indicator level of 70 mAHD.

Records of quantities of water disposed of into the MWDP.

Quantities of water disposed of into the MWDP were measured and recorded each day, and reconciled monthly as part of the Saline Water balance (see Figure 27). An average of 3.7 ML per day was disposed into the MWDP during FY18.

1.2.11 Deliverables (WA 2.4)

Records of pond levels and pond wall condition (sewer ponds).

Sewage waste generated by Olympic Village (OV) is gravity fed to three on site chambers and pumped to the OV treatment facility west of the camp. The treatment facility consists of primary and secondary storage ponds and a permanent evaporation pan. The secondary ponds are mechanically aerated.

The OV treatment facility is inspected daily for security, inflow, wall integrity and available freeboard in storage ponds. Freeboard is reported daily and recorded. Inflow was recorded daily and averaged at ~312 kl/day for FY18. Pond wall condition was maintained in good condition during the reporting period.

Sewage waste generated by the Mine and Process plant is treated onsite. The onsite facility consists of a lined primary lagoon and lined evaporation pond. Inflow for FY18 averaged at ~198 kl /day which is greater than design capacity and occurred due to high levels of site personnel during shutdown activities. Regulatory approval was obtained for emergency onsite irrigation and offsite disposal to manage these increased levels. A project to upgrade facilities has been initiated and is expected to be completed during FY19.

A chemical and biological testing regime is undertaken quarterly for both the onsite and OV facilities. All results are analysed and logged. All results were within expected parameters in FY18.

1.2.12 Deliverables (GW 2.5)

Data demonstrating that radionuclide concentrations are below upper limits.

Surface ponds which hold groundwater used for road watering were monitored and analysed during FY18 for specific radionuclides. Results from samples analysed in September 2017 were below the upper limit for radionuclide ^{238}U and ^{226}Ra of 50 Bq/L and 5Bq/L respectively (Table 9, Figure 37, Figure 38).

Table 9: Radionuclide analysis for dust suppression water.

	Analyte	^{238}U (Bq/L)	^{230}Th (Bq/L)	^{226}Ra (Bq/L)	^{210}Pb (Bq/L)	^{210}Po (Bq/L)
Upper Limits		50		5		
Sample site	Date					
A Block	Sept 2017	1.02	0.015	1.4	0	0.3
TCAF	Sept 2017	3.3	0.04	1.5	0	0.5
Turkey Nest	Sept 2017	0.025	0.11	2.3	0	0.4

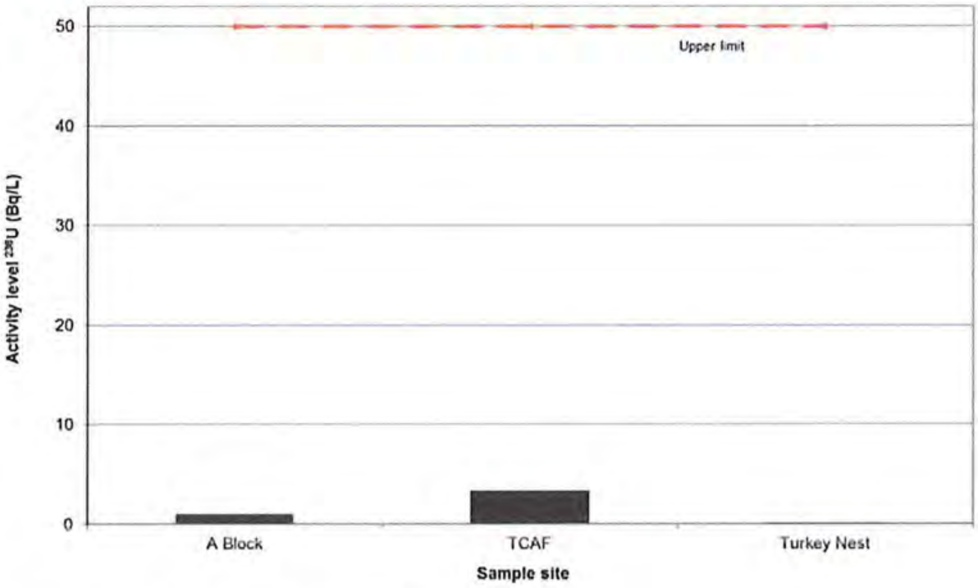


Figure 37: Mine water sample ^{238}U levels and upper limit FY18

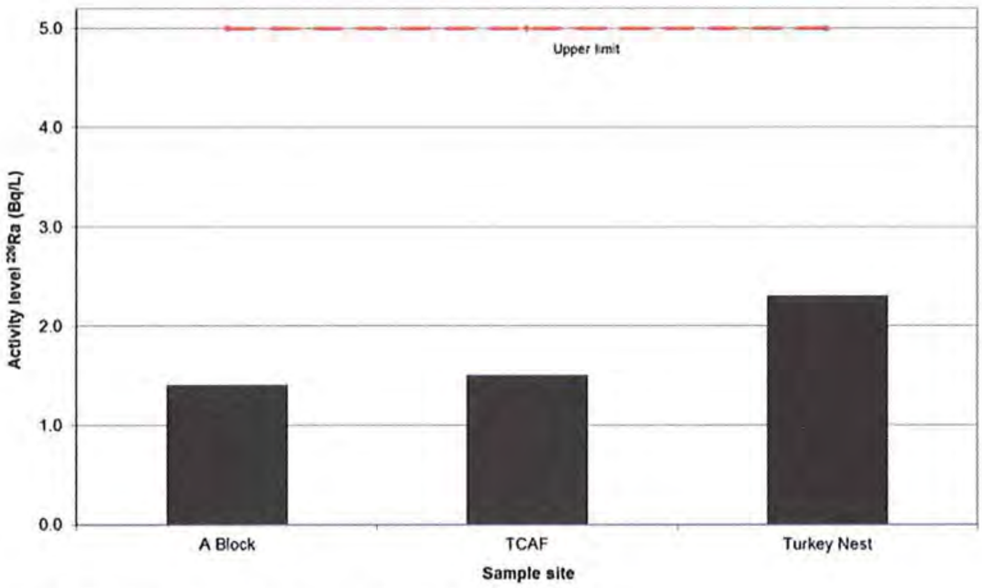


Figure 38: Mine water sample ^{226}R levels and upper limit FY18

A review of results and provision for increased monitoring frequency where concentrations are trending towards upper limits.

No samples collected during FY18 showed levels approaching upper limits.

1.2.13 Targets FY18

Maintain an industrial water efficiency of 1.18kL/t at the budgeted production rate.

In FY18 the GAB Industrial Water Efficiency of the operation was 1.19kL/t compared to the target of 1.16 kL/t and 0.96kL/t for FY17. An increase in kL of GAB water per tonnes milled is due to the SCM17 Smelter Shutdown and decreased production efficiency during this time. Historical GAB industrial water efficiency is given in Figure 25.

Maintain a domestic water use target of 3.2 ML/d average

Domestic water use during FY18 averaged 2.3 ML/d, below the target of 3.2 ML/d, as outlined in the Great Artesian Basin Wellfields Report (BHP Olympic Dam 2018c).

1.2.14 Action plan FY18

Continue work on establishing Practical Reference Heads (PRHs).

Temperature inclusive drawdown is reported at all GAB wells in FY18 (BHP Olympic Dam 2018c).

Continue implementation of water use conservation and recycling initiatives.

In FY18 ODC has proposed and costed projects for the oncoming Great Artesian Basin Infrastructure Investment Program (GABIIP) to be carried out in FY19 including the control of flowing wells and repair of faults which could lead to wastage for GAB water.

Continue substitution of saline water for high quality water where possible.

Saline water continues to be used in lieu of high quality water where feasible, including use in CAF, road watering, construction and underground drilling activities.

Saline water is not being used to augment the process water stream as this would result in an unacceptable increase in chloride in the system, which affects plant performance.

2 Storage, transport and handling of hazardous materials

2.1 Chemical / hydrocarbon spills

2.1.1 Environmental Outcome

No significant site contamination of soils, surface water or groundwater, as a result of the transport, storage or handling of hazardous substances associated with ODC's activities.

No significant site contamination of soils, surface water or groundwater occurred in undisturbed areas in FY18. All spills were appropriately contained and cleaned up as soon as practicable. Active monitoring and management of legacy hydrocarbon sites was continued during FY18. This is explained further in section 2.1.2.

2.1.2 Compliance criteria

No site contamination leading to material environmental harm (as defined in the EMM) arising from hydrocarbon/chemicals spills within the SML and wellfields designated areas.

During the reporting period, 33 chemical and hydrocarbon spills occurred across ODC operations. All spills were contained and cleaned up as soon as practicable. Three legacy hydrocarbon spill sites exist (one on the SML and two in the wellfields area), all being actively monitored and managed. For example, the hydrocarbon plume at the 3ML tank shows minor migration in a south easterly direction, and limited natural attenuation of the plume is occurring. A Detailed Site Investigation (DSI) has been carried out in FY18 and the results are being assessed. In addition, PS1 remediation has successfully treated a groundwater volume in excess of 4 ML since commencing operation in late 2014. Finally, PS6A remediation has treated groundwater in excess of 12 ML since commencing operation in mid-2014 and recovered approximately 39,800 L of light non-aqueous phase liquid (LNAPL).

Therefore, it is concluded that no new material environmental harm has arisen from hydrocarbon/chemical spills within the SML and wellfields designated areas.

2.1.3 Leading Indicators

- None Applicable

2.1.4 Targets FY18

Corrective actions for all reportable spills of chemicals and hydrocarbons are implemented in a timely manner and do not result in material environmental harm (as defined in the EMM). (Note: Spills are reportable if they result in potential or actual material environmental harm in accordance with the EP Act 1993)

One reportable spill of sewage occurred in FY18 on the 11th December 2017. The spill occurred adjacent to the A block saline settling dam. Water samples taken from the A block saline dam indicated very low levels of *Escherichia coli*. The investigation revealed that the sewer leak was a result of ad hoc excavations for clean out operations at the A Block dam as well as a pipe failure. Since the event, work has been undertaken to establish a maintenance strategy on the site sewerage system.

The spill was reportable under the EP Act as the cost of remediation was in excess of $5000 and notification was required under section 83 of the EP Act (notification where serious or material environmental harm caused or threatened). [Notification was provided to the EPA in accordance with the EP Act on the 11th December 2017]. This spill did not trigger section 83A of the EP Act (notification of site contamination of underground water) as no site contamination of underground water occurred as a result of the spill. This reportable spill did not result in material environmental harm as defined in the EMM, which is a major impact (<5 years) to land, biodiversity, ecosystem services, water resources or air.

2.1.5 Action plan FY18

Maintain a register of recordable chemical and hydrocarbon spills and corrective actions. (Note: An internally recordable spill of chemicals and/or hydrocarbons is defined as a spill of 10 litres or greater, outside of a bund, in a single event.)

During FY18 a register of recordable chemical and hydrocarbon spills and corrective actions were maintained. In FY18 there were 33 internally recordable chemical and hydrocarbon spills across site. The majority (25) of the 33 spills occurred above ground in the plant smelter and processing areas with eight of the 33 occurring at the mine end. The mine end spills did not impact or interact with groundwater. No spills occurred outside the plant area or off the SML or impacted environmental receptors such as flora, fauna or water bodies.

Of the 33 spills; six were hydrocarbon spills with the majority of the spills resulting from loss of containment on plant equipment across site and 13 were effluent spills caused by blocked or failing sewerage lines. The remaining 14 chemical spills consisted of mainly weak acid and electrolyte spills from leaking pipe racks and instrumentation failures resulting in bund and tank overflows.

Internally reportable chemical and hydrocarbon spills have increased compared with previous years as shown in Figure 39. The increase in effluent/sewerage spills across site is a result of aging equipment and system capacity. Substantial work is being undertaken to improve and upgrade the site sewerage system capacity with an upgrade planned for FY19. Furthermore, substantial work has been made towards developing a good reporting culture for spills and other environmental events to ensure all events are reported in a timely and accurate manner.

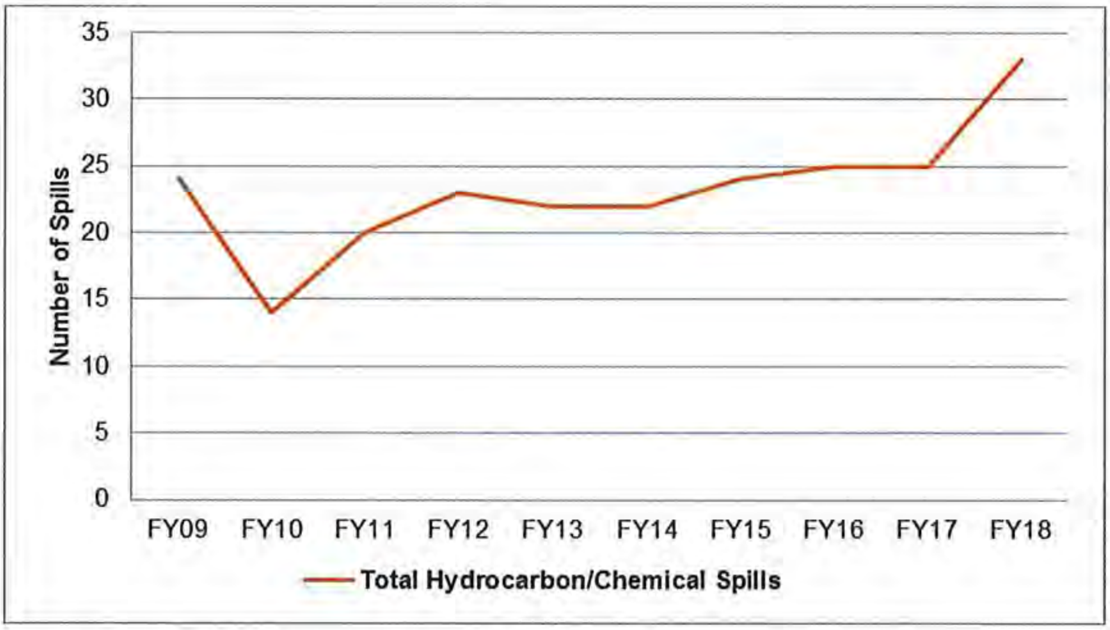


Figure 39: Historical hydrocarbon/chemical spills

Continue to implement environment improvement plans for areas of concern, as identified through the annual Aspect and Impact risk register review.

All maintenance and inspections carried out for all tanks and bunds have been recorded in 1SAP as a work item. This ensures that tanks and bunds are regularly maintained and recorded for tracking and auditing purposes.

Bunds that do not meet the recent EPA guidelines have undergone a risk assessment with additional controls put in place if required to reduce the risk of spills. The controls include safe fill levels; regular inspections and maintenance and online monitoring via Citect. This is all captured in our Aspects and Impacts register as well as 1SAP for tracking purposes.

2.2 Radioactive process material spills

2.2.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive process material spills from ODC's activities.

BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from operational activities and radioactive emissions, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1mSv/y limit. During FY18 there were no radioactive process material spills outside operational areas. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken by ODC.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive process material spills from ODC's activities.

No significant impacts to populations of listed species or ecological communities were recorded as a result of operational activities, including the effects from any radioactive process material spills. Impacts to listed species and ecological communities are avoided by ensuring that there is no uncontrolled loss of radioactive material to the natural environment. As there was no loss of radioactive material to undisturbed environment in FY18, no impact to populations of listed species or ecological communities occurred.

2.2.2 Compliance criteria

A dose limit for radiation doses to members of the public of 1 mSv/y above natural background.

The total dose to members of the public at Roxby Downs Monitoring Site (RDMS) and Olympic Village Monitoring Site (OVMS) due to contribution from ODC operations in FY18 was 0.023 mSv and 0.033 mSv, respectively. For more detail refer to section *3.4 Radioactive Emissions.*

No significant radioactive contamination arising from uncontrolled loss of radioactive material to the natural environment. *NOTE: Significant is defined as requiring assessment and remedial action in accordance with the NEPM 1999 or EPP 2015 and the Mining Code. Measurement and monitoring is carried out in response to a specific event.*

In FY18 there were 13 radioactive material spills within the surface operational area. The majority of these spills were in the SX and Hydromet areas and were a result of failed pipes and feed spools. Of the spills in FY18 none required assessment and remedial action in accordance with the NEPM 1999, EPP 2015 or the Mining Code. As stated in section 2.2.1 above, there was no uncontrolled loss of radioactive material to the natural environment in FY18.

2.2.3 Leading Indicators

- None applicable

2.2.4 Targets FY18

No spill of Radioactive Process Material into an undisturbed environment.

There was no uncontrolled loss of radioactive material to the undisturbed environment in FY18.

Corrective actions resulting from a reportable spill of radioactive process material are executed in a timely manner to ensure no adverse impacts to human health.

During FY18, 13 recordable radioactive material spills occurred within the surface operational area. The majority of these spills were in the SX and Hydromet areas. These spills were contained and remediated resulting in no adverse impact to human health. No reportable spills occurred in FY18.

2.2.5 Action plan FY18

Maintain a register of recordable spills of radioactive process material resulting from operations at Olympic Dam. (Note: Reportable and recordable spills of radioactive process material as defined by the Criteria and Procedures for Recording and Reporting Incidents as SA Uranium Mines (DSD), known as 'Bachman Criteria'.

A register of recordable spills was maintained. During FY18, there were 13 radioactive process material spills across site, which occurred at the SX, hydromet; concentrate and TRS areas. The number of radioactive process material spills shows a decreasing trend since FY11 as shown in **Figure 40**. This is attributed to planned maintenance and work management through 1SAP.

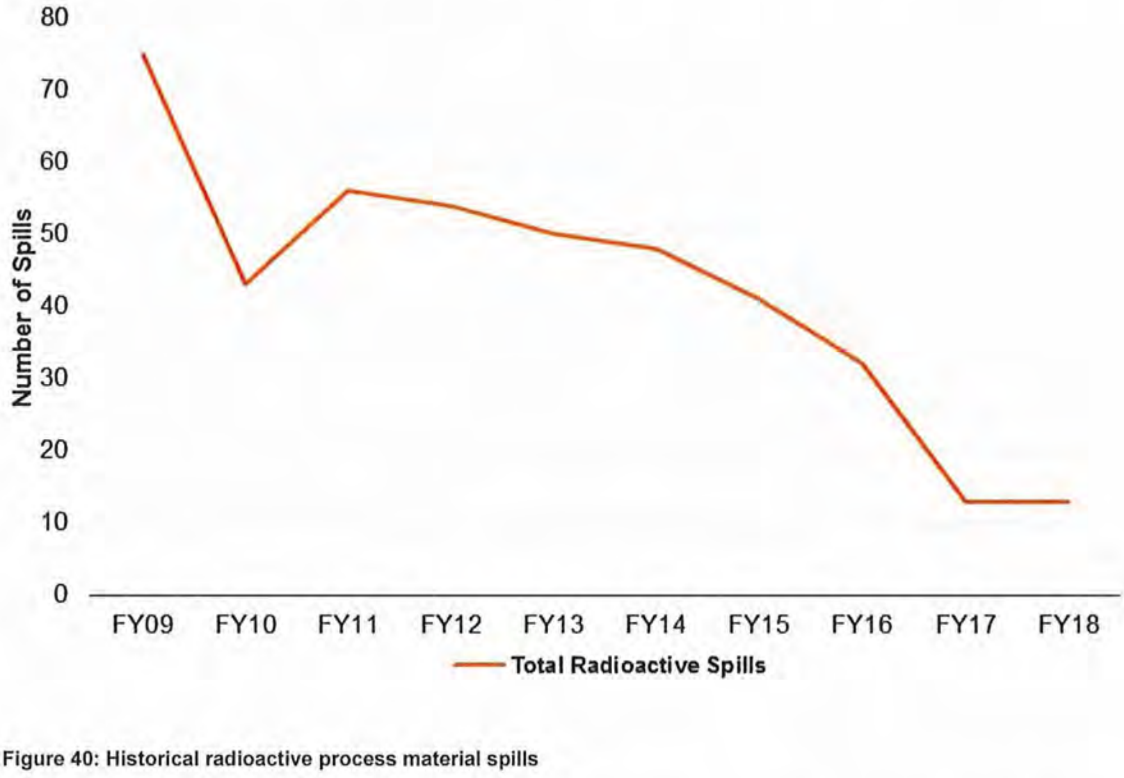


Figure 40: Historical radioactive process material spills

Continue to implement environment improvement plans for areas of concern as identified in the annual Aspects and Impacts risk register review.

All areas continued with planned maintenance tasks for tanks, pipes and bunds. These plans are captured and monitored through 1SAP. The adherence to planned maintenance ensures less radioactive process material spills as demonstrated in Figure 40.

3 Operation of industrial systems

3.1 Particulate emissions

3.1.1 Environmental Outcome

No adverse impacts to public health as a result of particulate emissions from ODC's activities.

No adverse impacts to public health as a result of particulate emissions from operations conducted by ODC occurred during FY18. Condition 49(a) of the Major Development Approval prescribes ground level criteria for dust concentrations. Measured ground level dust concentrations derived from operations at Olympic Dam and recorded at sensitive receptor sites were below compliance criteria for PM_{10} dust at all times during FY18.

3.1.2 Compliance criteria

Ground level PM_{10} dust concentrations at Roxby Downs derived from construction and operational sources at Olympic Dam must not exceed the PM_{10} 24-hour average of 50µg/m³.

ODC notes that Olympic Village is not referenced under Condition 49 of the Major Development Approval and is therefore not considered a compliance station. However, Olympic Village is the primary workers village at Olympic Dam and is considered a sensitive receptor site. For this reason data pertaining to ground level dust concentration at Olympic Village has also been included into this report.

The highest 24-hour average recorded for operational contributed PM_{10} dust was 28.95µg/m³ and 40.36µg/m³ at Roxby Downs and Olympic Village respectively. This is below the limit of 50µg/m³ and is discussed further in section 3.1.4.

3.1.3 Leading Indicators

- None applicable

3.1.4 Deliverables

Records of particulate emissions from Smelter 2 to assess compliance with the emission limits of EPA Licence 1301 and the Environment Protection (Air Quality) Policy 2016 (AE 2.1)

The Environment Protection (Air Quality) Policy 2016 prescribes a level for emissions of particulates from any process. This level is referenced in EPA Licence 1301 Authorisation Reference (37-43). Sampling of smelter stack emissions and analysis for particulate concentrations are undertaken periodically to assess the performance of gas cleaning systems (EPA Licence 1301 Authorisation Reference (37-43)). Particulate emissions from the Acid Plant Tails Stack (APTS), Concentrate Dryer Stack and Main Smelter Stack were tested during FY18. The results of this testing program are summarised in Table 10 and Table 11.

Emissions of particulates from the Main Smelter Stack and the Acid Plant Stack met requirements of the Environment Protection (Air Quality) Policy 2016 during the reporting period for isokinetic testing (Table 10). No exceedances of ground level concentrations (GLC) of PM_{10} as per schedule 2 of the EP Air quality Policy 2016 occurred in FY18.

Table 10: Measured particulate concentrations at the Main Smelter Stack and Acid Plant Stack (mg/Nm³)

	Main Smelter Stack (mg/Nm³)	Acid Plant Stack (mg/Nm³)
August 2017	23	2
February 2018	21	na

Table 11: Measured particulate concentrations at the Concentrate Dryer Stack (mg/Nm³)

	Concentrate Dryer Stack (mg/Nm³)
September 2017	166
April 2018	308*

Note: Environment Protection (Air Quality) Policy 1994 Limit was 250 mg/Nm³. The Environment Protection (Air Quality) Policy 2016 Schedule 4 is 100mg/Nm³ and Schedule 2 GLC for PM_{10} is 0.05 mg/m³. The GLC was not exceeded at sensitive receivers (Figure 42 and Figure 43).* see below event description.

On the 17th April 2018 isokinetic testing of the Concentrate Dryer Stack revealed that particulates exceeded the EPA compliance limit for BHP of 250mg/Nm³ and were averaged at 308mg/Nm³. Following inspections it was demonstrated that Dryer 1 bag house was the cause of the high particulates. A full baghouse replacement occurred and follow up testing demonstrated Dryer 1 compliance at 116mg/Nm³.

Records of particulate emissions from Calciner A and B to assess compliance with the relevant particulate emission limit specified in Environment Protection (Air Quality) Policy 2016 (AE 2.2)

Particulate emissions from Calciner A and B are measured on a quarterly basis by isokinetic sampling, where possible, depending upon process reliability and plant availability (Table 12). Any measurement above 250mg/Nm³ is investigated and reported to EPA Regulation and Compliance. The isokinetic stack-sampling filters used to capture particulates are also analysed for ^{238}U activity. Results from the uranium analysis, together with data obtained from the process control system, are used to estimate total uranium discharged from the stacks, and subsequently reported in the LM1 Radiation Annual Report.

Scheduled sampling of the Calciner gas cleaning systems occurred in July 2017, December 2017; January 2018 and April 2018. Emission of particulates from Calciner A and B met the requirements of the Environment Protection (Air Quality) Policy 2016 during the reporting period and did not result in GLC exceedance of particulates at sensitive receivers (Table 12). The particulate emission trend for the Calciner is presented in Figure 41.

Table 12: Measured particulate concentrations in Calciner emissions (mg/Nm³)

	Calciner A (mg/Nm³)	Calciner B (mg/Nm³)
July 2017	76	116*
December 2017	15	offline
January 2018	23	23
April 2018	28	25

* Environment Protection (Air Quality) Policy 1994 Limit was 250 mg/Nm³. The Environment Protection (Air Quality) Policy 2016 Schedule 4 is 100mg/Nm³ and Schedule 2 GLC for PM_{10} is 0.05 mg/m³. The GLC was not exceeded at sensitive receivers (Figure 42 and Figure 43). In accordance with the transitional provisions of the EP (Air Quality) Policy 2016 the new limit will apply within 2 years of 1/9/2016.

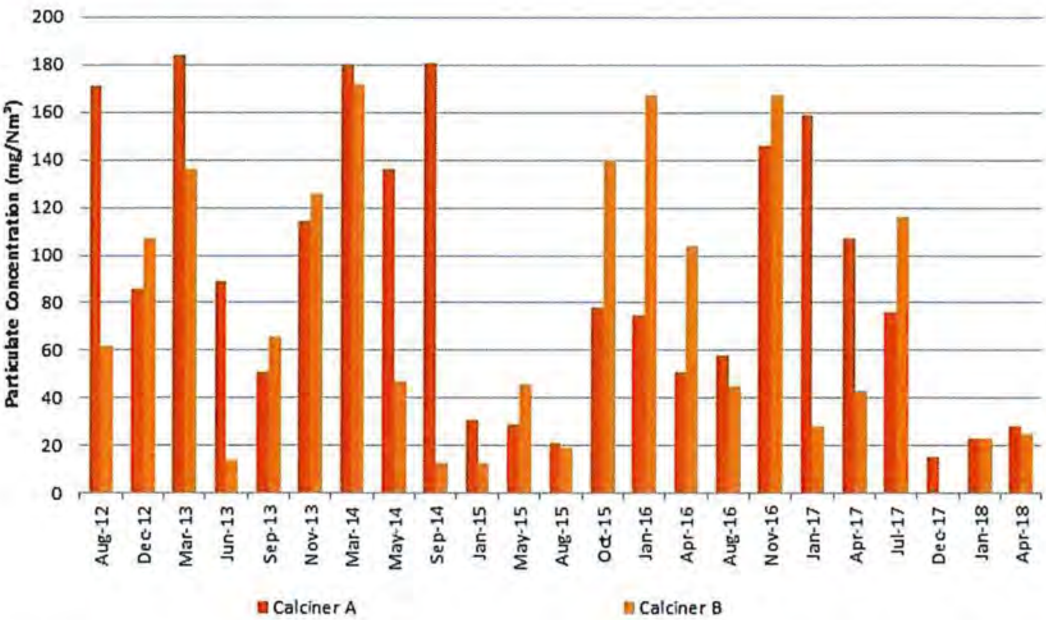


Figure 41: Historical Calciner quarterly isokinetic particulate emissions.

Records of particulate and hydrogen sulphide emissions from the Slimes Treatment Plant to assess compliance with the emission limits specified in the Environment Protection (Air Quality) Policy 2016 (AE 2.3).

Particulate and hydrogen sulphide emissions from the Slimes Treatment Plant are measured on a biannual and annual basis respectively by isokinetic sampling. Any measurement above 100 mg/Nm^3 for particulates from the roaster scrubber or above 5 mg/Nm^3 of hydrogen sulphide from the NOx Scrubber is reported to EPA Regulation and Compliance and then investigated. See Table 13 below for the results:

Table 13: Measured particulates and Hydrogen Sulphide concentrations (mg/Nm³)

	Saunders Furnace Particulates (mg/Nm³)	NOx Scrubber Hydrogen Sulphide (mg/Nm³)
March 2018	21	<0.03
June 2018	72	

Records of real-time monitoring of particulates to ensure that concentrations at Roxby Downs remain within the compliance criteria (AE 2.6)

The real-time dust monitoring system records data at 10 minute intervals of ground level dust concentrations at sensitive receptor sites. The calculation of the operational component of these levels is determined by subtracting dust concentrations measured at the Northern background site from measurements recorded at sensitive receptors during attributable wind direction periods. The real time operational dust concentration results for Roxby Downs and Olympic Village are shown in Figure 42 and Figure 43. The highest 24-hour average recorded for operational contributed PM10 dust was

28.95µg/m3 and 40.36µg/m3 at Roxby Downs and Olympic Village respectively.

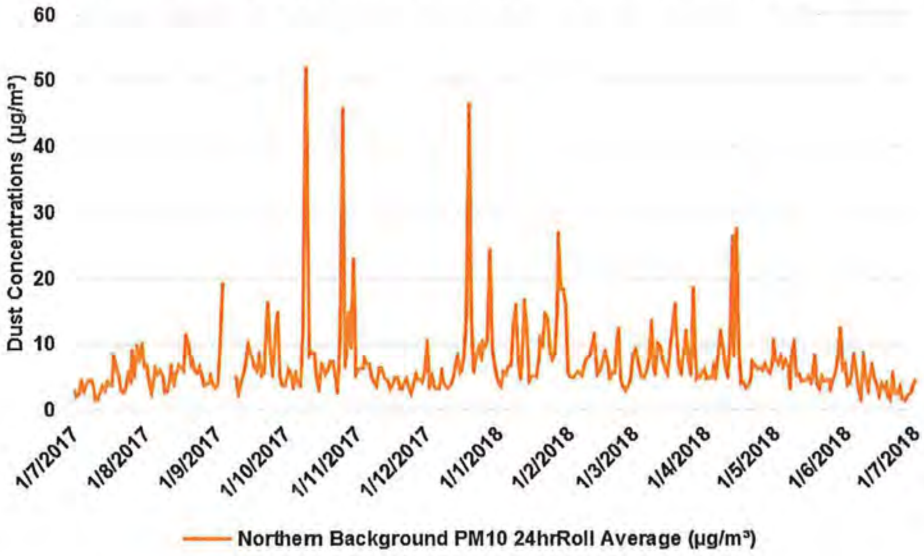


Figure 44 represents real time 24-hour average background PM_{10} dust concentrations.

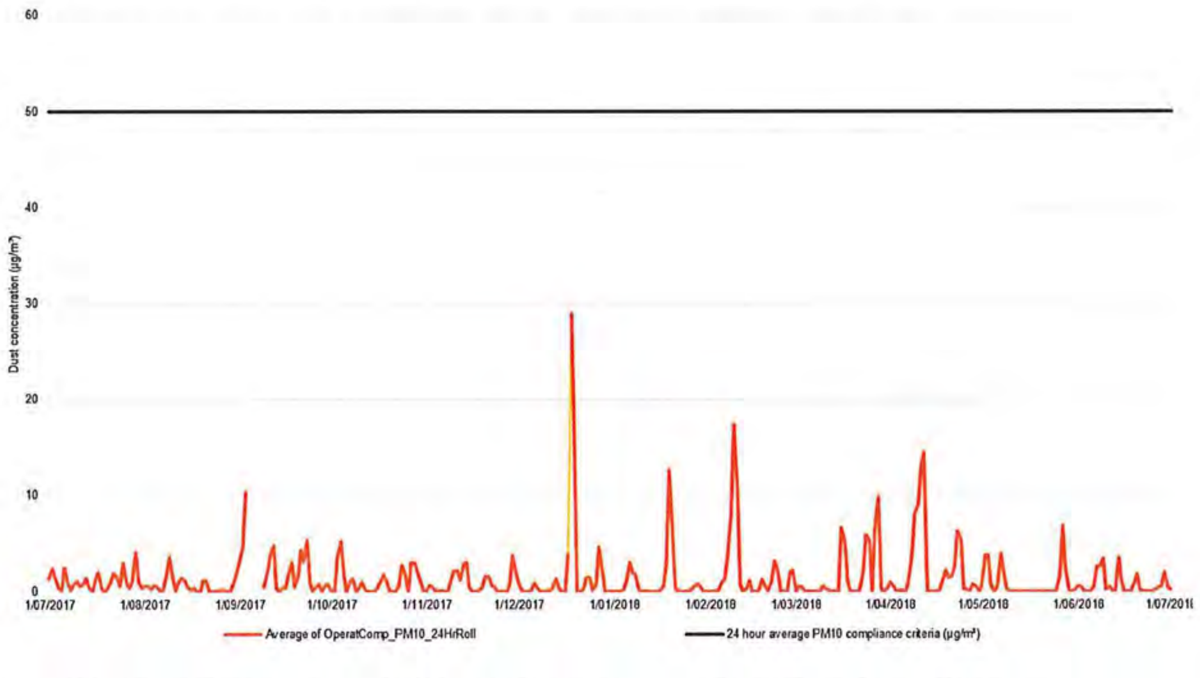


Figure 42: Real time PM_{10} 24-hour 'operational contribution' dust concentrations at Roxby Downs (FY18)

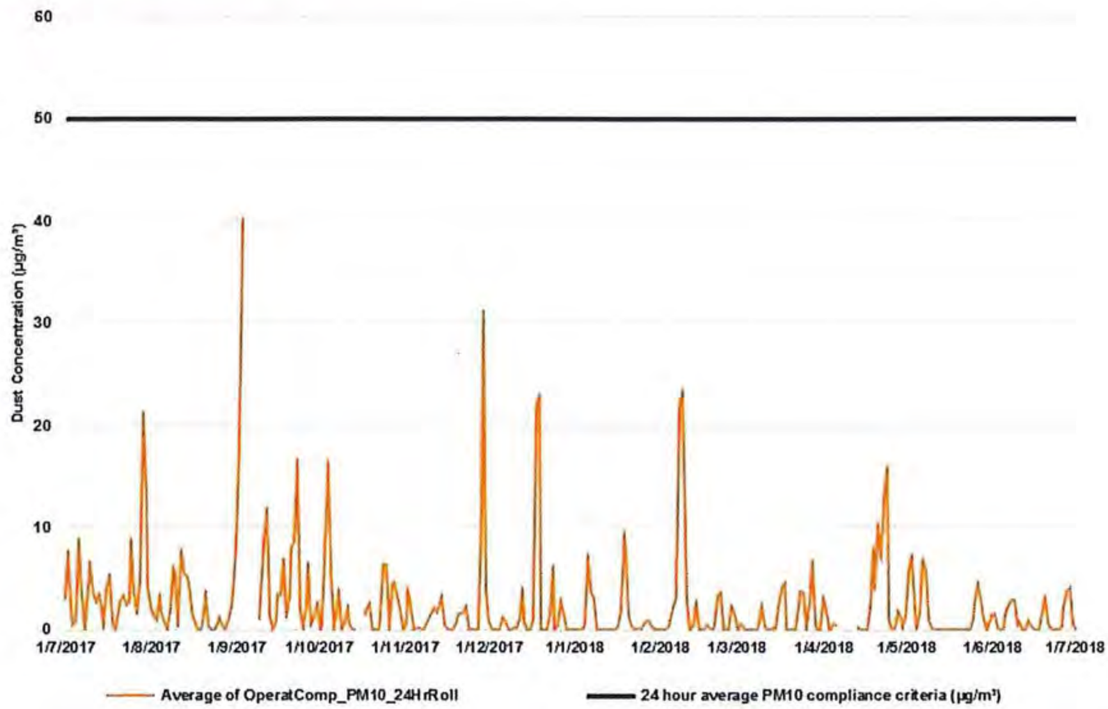


Figure 43: Real time PM_{10} 24-hour 'operational contribution' dust concentrations at Olympic Village (FY18).

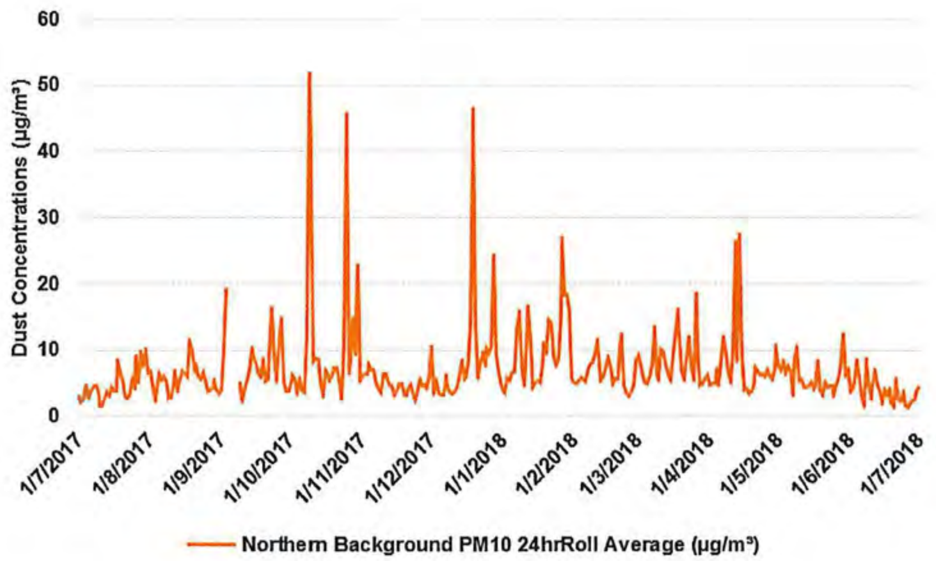


Figure 44: Real time dust concentrations at Northern Background Station (FY18)

Provision of real-time particulate information to inform the management of dust producing activities at the operation (AE 2.6)

The real time dust monitoring stations are recording information at 10 minute intervals with all information stored and managed on the Airodis air management data base. A daily report is distributed to stakeholders which shows background and operationally contributed PM_{10} dust levels. If high winds and storms are anticipated a site wide weather warning is circulated to all operational areas, with site ceasing outdoor operations during storm events.

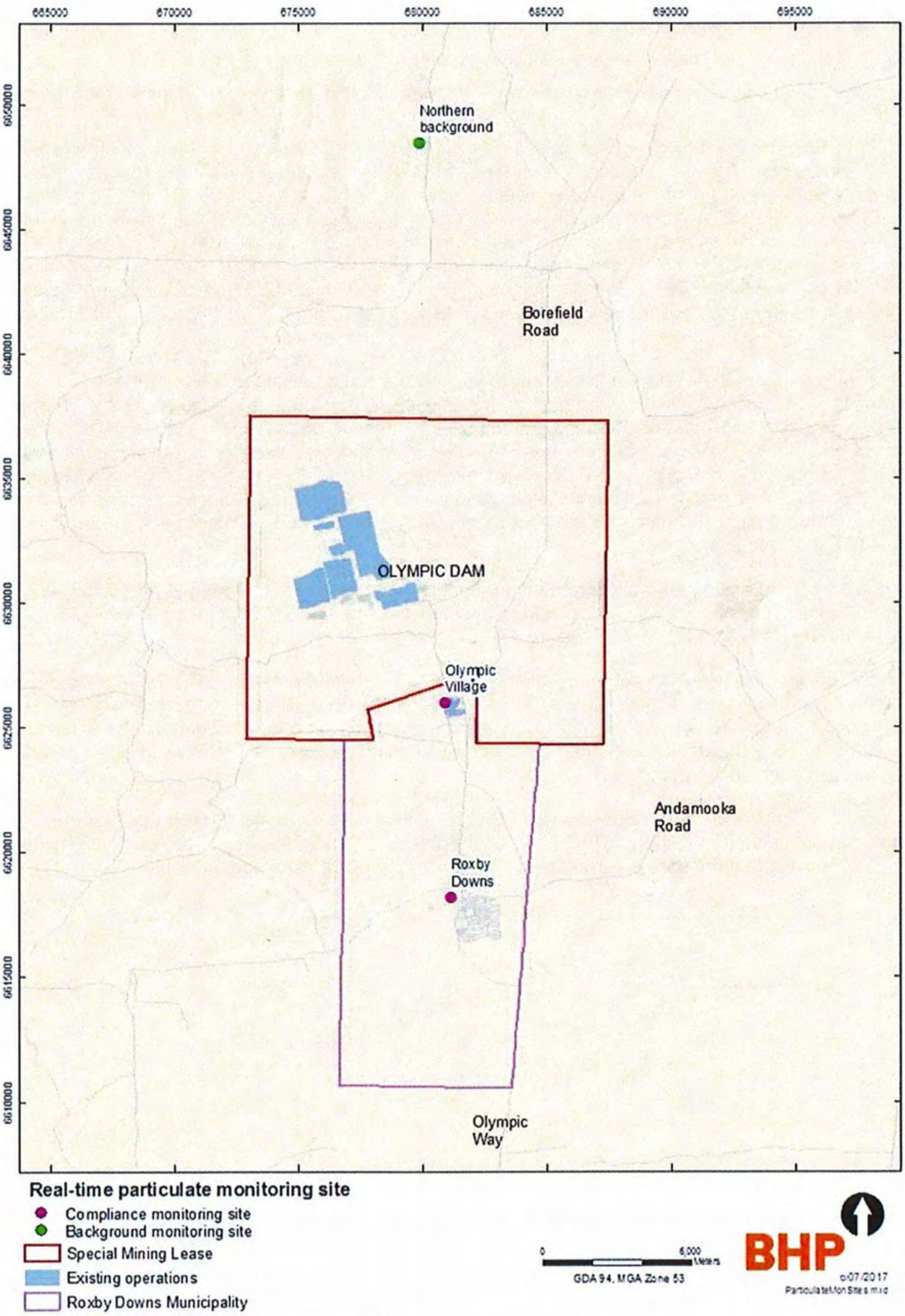


Figure 45: Location of real time dust monitoring sites.

3.1.5 Deliverables (FL 2.1)

A report on the annual changes in perennial communities within and surrounding the SML.

Provide a comparative assessment on perennial species existing at different distances from the Main Smelter Stack.

In FY18, 65 permanent quadrats (i.e., sites) were monitored for perennial vegetation (Figure 46). The mean percentage relative abundance of most plant species at control sites in FY18 was similar to previous years. *Acacia ligulata* had the greatest relative abundance overall from 2011 to 2017, followed by *Dodonea viscosa*. A linear regression analysis of Treatment and Control sites found that *Acacia ligulata* significantly decreased over time (Respectively, $F_{1,5} = 54.479$, $p < 0.001$; $R^2 = 0.916$; $F_{1,5} = 34.795$, $p < 0.001$, $R^2 = 0.874$) and *Dodonea viscosa* significantly increased over time (Respectively, $F_{1,5} = 76.134$, $p < 0.001$; $R^2 = 0.938$; $F_{1,5} = 93.559$, $p < 0.001$; $R^2 = 0.949$; Figure 2 and Figure 3). Other species were found to decline as well, however, this was consistent between Control and Treatment sites.

Simpson's Index is a measure of the extent to which sites are dominated by one or more species. A Simpson's value of one indicates a single species exclusively dominates a site, whereas a value closer to zero suggests that numerous species are equally abundant. Simpson's index scores were averaged across 2006 to 2017. A Mann-Whitney ANOVA of Simpson's index values for Callitris vegetation sites found that plant diversity was not significantly different at Treatment compared to Control sites ($F_{6,1} = 0.456$, $p = 0.649$). In addition, a Mann-Whitney ANOVA of Simpson's index values for Acacia vegetation sites found that plant diversity was also not significantly different at Treatment compared to Control sites ($F_{12,43} = -0.542$, $p = 0.588$).

In addition, a regression analysis determined that plant species diversity averaged over 2006 to 2017 did not significantly change with distance from the operation (up to 27 km from the main smelter stack; $F_{1,65} = 0.057$, $p = 0.813$; $R^2 < 0.001$; Figure 47).

Overall, plant diversity did not appear to alter between Control and Treatment sites for both Acacia and Callitris vegetation types. *Acacia ligulata* and *Dodonea viscosa* remain the two most dominant species with *Acacia ligulata* decreasing and *Dodonea viscosa* increasing in relative abundance over time. It is important to note that relative abundance is not an absolute number, it's relative to other perennial species recorded during monitoring.

In addition, Simpson's index values average over a maximum of 11 years showed that plant diversity could not be linked to proximity of the mine. Therefore, the operation does not appear to be having a significant impact on the species diversity of surrounding perennial flora communities.

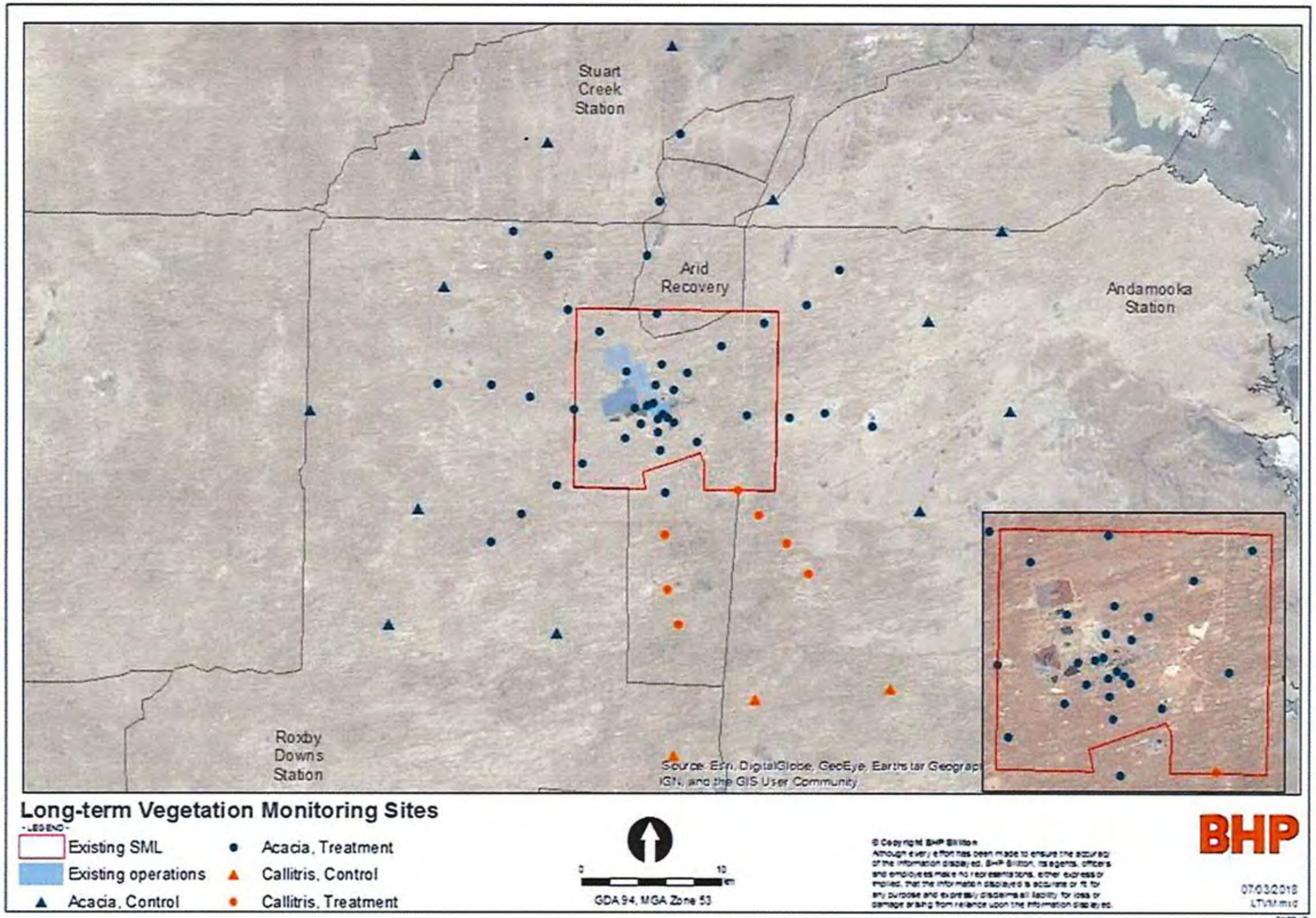


Figure 46: Location of radial sample sites monitored in FY18.

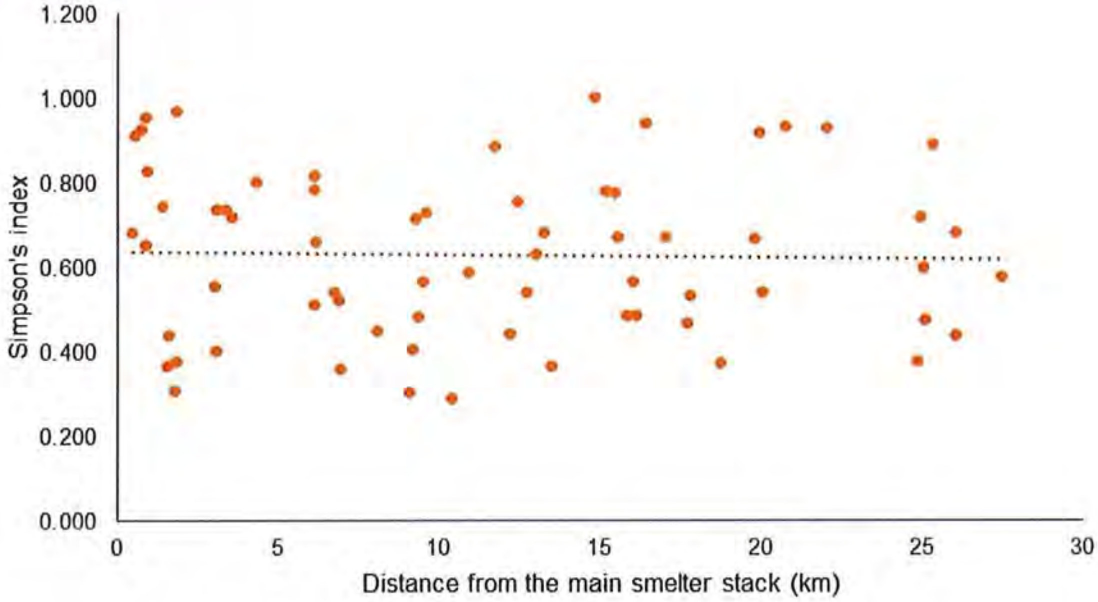


Figure 47: Simpson's index averaged over 2006 to 2017 for each site and plotted against the distance of the site from the main smelter stack.

3.1.6 Target FY18

- None applicable

3.1.7 Action plan FY18

Implement an Environmental Improvement Plan should any significant increase of operationally contributed PM_{10} 24 hour average of $50_{ug}/m^3$ occur over the year.

No increase of operationally contributed PM_{10} 24 hour average of $50_{ug}/m^3$ occurred over the year. No improvement plan is required at this present time.

3.2 Sulphur dioxide emissions

3.2.1 Environmental Outcome

No adverse impacts to public health as a result of sulphur dioxide emissions from ODC's operations.

There were no adverse impacts to public health as a result of sulphur dioxide (SO_2) emissions from ODC's activities during FY18.

National Environmental Protection Measure (NEPM) levels for ambient air quality are based on protection of human health. Roxby Downs and Olympic Village ambient SO_2 analyser results for the reporting period showed no exceedance of the NEPM for ambient air quality SO_2 at either Olympic Village or Roxby Downs Township.

3.2.2 Compliance criteria

Annual average SO_2 concentration of less than 0.02 ppm at sensitive receivers, Olympic Village and Roxby Downs.

The measured annual average SO_2 concentrations for the reporting period was 0.0000 and 0.0006 at Roxby Downs and Olympic Village respectively, which is less than the 0.02 ppm NEPM limit.

24-hour average SO_2 concentration of less than 0.08 ppm at sensitive receptors, Olympic Village and Roxby Downs

The measured maximum 24-hour average SO_2 concentrations for the reporting period was 0.0020 ppm and 0.0030 ppm for Roxby Downs and Olympic Village respectively. This is below the 0.08 ppm NEPM limit.

One-hour average SO_2 concentration of less than 0.2 ppm at sensitive receptors, Olympic Village and Roxby Downs

The measured maximum hourly average SO_2 concentration for the reporting period was 0.0022 ppm and 0.0044 ppm for Roxby Downs and Olympic Village respectively, which is less than the 0.2 ppm NEPM limit.

3.2.3 Leading Indicators

- None applicable

3.2.4 Deliverables

Calibration records for SO_2 analysers on the Main Smelter Stack and Acid Plant Tails Gas Stack (AE 2.1).

The Acid Plant Tail Gas Stack (APTS) and Main Smelter Stack (MSS) SO_2 analysers were maintained in accordance with site procedures and manufacturer's recommendations throughout the reporting period. Calibration maintenance plans (MPs) are scheduled through 1SAP and are automatically generated. These MPs are part of Olympic Dams' pollution control register and monitored for completion frequently. Currently, the in stack real time SO2 and particulate analysers on the MSS and the APTS are calibrated on a weekly and quarterly basis. All calibration maintenance plans were completed for FY18 and the calibration records are kept electronically.

Records of SO_2 emissions to assess compliance with the monitoring and reporting requirements of EPA Licence 1301 and the Environment Protection (Air Quality) Policy 2016 (AE 2.1).

Isokinetic sampling of the Main Smelter Stack and Acid Plant Tail Gas Stack was undertaken in August 2017 for sulphur trioxide, with sulphur dioxide testing in August 2017 and February 2018. The results indicate continued compliance with the requirements of EPA Licence 1301 and the Environment Protection (Air Quality) Policy 2016. Table 14 and Table 15 display the results for FY18.

Table 14: Smelter 2 Main Smelter Stack sampling results FY18

Sampling Point Main Smelter Stack	Total acid gas emissions (mg/Nm^3)	Sulphur trioxide and acid mist emissions* (mg/Nm^3)	Sulphur dioxide emissions ** (mg/Nm^3)
Reporting Level	**3000**	**100**	**2400**
August 2017	69	0.7	68
February 2018	-	-	110

*** Expressed as sulphur trioxide equivalent**

** EPA Licence 1301 Licence requirement level without sulphur trioxide

Table 15: Smelter 2 Acid Plant Tails Stack sampling results FY18

Sampling Point Acid Plant Tails Gas Stack	Total acid gas emissions (mg/Nm^3)	Sulphur trioxide and acid mist emissions* (mg/Nm^3)	Sulphur dioxide emissions ** (mg/Nm^3)
Reporting Level	**3000**	**100**	**2400**
August 2017	614	0.6	613
February 2018	-	-	375

*** Expressed as sulphur trioxide equivalent**

**** EPA Licence 1301 Licence requirement level without sulphur trioxide**

Data to confirm that approximately 99 per cent of all SO_2 generated during the smelting process is captured. (AE 2.1)

The percentage of SO_2 recovery for the reporting period FY18 was 98.99 %. This recovery result has decreased from 99.00 % last reporting year, however remains compliant with the required approximate 99 % capture deliverable.

Records of ground level SO_2 concentrations at Olympic Village and Roxby Downs Township to assess compliance with the ground level SO_2 concentration requirements of the Ambient Air Quality NEPM and the values contained in schedule 2 of the Environment Protection (Air Quality) Policy 2016. (AE 2.4)

Ambient SO_2 1 hour, 24 hour, and 1 year average (mean) concentrations for FY18 at Olympic Dam Village and Roxby Downs were measured by real time continuous ambient SO_2 monitors in accordance with EPA Licence 1301 Condition (305-138). Measured maximum average 1 hour, 24 hour, and 1 year concentrations for Roxby Downs and Olympic Village along with the applicable NEPM values, are presented in Table 16 below. The results of the measured concentration for the reporting period show that no exceedance of the NEPM for ambient air quality for SO_2 occurred at Olympic Village or Roxby Downs Township (Figure **48** - Figure 53).

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Table 16: Measured maximum average (mean) ambient SO2 concentrations at Roxby Downs and Olympic Village.

	Annual average concentration (ppm)	Maximum 24 hour average concentration (ppm)	Maximum Hourly average concentration (ppm)
Roxby Downs			
NEPM	**0.02**	**0.08**	**0.2**
Measured Concentration	0.0000	0.0020	0.0022
Olympic Village			
NEPM	**0.02**	**0.08**	**0.2**
Measured Concentration	0.0006	0.0030	0.0044

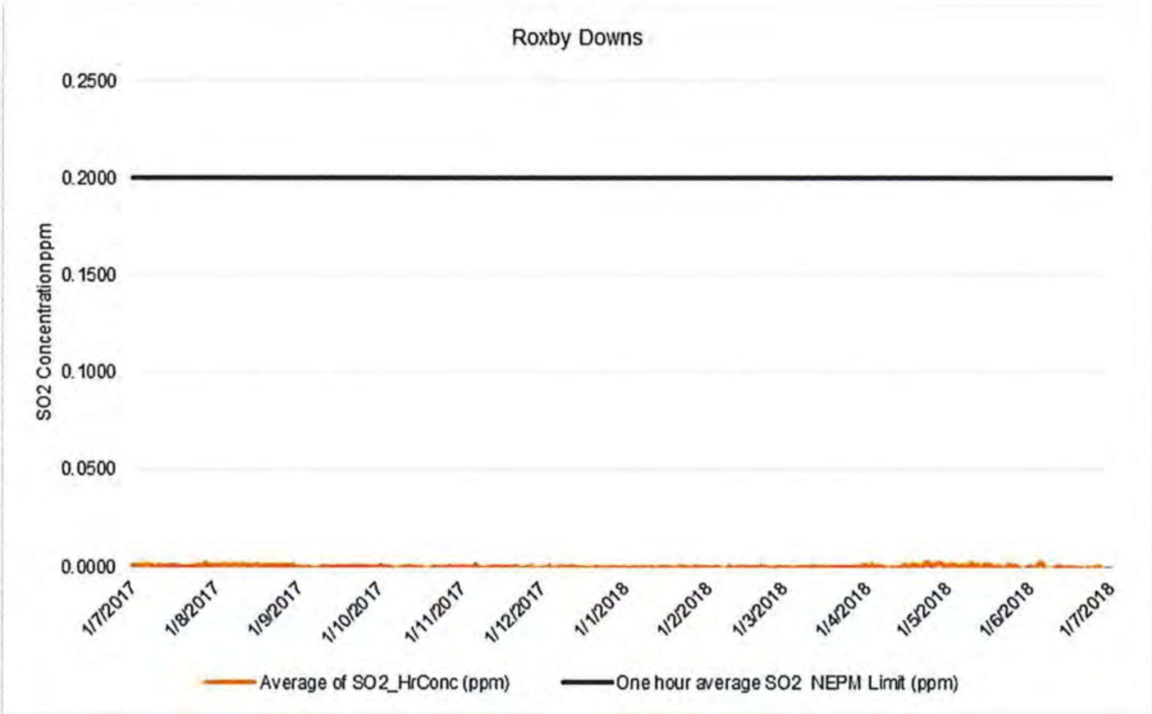


Figure 48: **Measured hourly mean SO_2 concentration at sensitive receptor, Roxby Downs.**

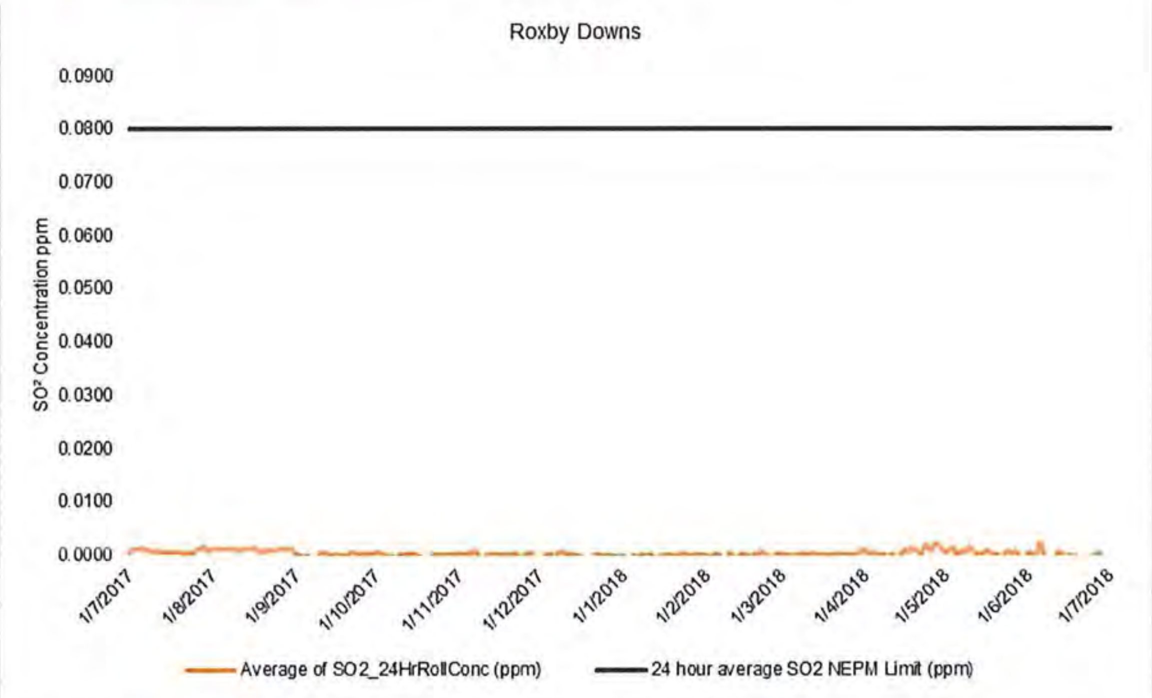


Figure 49: Measured 24 hour mean SO_2 concentration at sensitive receptor, Roxby Downs.

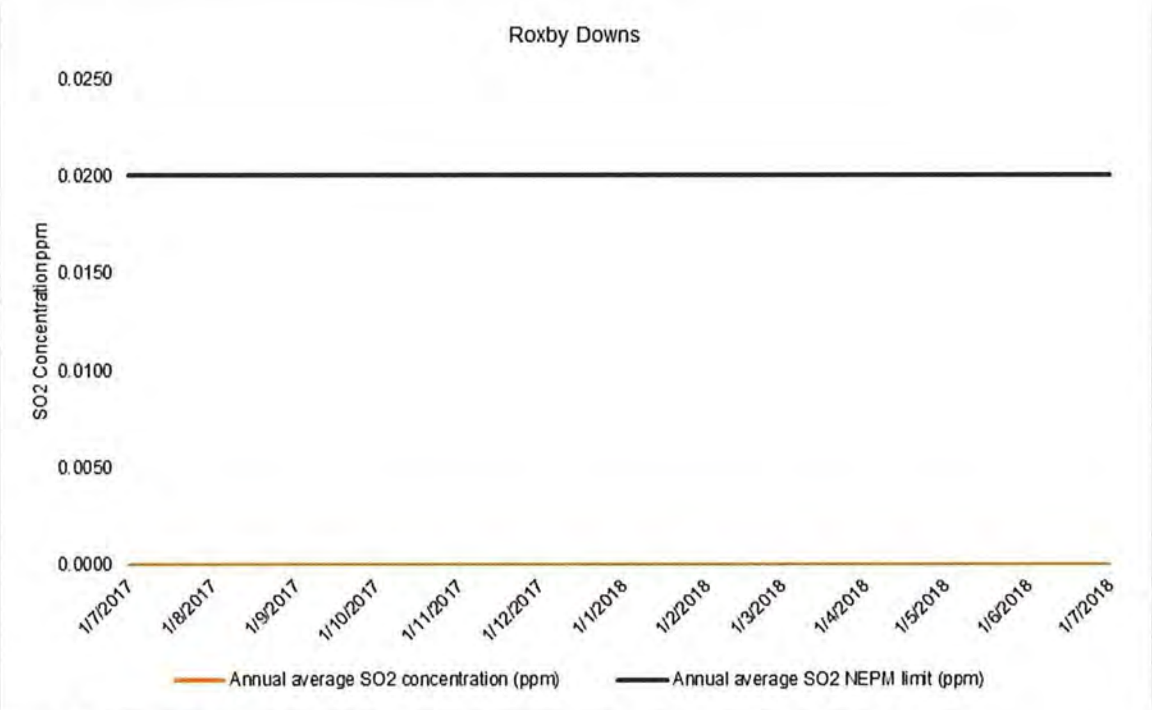


Figure 50: Measured annual mean SO_2 concentration at sensitive receptor, Roxby Downs.

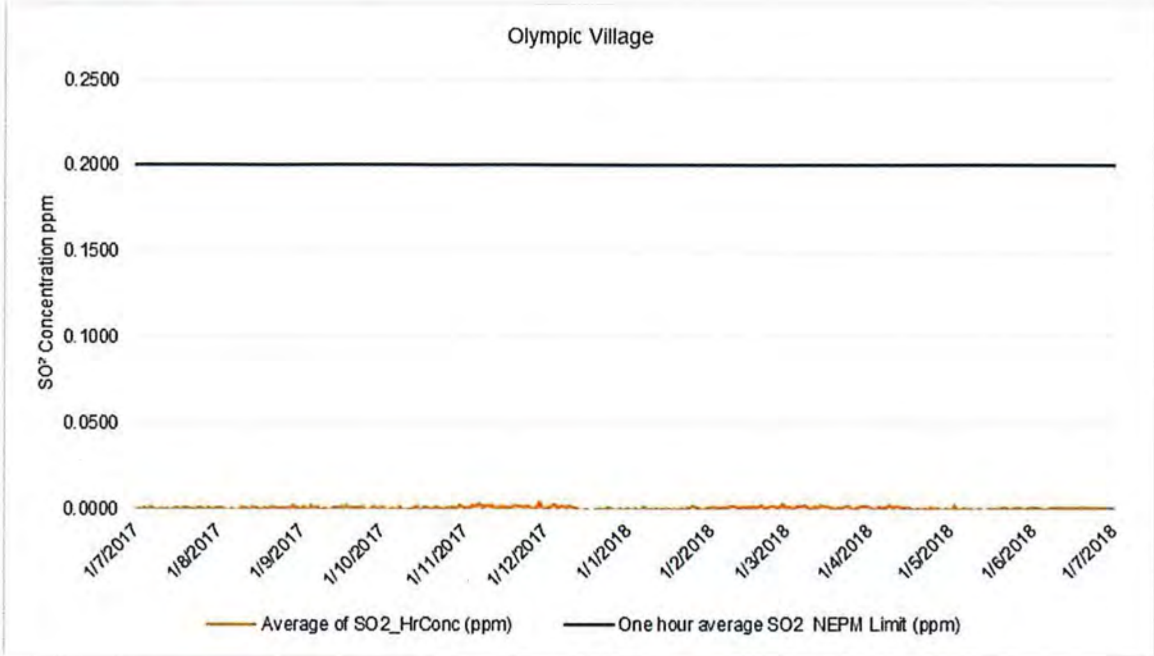


Figure 51: Measured hourly mean SO_2 concentration at sensitive receptor, Olympic Dam.

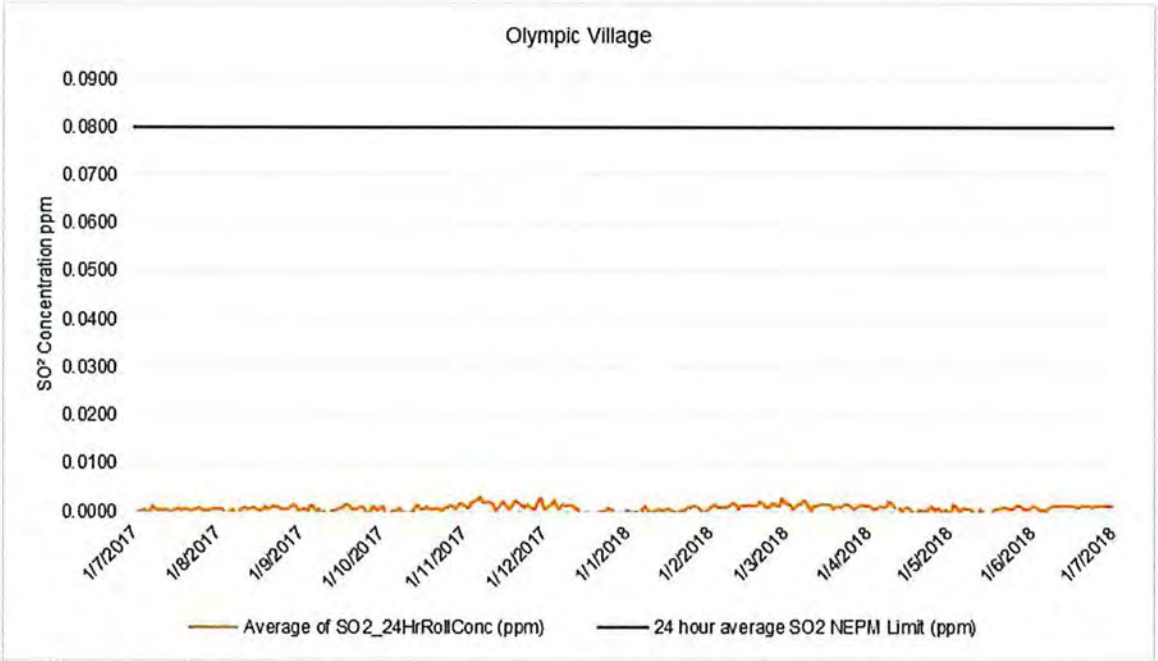


Figure 52: Measured 24 hour mean SO_2 concentration at sensitive receptor, Olympic Dam.

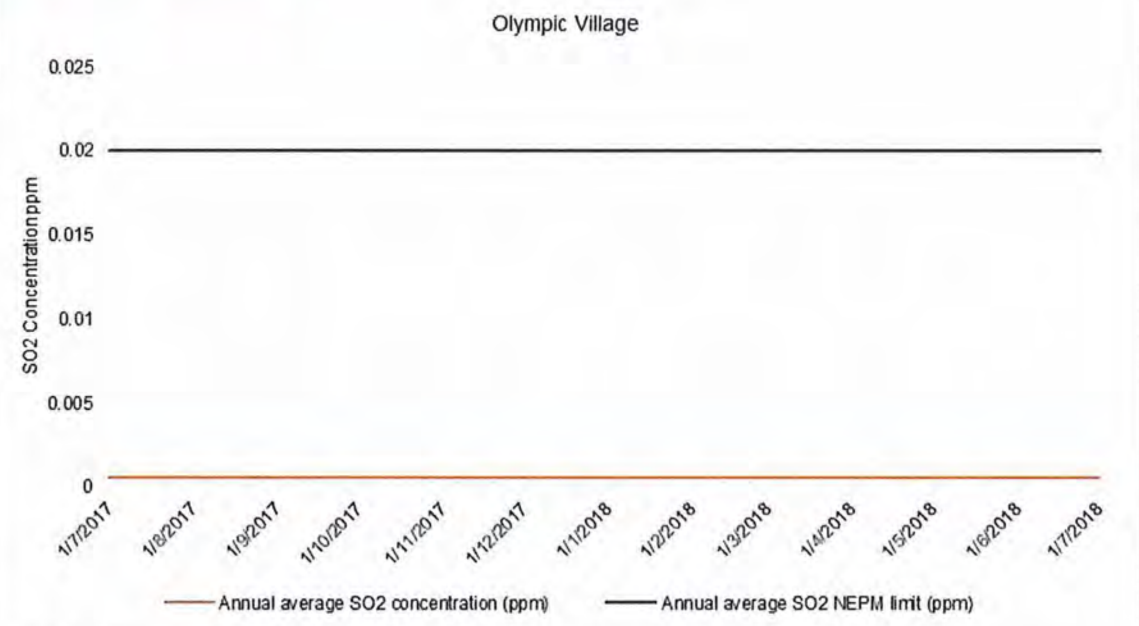


Figure 53: Measured annual mean SO_2 concentration at sensitive receptor, Olympic Dam.

3.2.5 Targets FY18

Approximately 99 percent of all SO_2 generated during the smelting process is captured.

This has been achieved. See section 3.2.4 deliverables where this has been reported.

3.2.6 Action plan FY18

- None applicable

3.2.7 Continuous Improvement

Investigate threshold levels for effects of sulphur dioxide SO_2 on flora in the region of Olympic Dam

An investigation was conducted to determine how point source SO_2 emissions from the Olympic Dam Mine site main stack influenced ambient SO_2 levels in the surrounding region and if these ambient SO_2 levels impact the plant diversity of the area and sulphur uptake in plant leaves.

As the point source SO_2 levels from the main stack are known, the study aimed to determine the resultant ambient SO_2 levels in the surrounding region and if these ambient SO_2 levels influence or impact the plant species diversity in the area. Leaf samples were also taken to determine their sulphur content.

To achieve this the following data was collected and analysed:

- Twenty four monitored vegetation sites were selected, on the special mining lease (SML) and up to 25km off the SML. Their mean diversity was determined based on data collected between 2006 and 2016.
- Ambient levels of SO_2 were sampled and recorded using SO_2 Radiello passive samplers placed at twenty three of the monitored vegetation sites. Not all 24 sites could be sampled due to access constraints.

- Real time ambient SO_2 data was collected at Roxby Downs and Olympic Village monitoring stations and compared to ambient SO_2 Radiello passive samplers placed at the above vegetation sites.
- Leaf samples were collected from *Acacia ligulata* and *Dodonea viscosa* at eighteen of the monitored vegetation sites and analysed for sulphur leaf content. Not all 24 sites could be sampled due to time and access constraints.

The project compared the following:

- Ambient SO_2 levels at 23 vegetation sites was recorded with SO_2 Radiello passive samplers and compared to real time ambient SO_2 data obtained from the real time monitors at Roxby Downs and Olympic Village stations. This data was compared to the distance from the stack and treatment versus control sites.

- The 24 vegetation sites were defined as treatment or control sites. Treatment sites were those considered to be close to the stack and likely to be impacted by point stack emissions while control sites are ~25km from the main stack and are unlikely to be impacted by stack emissions due to their distance from the stack. The diversity (as measured by *Simpsons index) of the 24 vegetation sites (treatment and control) was compared to the distance from the stack. The diversity of the control and treatment sites were compared to each other.

- As the prevailing wind is south south east (BOM 1997-2017) the 24 vegetation sites (treatment and control) were divided into two with all sites to the north, north east, north west and west in one half while all vegetation sites to the south; south west; south east and east were in the second half. The diversity of the two areas were compared.

- The leaf sulphur content of *A. ligulata* and *D. viscosa* were compared to determine if the species differ in their uptake of SO_2 indicating a more tolerant species. The leaf Sulphur content of the two species were then compared to their distance from the stack to determine if a relationship existed between distance and sulphur uptake.

The project analysis determined that ambient SO_2 data from the real time Roxby Downs and Olympic Village monitoring stations show low mean annual ambient SO_2 levels of 0.0000 ppm and 0.0001 ppm respectively for the region. This was collaborated with the Radiello samplers that were placed at varies vegetation sites in the Olympic Dam region displaying less than results due to the low detectability of the ambient SO_2. Even though the levels recorded are very low the data did demonstrate that ambient SO_2 levels were higher at vegetation treatment sites closer to the stack than at the control sites which are further away from the stack.

In the northern hemisphere it is known that at and above a critical level of 0.007 ppm SO_2, adverse effects on receptors such as plants and ecosystems may occur. Evidence suggest that plants adapted to water limited environments have biological mechanisms in place that also confer a degree of resistance to SO_2 stress as these mechanisms essentially prevent SO_2 being absorbed or getting into the plant.

Based on research for arid environments, levels of < 0.046 ppm has a positive effect and negative effects were noticed from 0.500 ppm and up on desert plants in arid regions depending on the plant. As ambient SO_2 levels measured in the Olympic Dam region are below 0.007 ppm in the region, and as previous research suggests a negative impact to plant and plant diversity (as measured by Simpson's index) would not be evident. This was confirmed when plant diversity (as measured by Simpson's index) was compared to the distance from the stack and it was not significant, $r = -.151$ $p = .482$. The control sites, which are further away, did appear to have a lower Simpson's index (higher diversity) compared to the treatment sites although it was not significant, $p = .282$. (Figure 6 and table 4 represent the data analysis).

*Simpson's Index is a measure of the extent to which sites are dominated by one or more species. A Simpson's value of one indicates a single species exclusively dominates a site, whereas a value closer to zero suggests that numerous species are equally abundant.

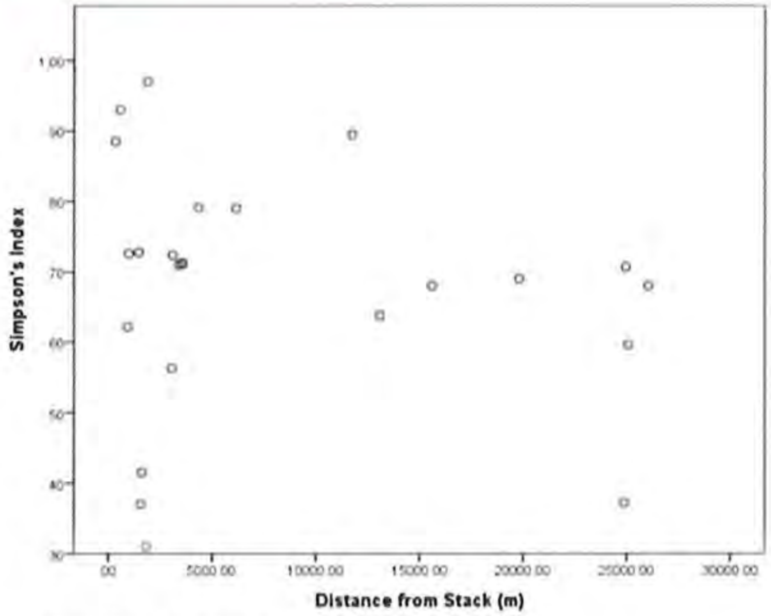


Figure 6: Graph scatterplot displaying plant diversity and distance

Table 4: Pearson correlation for diversity and distance –There is a small negative correlation between diversity an distance from the stack however it is not significant, r = -.151 p = .482

Correlations

		Distance from Stack (m)	Simpson's Index
Distance from Stack (m)	Pearson Correlation	1	-.151
	Sig. (2-tailed)		.482
	N	24	24
Simpson's Index	Pearson Correlation	-.151	1
	Sig. (2-tailed)	.482	
	N	24	24

Previous research show low levels < 0.046 ppm could have a positive effect on desert plants in arid regions and this could be true with the low levels of SO_2 recorded in the Olympic Dam region. The assumption was made that as the prevailing wind direction was south; south east the majority of stack emission SO_2 deposition would be towards the north; north west and to some extent north east and west. This in turn could influence plant diversity between the two areas. When the two areas diversity was compared to each other no significant difference was observed. This could indicate that ambient SO_2 emissions are too low to be having a positive or a negative impact on plant diversity in the area (Figure 7 and table 5 display the data analysis).

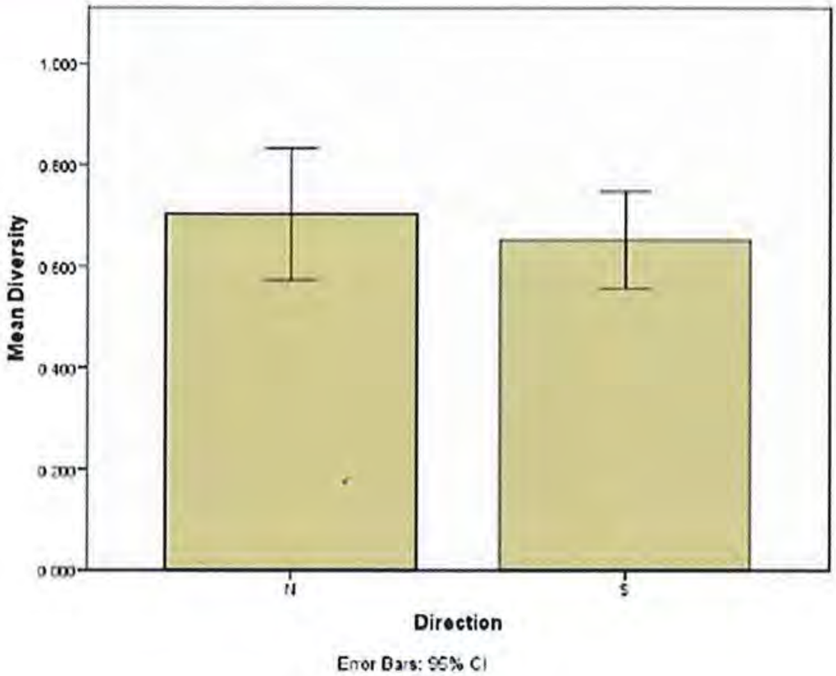


Figure 7: Bar chart displaying diversity between northerly and southerly sites

Table 5: Independent samples test for diversity between northerly and southerly sites. There was no statistical difference between the northerly and southerly sites, t (22) = .701, p =.491

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Diversity	Equal variances assumed	.511	.482	.701	22	.491	.050371	.071885	-.098709	.199450
	Equal variances not assumed			.688	19.262	.500	.050371	.073188	-.102672	.203414

Leaf sulphur content of the *A.ligulata* was compared to the *D. viscosa* and it indicated that *A. ligulata* have higher leaf sulphur content than *D.viscosa*. This could indicate *D.viscosa* are more resistant to SO_2 however *A.ligulata* and *D.viscosa* were far more abundant and widely dispersed than all other species and therefore it is not evident that the increased leaf sulphur content in the *A.ligulata* is causing reduced growth and productivity. Although increased uptake of SO_2 causes reduced growth and productivity due to accumulation of sulphite and sulphate within the plant, SO_2 can cause positive effects on physiological and growth characteristics of plants at very low concentrations, especially in sulphur-deficient soils.

The sulphur level of the soil and the leaf sulphur content could be investigated further to understand if the soil is sulphur deficient and thus possibly having a positive effect on *A. ligulata* species. Alternatively *A. ligulata* could just be naturally higher in leaf sulphur content. This is demonstrated in the data analysis whereby *A. ligulata* and *D. viscosa* was compared to their distance from the stack. The leaf sulphur content of *A. ligulata* and *D. viscosa* was compared to their distance from the stack. There is no significant relationship between *A. ligulata* and *D. viscosa* leaf sulphur content and their distance from the main stack. The increased leaf sulphur content is not therefore attributable to the main stack SO_2 emissions.

From the study we have determined that the ambient SO_2 in the Olympic Dam region is very low and generally below 0.0001 ppm over the monitored period (1/7/2016 to 30/6/2017). Olympic Dam has not exceeded the NEPM standards at monitored sites during the monitored period. This is mainly due to the fact that the Olympic Dam Mine recovers/captures approximately 99 % SO_2 to produce sulphuric acid and provides good dispersion of the small amount of residual SO_2. Another factor is that the Olympic Dam mine is situated in a remote arid environment with minimal industry contributing to ambient SO_2 levels around the region. Although monitored vegetation sites demonstrated differences in diversity with some having low plant diversity and some being diverse, no significant relationship, neither positive nor negative, between plant diversity and leaf sulphur content across 24 study sites ranging from ~0.3km to 25km in distance to the main stack was observed. This is attributed to the low ambient (<0.0001ppm) SO_2 levels in the region. The vegetation sites are situated on the mine site while others are on surrounding pastoral stations and within the municipal town lease area. The difference in diversity of the vegetation sites could be attributed to disturbance by pastoral activities; cattle and off road driving by the local town people. On the mine site land clearing and dust impacts from plant and equipment travelling on unsealed roads could impact diversity of vegetation sites.

In the northern hemisphere it is known that at and above a critical level of 0.007 ppm SO_2, adverse effects on receptors such as plants and ecosystems may occur. Research for arid environments suggests levels of < 0.046 ppm have a positive effect and negative effects on desert plants in arid regions are noticed from 0.5ppm and up depending on the plant. The research and data suggests that if there is an increase of ambient SO_2 levels above 0.007 ppm but below 0.046 ppm we could possibly see an effect on plants, either positive or negative, in the Olympic Dam region. Even with ongoing operations and possible expansions predicted at Olympic Dam it is highly unlikely operations will increase ambient SO_2 levels to such an extent. This is due to the design of the gas cleaning equipment that captures approximately 99% of the generated SO_2 and good dispersion of the small amount of residual SO_2 which results in compliance to Air Quality Policy ground level concentrations for SO_2.

(**Lamb, S. 2017,** '*An investigation into sulphur dioxide (SO_2) emissions at the Olympic Dam Mine Site to determine if it is impacting the diversity of native plants in the arid Olympic Dam region of South Australia*', unpublished report to BHP Billiton Olympic Dam, Central Queensland University).

3.3 Saline aerosol emissions

3.3.1 Environmental Outcome

No significant adverse impacts to populations of listed species (South Australian, Commonwealth) as a result of ODC's activities.

No significant adverse impact to populations of listed species from saline aerosol emissions was observed during FY18. Observations made during environmental inspections and supported by data collected during various flora and fauna monitoring programs, did not find any significant adverse impacts to listed species.

3.3.2 Compliance criteria

No loss of an important population of Plains Rat (*Pseudomys australis*).

There was no loss of an important population of Plains Rat during FY18 as a result of saline aerosol emissions. No loss of habitat to support an important population of Plains Rat was observed during the annual monitoring of emission impacts to vegetation, which are used to assess impacts to flora within the potential impact area. Standards for raise bore design (see section 3.3.6) ensure pollution controls are applied consistently to all new raise bores which ensures that the majority of the salt deposited is reduced to a smaller radius surrounding the raise bore.

3.3.3 Leading Indicators

- None applicable

3.3.4 Deliverables (AE 2.5)

Records from background salt deposition monitoring jars at the edge of the SML against the background limit of 20mg/m^2/day. (AE 2.5).

A system of salt deposition monitoring jars are located on the edge of the SML, north, south, east and west. Please see Figure 1. Background salt deposition monitoring results, recorded at the edge of the SML, from the FY18 monitoring period are presented in Figure 2. Recorded salt deposition levels are below the background limit of 20mg/m^2/day.

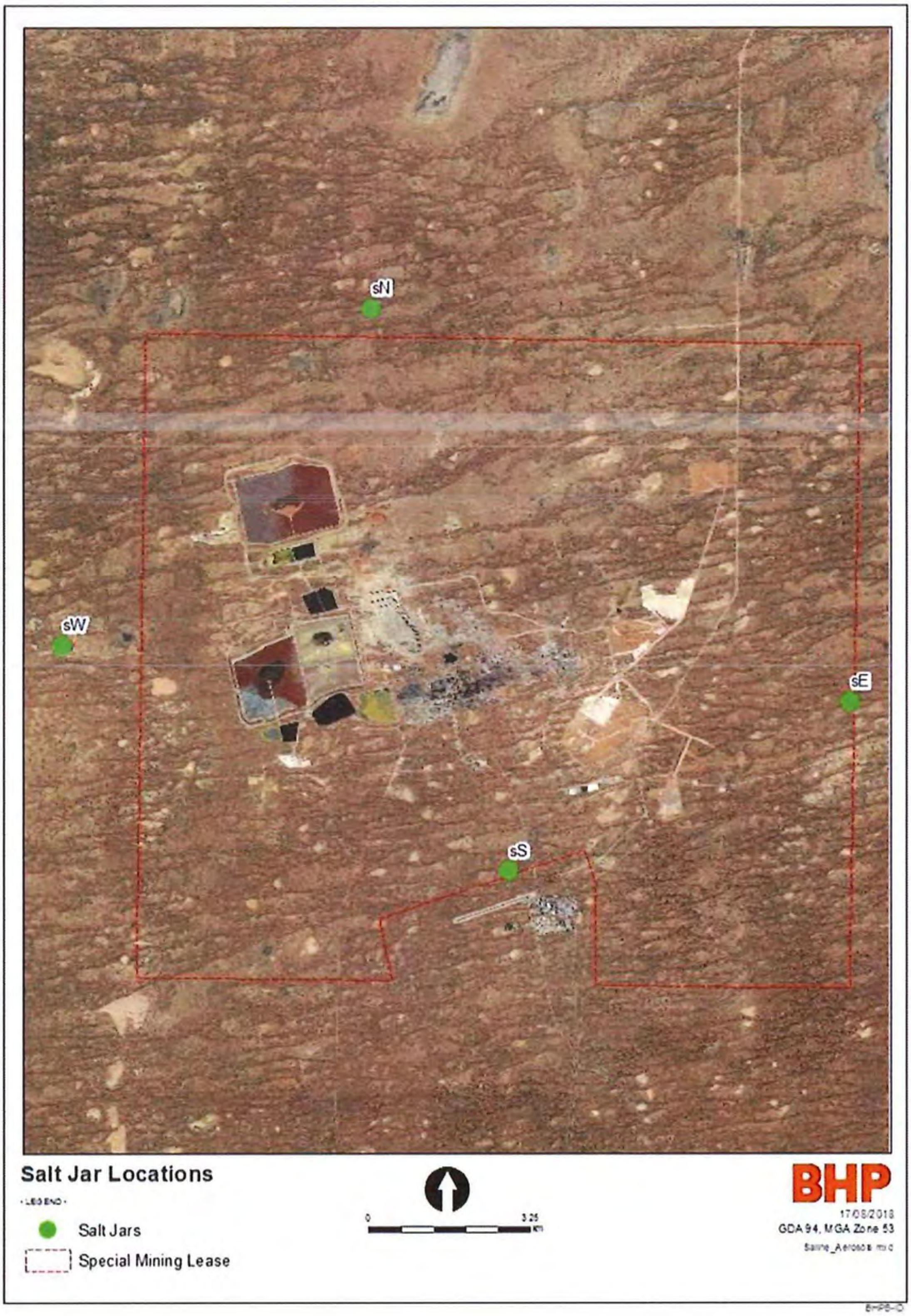


Figure 54: Salt Jar deposition monitoring locations FY18

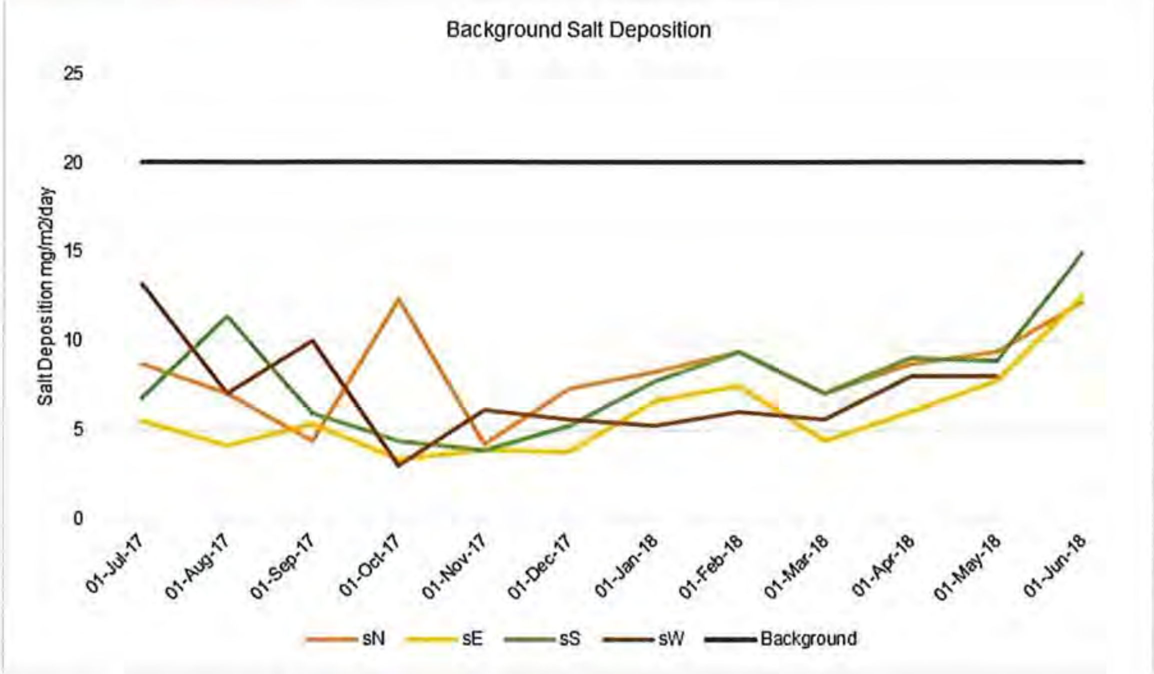


Figure 55: Salt deposition at all monitored raise bores for FY18.

A statement of impacts to the Plains Rat (AE 2.5).

Impacts to flora within the impact zone of the operation are modelled through monitoring of long term changes to perennial vegetation (see Chapter 3.1 Particulate Emissions). Results of these programs and historical fauna programs have demonstrated that the impact to flora and fauna is largely restricted to the vicinity of the operation and is rainfall dependent. No Plains Rats species were observed to be impacted directly by saline emissions in FY18.

3.3.5 Target FY18

Monitor the deposition of salt from saline aerosol emissions at the edge of the SML against background levels of 20 mg/m^2/day.

Salt deposition monitoring as a result of saline emissions occurs on a monthly basis. A monthly maintenance plan (MP) is scheduled through SAP and is automatically generated. This MP is part of ODC's pollution control register and monitored for completion frequently. All maintenance plans were completed for FY18 and the records are kept electronically. Please see section 3.3.4 deliverables where the results of this monitoring have been reported.

3.3.6 Action plan FY18

Install and maintain controls as per the design standard around raise bores.

Standards for raise bore design ensure controls are applied consistently to all new raise bores. Raise bores are designed and constructed with 20 m splash ponds with surrounding barricades/walls. The exhaust outlet is inverted over the splash pond. This ensures that the majority of the salt deposited is reduced to a smaller radius surrounding the raise bore.

3.4 Radioactive emissions

3.4.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive emissions from ODC's activities.

BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from operational activities to less than a small fraction of the 1mSv/yr public dose limit prescribed by the International Commission on Radiological Protection (ICRP). As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at ODC.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive emissions from ODC's activities.

There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODC's activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota (NHB) assessment sites is used as an indicator of the potential exposure of listed species to radioactive emissions. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

3.4.2 Compliance criteria

Radiation doses to members of the public less than 1 mSv/y above natural background.

The total estimated dose (FY18) to members of the public at Roxby Downs Monitoring Site and Olympic Village Monitoring Site contributed by ODC operations was 0.023 mSv and 0.033 mSv respectively.

Deposition of project originated ^{238}U less than 25 Bq/m^2/y at non-human biota assessment sites.

The average deposition of U-238, calculated as an average of results at the four monitoring sites was determined to be 3.09 Bq/m^2/y, well below the 25 Bq/m^2/y compliance criteria.

3.4.3 Leading Indicators

Indications that a dose constraint of 0.3 mSv/y to members of the public above natural background will be exceeded.

Indications that a reference level of 10 µGy/h for impacts on non-human biota above natural background will be exceeded.

NOTE: The reference level for non-human biota is set as an interim criteria until such as an agreed national approach is determined.

No leading indicators were triggered. Doses to members of the public are below Olympic Dam's internal dose constraint of 0.3mSv/yr. Similarly the reference level of 10uGy/h for impacts on non-human biota has not been triggered.

3.4.4 Deliverables (ER 2.2)

Data leading to calculated estimates of annual radiation doses to members of the public in the critical groups identified.

The annual dose attributable to radon decay products (RDP) and radionuclides in dust is calculated and added to calculate the total annual effective dose for members of the public

Radon Decay Products

Monthly RDP averages and the five year rolling average for RDMS and OVMS during the reporting period are shown in Figure 56.

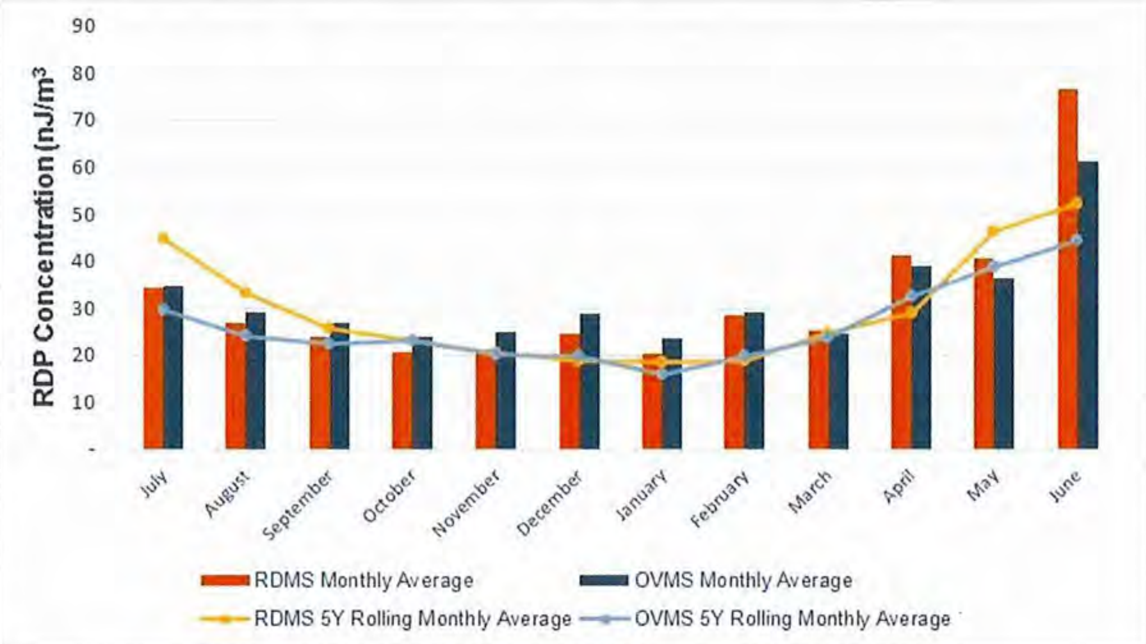


Figure 56: FY18 Radon Decay Products (RDP) monthly trends

The dose results provided in section 3.4.2 demonstrate that the dose to members of the public (as measured at RDMS and OVMS) due to RDP resulting from ODC operations is a small fraction of the applicable dose limit and indistinguishable from the limit of detection of the instrumentation used.

Analysis of historical monitoring data suggests that there is little operation related RDP concentration at these monitoring sites and the main source of RDP exposure at both OVMS and RDMS is from natural radiation background which shows significant seasonal variations as seen in Figure 56.

Radionuclides in Dust Dose Assessment

Monthly concentrations of the long lived radionuclides, ^{238}U, ^{230}Th, ^{226}Ra, ^{210}Pb and ^{210}Po for the 5 year period FY13-FY18 are shown in Figure 57 to Figure 61 (includes environmental background).

The estimated FY18 radiation doses to members of the public at RDMS and OVMS due to long lived radionuclides in dust were 0.0019 mSv and 0.0014 mSv (adjusted for background) respectively. These correspond to 0.19 % and 0.14% of the public dose limit of 1 mSv respectively. These results indicate that the variation in radionuclide concentrations shown in Figure 57 to Figure 61 do not have a significant impact on the overall public radiation dose. It is to be noted that the dust sampling and the radionuclide analysis processes have inherent uncertainties which contribute to the fluctuations seen in the radionuclide trends in Figure 57 to Figure 61.

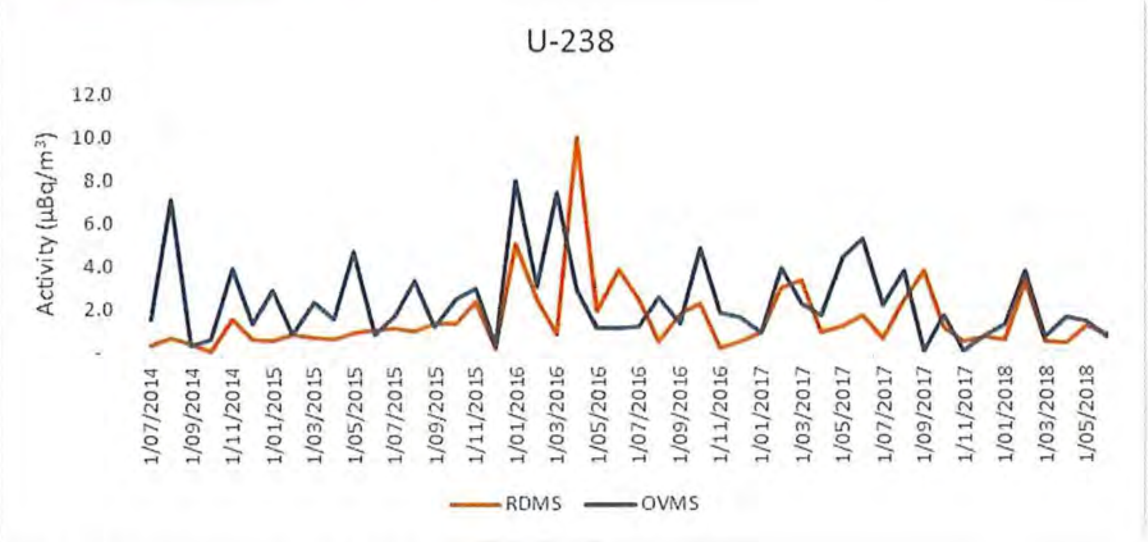


Figure 57: ^{238}U concentration for the 5 year period FY14-FY18 (PM10)

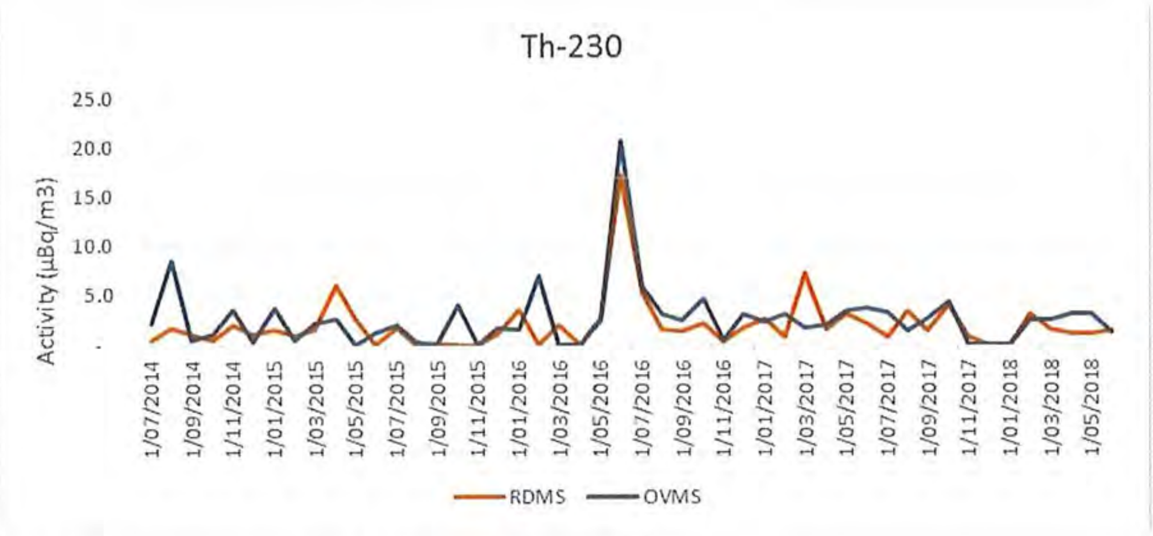


Figure 58: ^{230}Th concentration for the 5 year period FY14-FY18 (PM10)

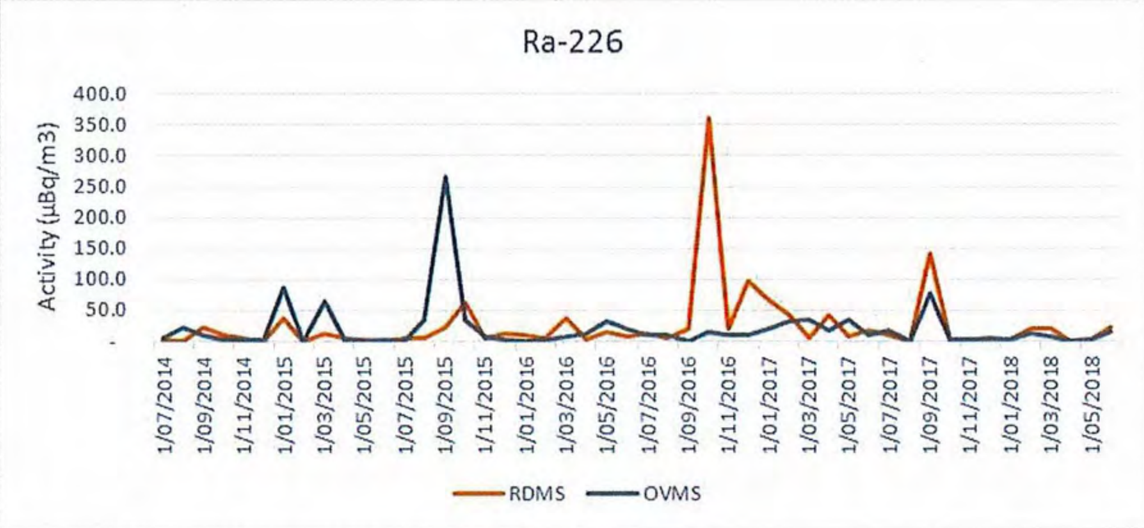


Figure 59: ^{226}Ra concentration for the 5 year period FY14-FY18 (PM10)

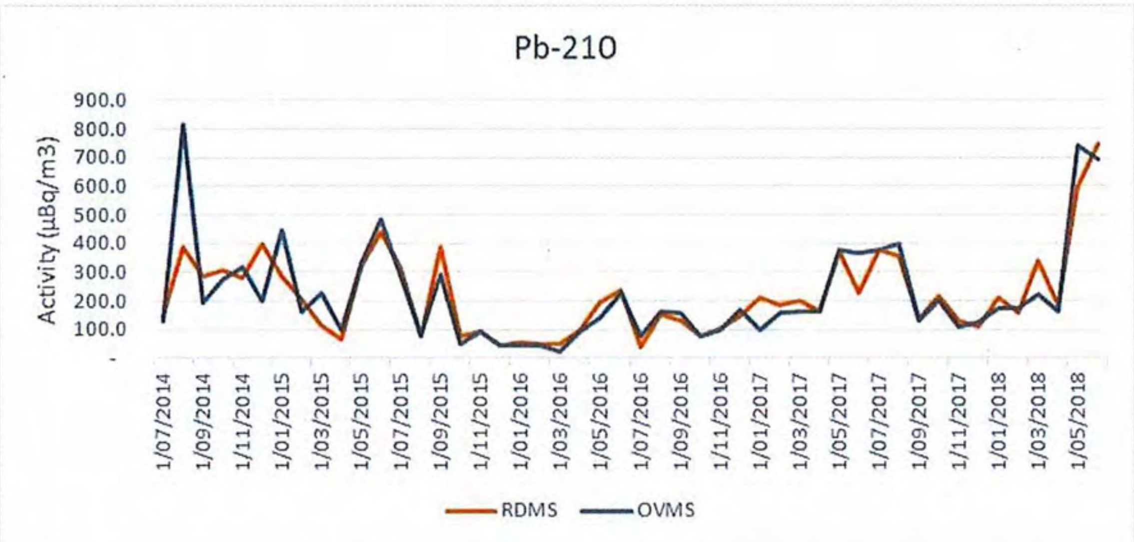


Figure 60: ^{210}Pb concentration for the 5 year period FY14-FY18 (PM10)

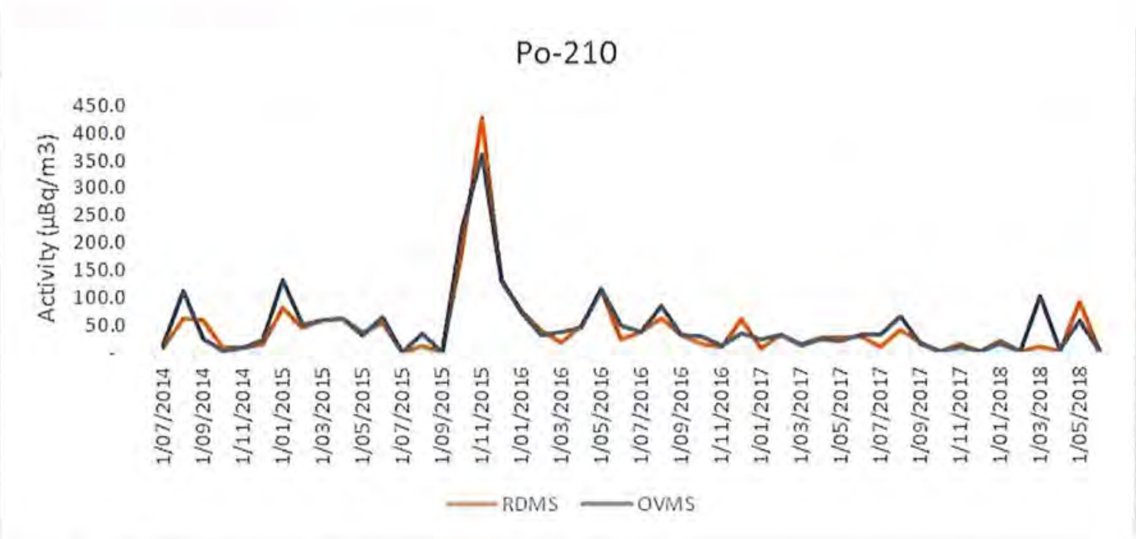


Figure 61: ^{210}Po concentration for the 5 year period FY14-FY18 **(PM10)**

Total Dose to Members of the Public

The total estimated dose (FY18) to members of the public at RDMS and OVMS contributed by ODC operations was 0.023 mSv and 0.033 mSv respectively, well below the 1 mSv/yr public dose limit and Olympic Dam's internal dose constraint of 0.3mSv/yr. Figure 62 shows the annual trend of public doses at RDMS and OVMS.

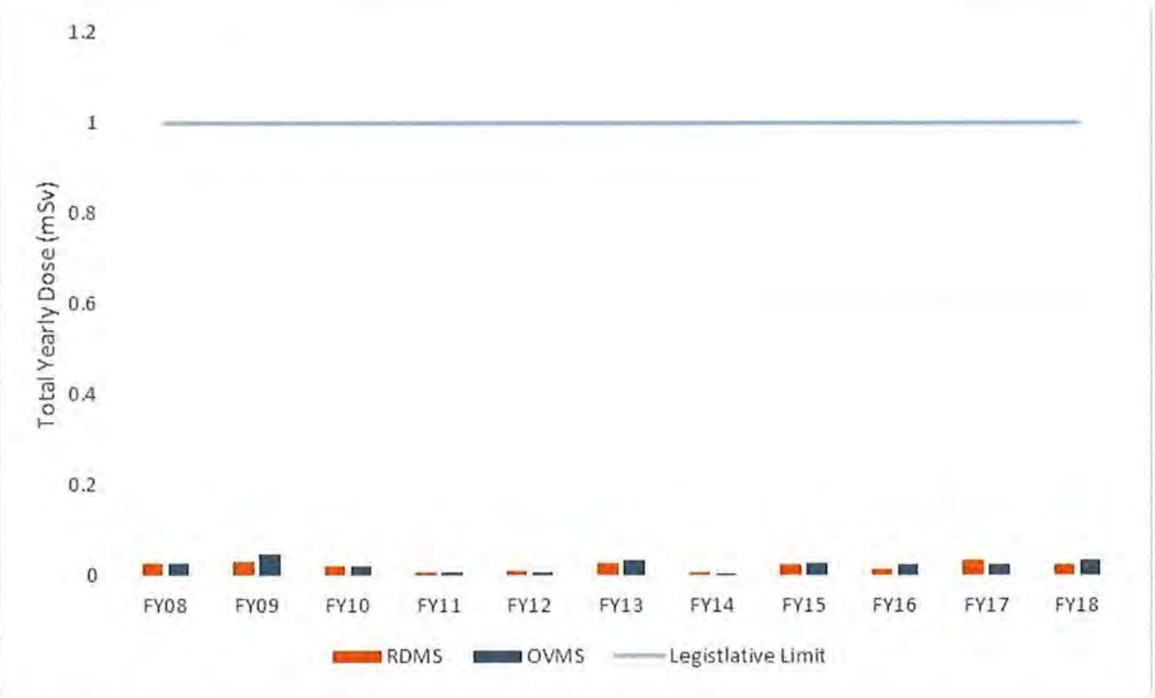


Figure 62: Yearly total effective dose trends for RDMS and OVMS

3.4.5 Deliverables (ER 2.3.3)

Records from passive dust deposition monitoring sites and comparison with the annual compliance rate of 25 Bq/m²/y at the NHB monitoring sites.

An assessment of the impacts to reference plants and animals (ARPANSA 2010) for the appropriate ERICA Tier level, including as necessary comparison of the results with the reference level of 10 µGy/h.

Dust deposition

Passive dust monitoring data for FY18 indicated an average project-originated (after background subtraction) ^{238}U deposition rate of 3.09 Bq/m²/yr. Passive dust (PD) monitoring sites PD1, PD4, PD8 and PD13 were used for this assessment (Figure 63), with site PD14 used as the background site. The results, shown in Table 17, are well below the criterion of 25 Bq/m²/yr.

Table 17 FY18 - Project originated dust and ^{238}U deposition

	Project Originated Total Dust Deposition*	Project Originated ^{238}U Deposition*	Compliance Criteria
	g/m²/y	Bq/m²/y	Bq/m²/y
PD1	-	7.58	25
PD4	13.78	2.84	25
PD8	-	2.19	25
PD13	-	-	25

* Cells left blank indicate that the results was less than background measurement

Dose rate reference level

The ERICA software tool (v1.2.1) was used to assess the significance of measured radionuclide dust deposition data, with a Tier 2 analysis conducted for all default terrestrial organisms. Table 18 shows the results of the ERICA analysis. It can be seen that dose rates for all organisms are less than 1 % of the reference dose level of 10 µGy/h.

The risk quotient is a unit-less measure that compares the calculated NHB dose rate with the reference dose level.

Table 18: FY18 Erica screening dose level and risk quotients

Organism	Total Dose Rate (µGy/h)	Reference Level (µGy/h)	Risk Quotient
Bird	7.33E-05	10	7.33E-06
Grasses & Herbs	3.36E-03	10	3.37E-04
Mammal - small-burrowing	5.71E-04	10	5.71E-05
Mammal - large	5.71E-04	10	5.71E-05
Shrub	2.70E-03	10	2.70E-04
Tree	4.97E-04	10	4.97E-05

Lichen & Bryophytes	2.53E-02	10	2.53E-03

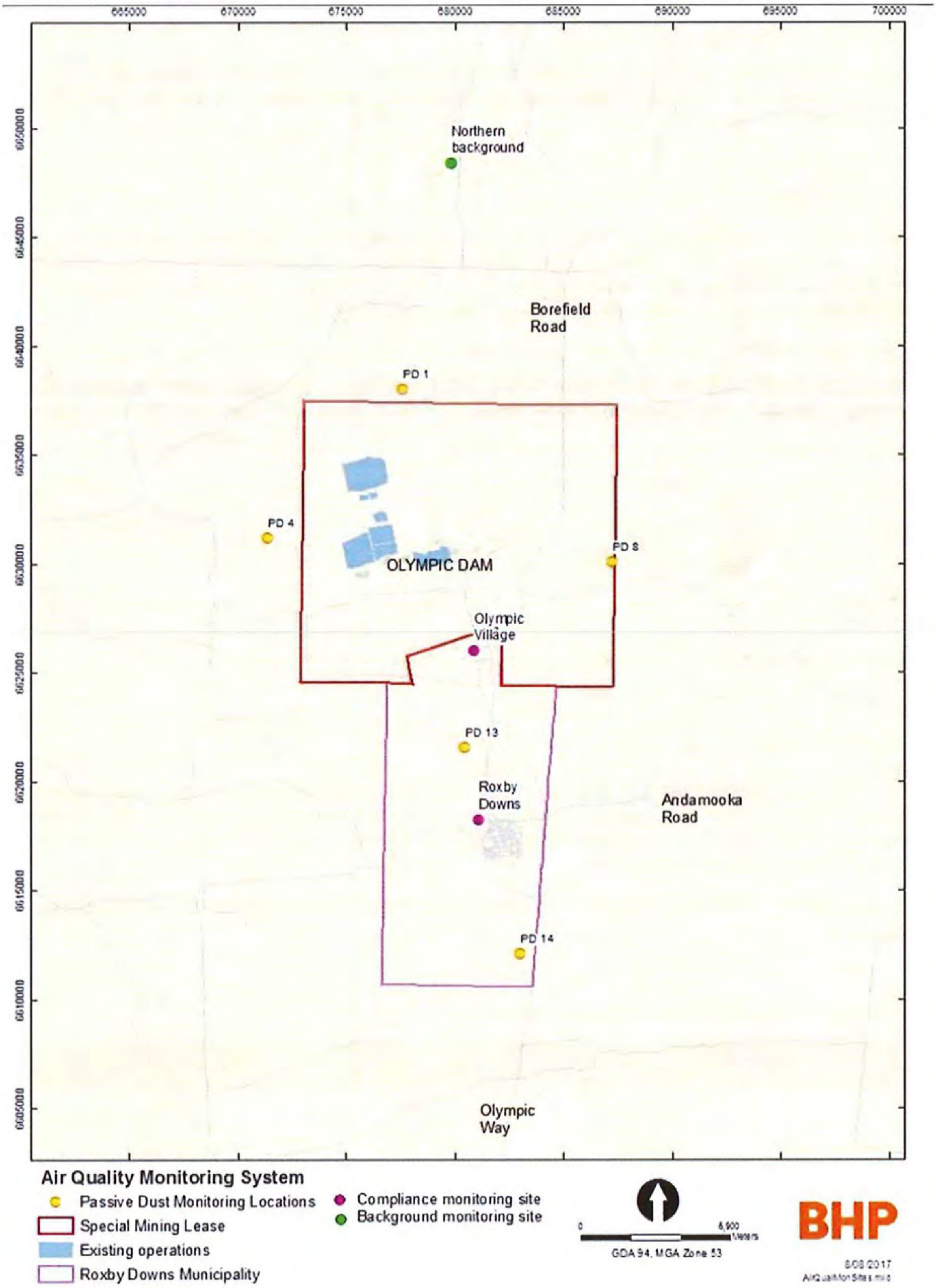


Figure 63: Location of dust deposition monitoring sites

3.4.6 Deliverables (ER 2.4)

A database of radionuclide concentrations in the environment over the long-term.

A database of radionuclide concentrations in has been maintained since 2005. Figure 57 to Figure 61 show the monthly trends of radionuclide concentration at RDMS and OVMS.

3.4.7 Targets FY18

Maintain radiation doses as low as reasonably achievable, social and economic factors taken into account, as assessed through the annual Radiation Management Plan review.

The results of the monitoring program have shown operational contributions to radiation dose for members of public to be extremely low being less than 5% of the public dose limit of 1mSv/yr.

3.4.8 Action Plan FY18

None applicable.

3.5 Greenhouse gas emissions

3.5.1 Environmental Outcome

Contribute to stabilising global atmospheric greenhouse gas concentrations to minimise environmental impacts associated with climate change.

BHP's climate change strategy focuses on reducing our operational greenhouse gas (GHG) emissions, investing in low emissions technologies, promoting product stewardship, managing climate-related risk and opportunity and working with others to enhance the global policy and market response. As a BHP group asset, ODC operates under the BHP group strategy.

3.5.2 Compliance criteria

Quantified emission reduction opportunities and achievements, reported annually.

As a major energy consumer, managing energy use, ensuring energy security and reducing GHG emissions at operations are key components of BHP's climate change strategy.

In FY2018, we began working towards a new five-year GHG emissions reduction target. Our new target, which took effect from 1 July 2017, is to maintain our total operational emissions in FY2022 at or below FY2017 levels while we continue to grow our business. Our new target builds on our success in achieving our previous five-year target which was to maintain GHG emissions at or below our 2006 adjusted baseline.

In addition to our five-year target, we have set the longer-term goal of achieving net-zero operational GHG emissions in the latter half of this century, consistent with the Paris Agreement.

See section 3.5.4 for a discussion of emission reduction opportunities and achievements.

3.5.3 Deliverables (EG 2.1)

Calculation of the site-wide GHG emission intensities, expressed as carbon equivalent intensity (kg CO_{2-e}/t milled).

GHG emissions were calculated using the National Greenhouse and Energy Reporting guidelines and emissions intensity was calculated and reported internally within BHP in line with monthly corporate reporting requirements. The calculated GHG emission intensity in FY18 was 83 kg CO_{2-e}/t ore milled, compared to 76 kg CO_{2-e}/t ore milled in FY17. The increased intensity reflects reduced efficiencies, mostly due to the major smelter maintenance shutdown between September and December 2017 resulting in reduced tonnes milled for the year.

3.5.4 Deliverables (EG 2.2)

An annual 'road map' that quantifies emission reduction opportunities and achievements.

Defining a pathway to net-zero emissions for BHPs long-life assets requires planning for the long term and a deep understanding of the development pathway for low emissions technologies. BHPs strategy is to develop emerging and deploy existing technologies that make step-change reductions in GHG emissions, both from our own operations and from the downstream processing and use of our products (as described below).

BHP has a suite of initiatives currently underway aimed at achieving reductions across its major operational emissions sources:

- Zero-carbon electricity supply: emissions from electricity use make up 46 per cent of BHPs operational emissions[1]. This includes both the power we generate ourselves and the power we buy from grids around the world. BHPs strategy seeks to accelerate the transition to lower carbon sources of electricity while balancing cost, reliability and emissions reductions.
- Zero-carbon material movement: emissions from fuel and distillate make up 35 per cent of BHPs operational emissions, primarily from the consumption of diesel in the course of material movement (for example haul trucks). BHPs strategy is to accelerate and de-risk technologies and innovations that can transition operations over time to alternate fuels and greater electrification of mining equipment and mining methods.
- Fugitive emissions: fugitive methane emissions from BHPs petroleum and coal assets make up 18 per cent of our operational emissions. BHPs strategy is to pursue innovation in mitigation technologies for these emissions, which are among the most technically and economically challenging to reduce.

In evaluating low emissions technology investment opportunities, we:

- consider technologies with the potential to deliver results across a range of time horizons;
- emphasise investments that can deliver material GHG savings;
- consider the ability of projects and technologies to leverage our global Operating Model (replicability, scale and market breadth);
- evaluate the potential for building capacity, capability and internal awareness across our business.

As well as helping us to reduce our own emissions, lessons from our low emissions technologies projects will be shared with others in our sector and more broadly. For example, we are participating in the Lakeland Solar and Storage Project, a three-year knowledge sharing partnership to demonstrate connecting large-scale battery storage to a fringe-of-the-grid solar project in regional Queensland, Australia. Outcomes of an extensive test program at Lakeland will provide insight for BHP and the resource sector with respect to security of energy supply. We are also working in collaboration with Australia's national research agency, CSIRO, to scope a project designed to determine the viability of measuring fugitive methane emissions in near real time from open-cut coal mining environments.

Olympic Dam relies on diesel equipment for development, production, ore handling and mine services. A trial is underway to deploy light electric vehicles (LEVs) powered by lithium ion batteries in Olympic Dam's underground fleet.

Data will be collected on the performance, power supply, maintenance support requirements, vehicle utilisation (charging time) and corrosion resistance of the vehicles during the 12-month trial period.

As well as reducing GHG emissions, LEVs can also lower operating costs and reduce worker exposure to diesel particulate matter (DPM). The trial is part of a broader initiative aimed at reducing DPM exposure to the lowest level technically feasible, in accordance with our occupational exposure limit.

In FY2019, a decision will be made on the full roll-out of LEVs to Olympic Dam's underground fleet. Knowledge gathered during the trial will also be shared within BHP to identify opportunities to accelerate the deployment of LEVs to reduce GHG emissions, DPM exposure and costs across our business.

A community of practice has been established to facilitate effective knowledge sharing. Additional studies are underway to assess the feasibility of electrifying other types of vehicles and mobile equipment, including at the Broadmeadow underground coal mine in Queensland, the Jansen Potash Project in Canada and at Western Australia Iron Ore.

Revised projections for energy use and GHG emissions at Olympic Dam over the next five years are shown in Table 19. Emissions are forecast to increase after FY19 due to increasing production and

[1] Includes Scope 1 emissions from our natural gas-fired power generation as well as Scope 2 emissions from purchased electricity.

changing ore grades which are forecast to result in proportionally higher energy use and emissions from the Smelter. As over 75% of total emissions are forecast from electricity, the actual emissions will be heavily influenced by the South Australian Electricity Emissions Factor which is used to calculate emissions. Similarly, actual emissions will be influenced by the strategy adopted for pursuit of group wide emissions targets.

Table 19: Energy Use Predictions by Type and GHG emissions for FY19 – 23.

Energy Type	FY19	FY20	FY21	FY22	FY23
Electricity (MWh)	1,100,748				
Diesel (kL)	30,059				
LPG (t)	15,778				
Petrol (L)	36,000				
Coke (t)	9,882				
Anode paste (kg)	370,579				
Fuel oil (kL)	5,487				
Oil (L)	103,459				
Grease (L)	16,597				
Soda ash (t)	902				
Acetylene (m^3)	3,888				
GHG emissions Scope 1 (t CO_{2-e})	174,927	172,924	156,813	186,579	194,278
GHG emissions Scope 2 (t CO_{2-e})	561,381	606,757	591,009	774,945	806,257

3.5.5 Leading Indicators

- None applicable

3.5.6 Targets FY18

- None applicable

3.5.7 Action plan FY18

- None applicable.

4 Generation of industrial wastes

4.1 Embankment stability of TSF

4.1.1 Environmental Outcome

No significant TSF embankment failure.

During FY18 the Tailings Storage Facilities (TSFs) were managed in accordance with the TRS Operations, Maintenance and Surveillance Manual (BHP Olympic Dam 2017d) and the Tailings Management Plan (BHP Olympic Dam 2017e) and no embankment failures of any magnitude occurred.

4.1.2 Compliance Criteria

No significant radioactive contamination arising from uncontrolled loss of radioactive material as a result of an embankment failure to the natural environment.
NOTE: Any embankment failure that leads to a reportable spill under the Bachmann Criteria will be considered significant. Significant is defined as requiring assessment and remedial action in accordance with the NEPM or EPP and the Mining Code. Measurement and monitoring is carried out in response to a specific event.

No uncontrolled loss of radioactive material to the natural environment as a result of an embankment failure occurred during FY18. To manage the risk of embankment failure, the rate of rise was maintained below 2 m per annum and the supernatant pond area was maintained below the 71 ha target set for this purpose.

4.1.3 Leading Indicators

Rate of rise of tailings at an average of 2 m per annum or less.

The rate of rise of tailings has been limited to 2 m per annum or less for all cells to ensure consolidation of tailings material. During the reporting period, tailings were distributed to TSF Cells 4 and 5 with an average rate of rise of the perimeter tailings beach of 0.8 m per annum with TSF4 and TSF5 at 0.72 m and 0.91 m per annum respectively.

The rate of rise of pore pressures within or adjacent to the TSF embankment is less than or equal to the rate of rise of tailings.

Assessing pore pressure against rate of rise provides an indication if excess pore pressures are developing in the embankment. The rise in phreatic level at VWP locations over the past year is less than or equal to the average rate of rise in tailings.

The maximum supernatant pond area of individual TSF cells does not exceed 15ha for TSF1, 23ha for TSF2/3, 90ha for TSF4 and 135ha for TSF5.
Note: Each TSF has been assigned a maximum supernatant pond size which is calculated using critical operating parameters, surface contours and an allowance for significant rainfall events. Operating beyond these ponds sizes may not result in embankment failure but are considered an appropriate leading indicator in which operational processes should be reviewed.

The supernatant ponds are visually checked against marker poles daily, estimated monthly and confirmed by satellite quarterly. Over the period the recorded pond sizes have been below the leading indicator sizes.

4.1.4 Deliverables (WA 2.1)

The tailings stored at the TSF have a concentration over the 10 Bq/g exemption limit and also a total activity over the 10,000 Bq exemption limit for Radium, which defines it as a radioactive material under ARPANSA guidelines.

Monitoring of the TSF, including rate of rise of tailings, supernatant pond area, and pore pressure all contribute to management of the TSF to ensure no uncontrolled loss of radioactive material to the natural environment or significant embankment failure.

Monitoring data showing the size and location of the supernatant liquor ponds in each TSF cell on a monthly basis (EPA 31543.500-433).

Large supernatant liquor ponds have the potential to impact upon embankment stability by increasing the phreatic surface within the tailings and embankments, which in turn can lower the strength of the tailings and embankment materials. The TSF pond areas during FY18 are shown in Figure 64. The ponds have been consistent in size, reflecting the low rainfall over this period (<50% of average).

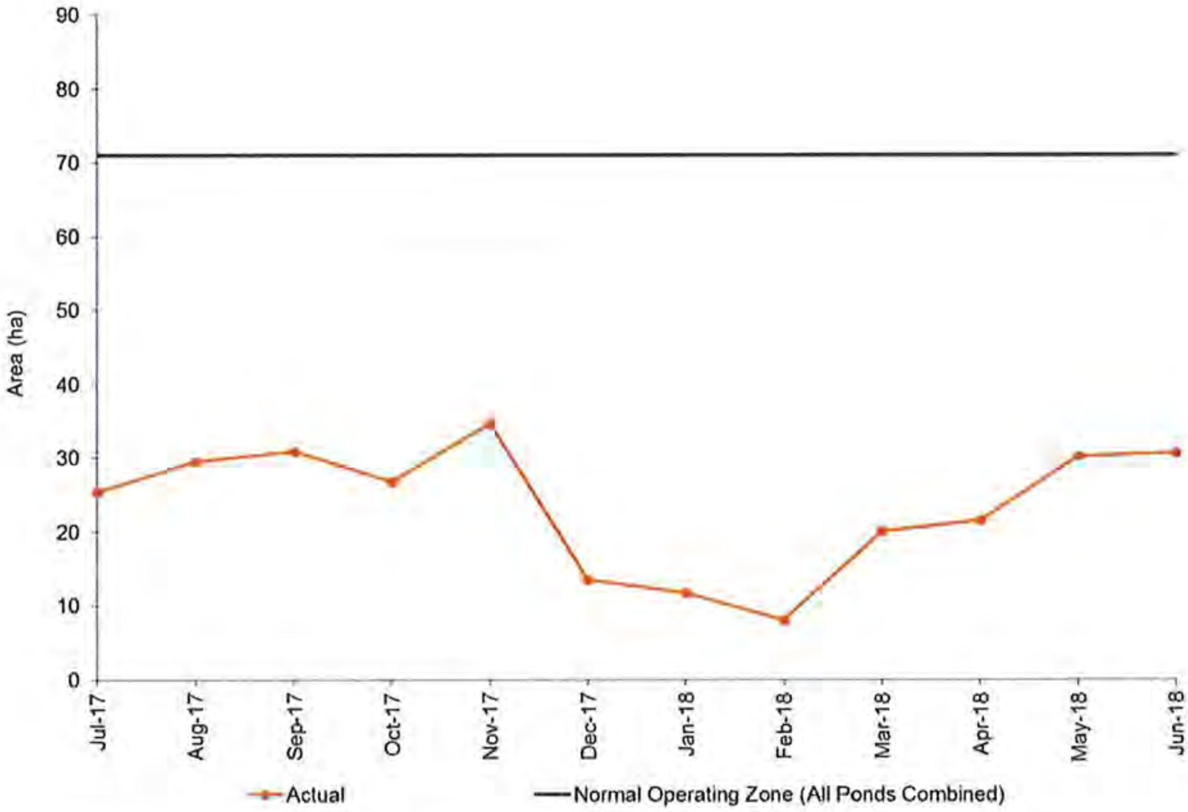


Figure 64: TSF Pond areas (ha) for FY18.

Monitoring data showing the rate of rise of tailings in each TSF cell.

At current processing rates, approximately 8 - 9 Mtpa of tailings, containing low levels of radioactivity are disposed of in the TSFs annually.

The rate of rise of tailings has been limited to 2 m per annum or less for all cells to ensure consolidation of tailings material. During the reporting period, tailings were distributed to TSF Cells 4 and 5 with an average rate of rise of the perimeter tailings beach of 0.8 m per annum with TSF4 and TSF5 at 0.72 m and 0.91 m per annum respectively. The reduction in rate of rise, when compared to the FY17 rate of 1.15 m per annum, is due to reduced production throughput resulting from the large shutdown that occurred during the period.

Tailings delivery to TSF Cell 4 prior to 2003 was biased towards the internal east wall as the availability of this wall for tailings deposition was largely unaffected by wall-raising activities, resulting in a higher beach level when compared to the external wall. A plan was initiated in 2003 to address this issue and bias the tailings delivery to TSF Cell 4 external walls. For FY18, the rate of rise along Cell 4 east wall decreased to 0.92 m from 1.27 m, in line with the general decrease overall.

No significant impacts have resulted from the difference in height between the internal east wall and external walls of TSF Cell 4. This issue will continue to be addressed by the program of reduced deposition to the east wall, gradually bringing it in line with other walls.

The elevation of tailings in the cells illustrated in Figure 65 gives an indication of the rate of rise of the perimeter tailings beaches.

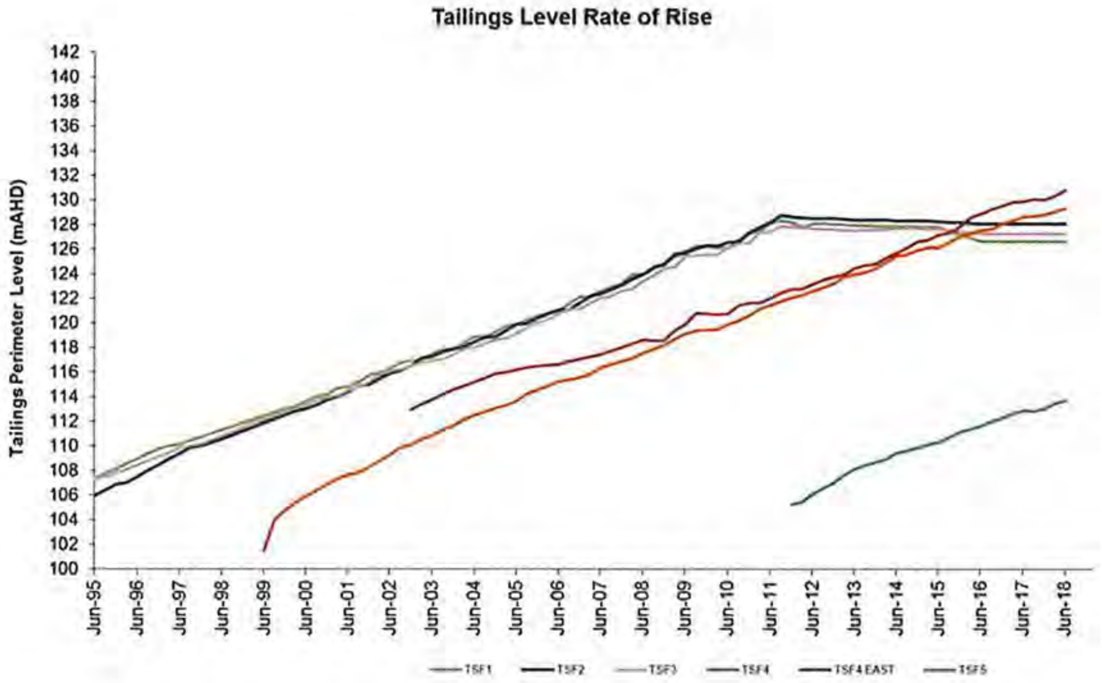


Figure 65: TSF rate of tailings rise.

Monitoring data showing the pore pressures within tailings adjacent to the external walls of the TSF.

Piezometers are monitored to assess the pore pressures within the tailings adjacent to the embankments of the TSFs. Piezometers installed at critical cross sections are monitored 3-weekly, whilst all other piezometers are monitored on a 2-monthly basis. Piezometers used include standpipe and vibrating wire piezometers.

ANCOLD provides minimum Factors of Safety (FoS) for different loading conditions. Results of the stability analysis undertaken in FY17 (Golder Associates, 2016) indicated that the estimated FoS for current and final geometries of Cell 1-3 and Cell 5 meet or exceed the minimum levels recommended by ANCOLD.

The 2016 assessment indicated the FoS for Cell 4 was lower than the minimum values, and prompted the TSF4 buttress programme. The initial stage was to provide for embankment stability to RL 131 m; this stage was completed in October 2017. The FoS for TSF4 has since improved (Table 20), however note is made that the buttress did not cover the entirety of the embankment, with one portion where the tailings pipeline infrastructure up the embankment and at the toe meant this area was unable to be buttressed. The relocation of this infrastructure and construction of the buttress will occur during the stage two works (providing stability to RL 136 m) currently underway. A smaller buttress was installed within the available area to provide interim stability.

Table 20: Stability Analysis Results (Golder Associates, 2016)

Wall Section	Static Loading FoS (min – 1.5)	Post-Seismic FoS (min – 1.0)
Cell 1/2/3 East Wall	RL 130.5 m: 1.61	1.61
Cell 4 North Wall	RL 131.0 m: 1.68	1.13
Cell 4 West Wall	RL 131.0 m: 1.65	1.05
Cell 4 South Wall (un-buttressed portion)	RL 131.0 m: *1.3*	*0.8*
Cell 5 North West Wall	RL 113.5 m: 2.52	N/A
	RL 131.0m: 1.55	1.43
Cell 5 South East Wall	RL 113.0 m: 2.43	N/A
	RL 131.0m: 1.57	1.45

* N/A = not assessed at intermediate height, assessed at final height only (worst case).

Piezometers locations around TSF 1-3, 4 & 5 are shown in Figure 66 to Figure 68.

Figure 66: TSF 1-3 piezometer locations

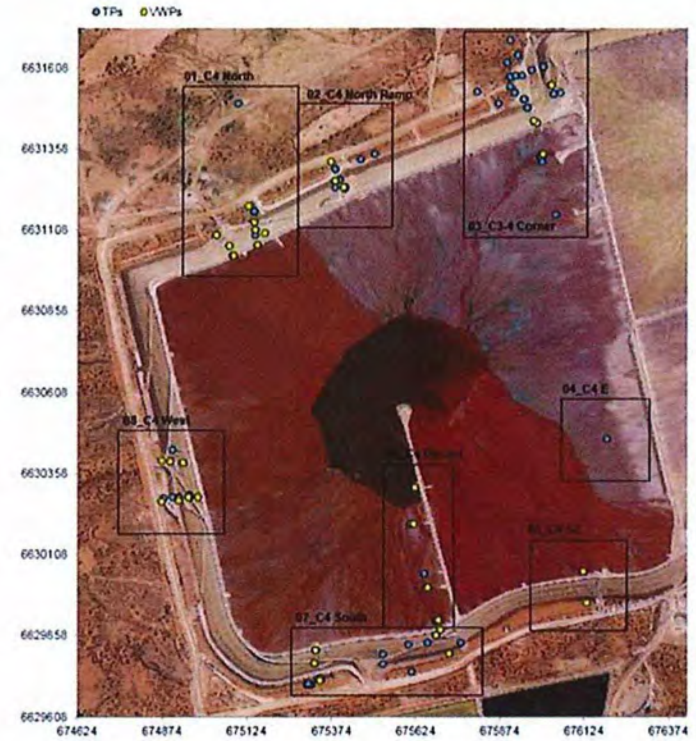


Figure 67: TSF 4 piezometer locations

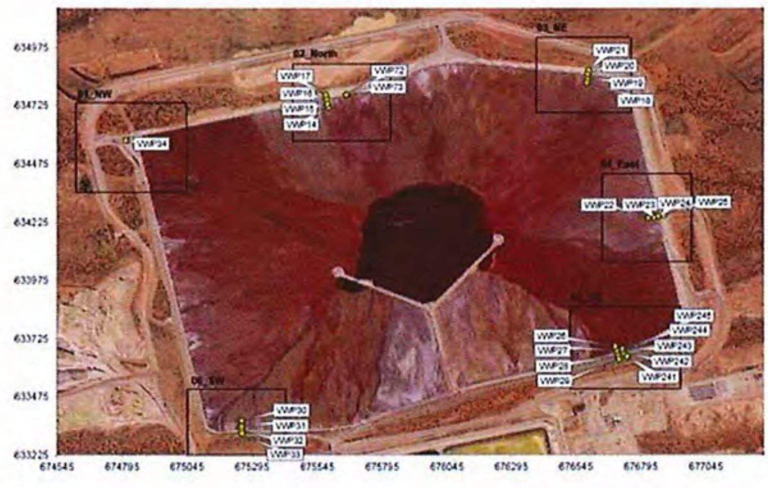


Figure 68: TSF 5 piezometer locations

Piezometers located in the East, North & South Wall of TSFs 1-3 generally show a gradual pressure drop consistent with no further addition of tailings. For example, the variation of VWP readings along East & South walls of TSF 1 are shown in Figure 69 and Figure 70.

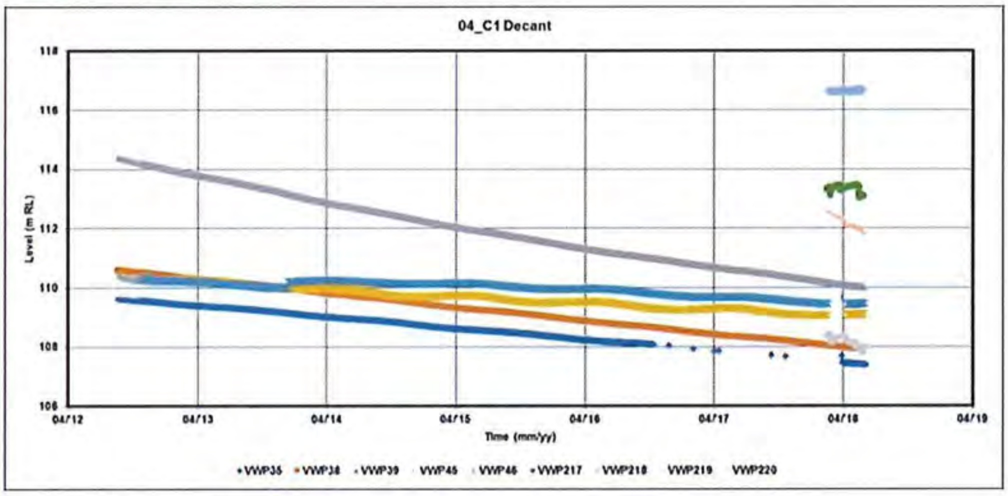


Figure 69: TSF 1 East Wall VWP readings

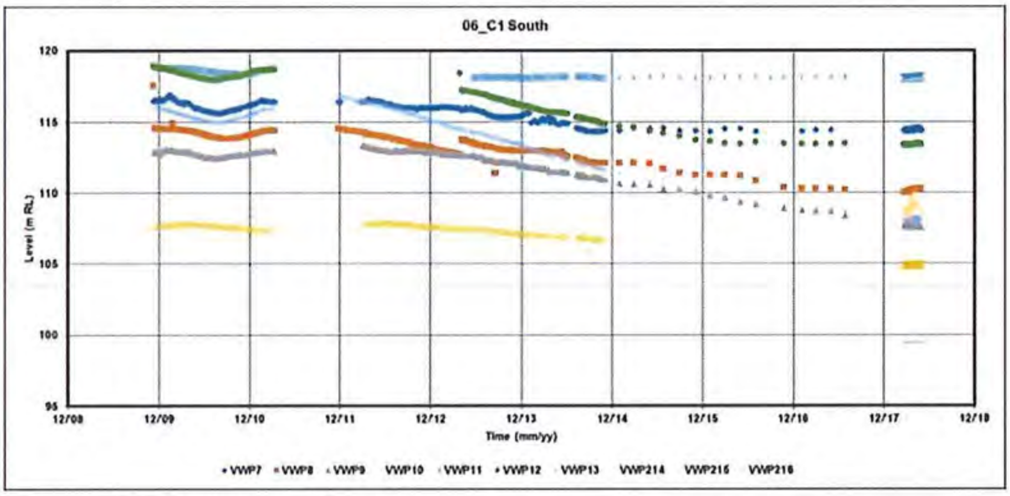


Figure 70: TSF 1 South Wall VWP readings

Piezometers installed in the tailings and upper embankment of TSF 4 show levels have been relatively constant over the period, with minor fluctuations. For example, the variation of VWP readings along South & West walls of TSF 4 are shown in Figure 71 and Figure 72. A very gradual increase can be discerned, which is as expected as tailings continue to be added in this TSF.

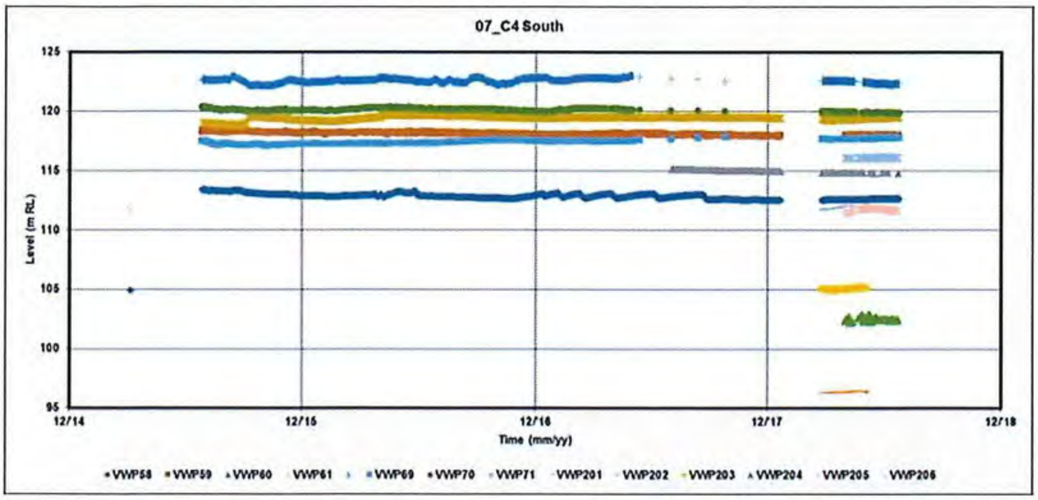


Figure 71: TSF 4 South Wall VWP readings

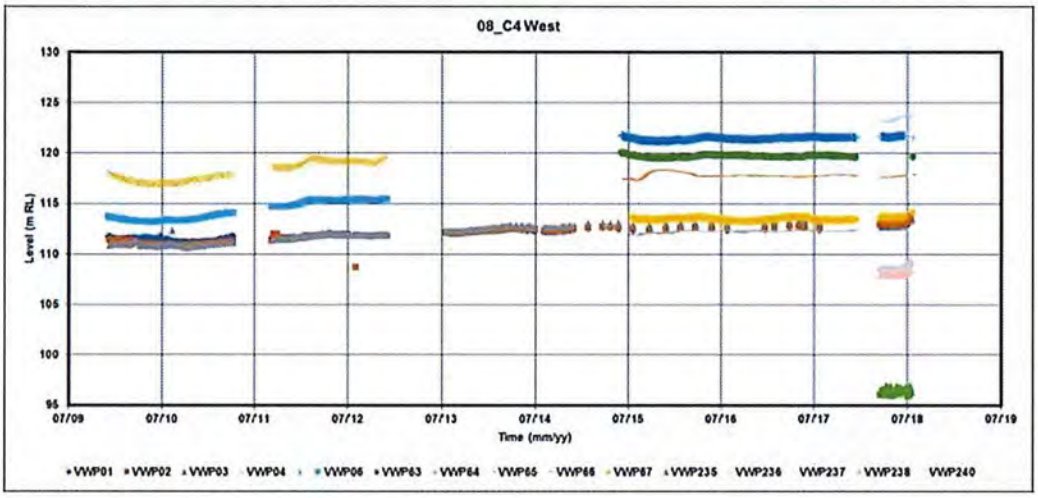


Figure 72: TSF 4 West Wall VWP readings

Piezometers installed in the tailings and upper embankment of TSF5 show levels have been relatively constant over the period, with minor fluctuations. A very gradual increase can be discerned, which is as expected as tailings continue to be added in this TSF. For example, the variation of VWP readings along TSF 5 South-East & North-East walls are shown in Figure 73 and Figure 74.

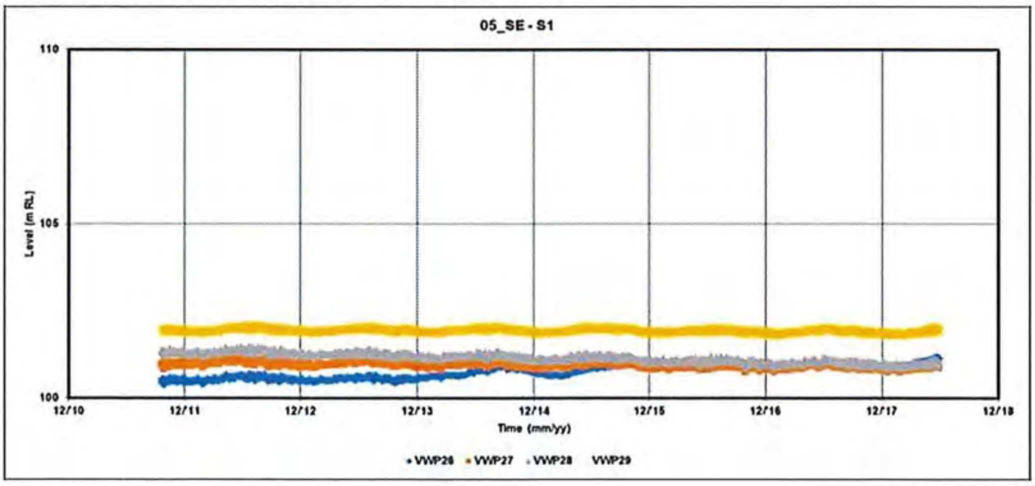


Figure 73: TSF 5 South East side VWP readings

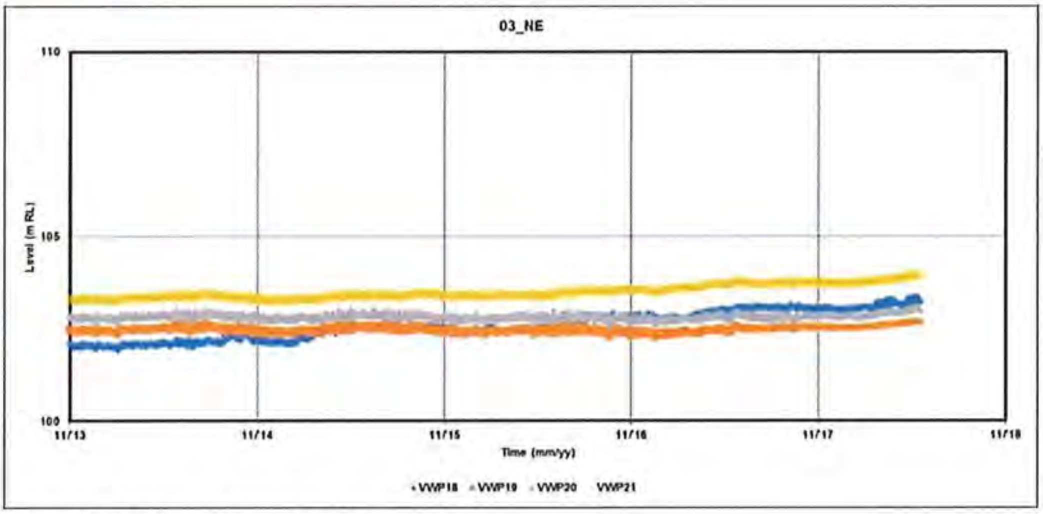


Figure 74: TSF 5 North East side VWP readings

During FY18 two 6-monthly operational reviews of the TRS were completed by SRK and one annual comprehensive review covering the period July 2016 - June 2017 was completed by KCB.

The reviews were carried out in accordance with the BHP TSF Management Guideline and ANCOLD Guidelines. All reviews confirmed that the Tailings Retention System, including the Tailings Storage Facilities and Evaporation Ponds, are in good condition and are well managed.

A review of the water balance on an annual basis (EPA 31543.500-435).

See section 4.2 Tailings seepage.

4.1.5 Targets FY19

None applicable.

4.1.6 Action plan FY19

Undertake periodic (2-3 year) CPTu testing of tailings to confirm strength parameters used in stability analysis.

CPTu testing of all the TSFs was last undertaken in August 2016. A program has been initiated for CPTu testing of the TSFs again, this is scheduled to occur in September 2018. The results will be used by SRK within a stability assessment model.

4.2 Tailings seepage

4.2.1 Environmental Outcome

No significant adverse impact on vegetation as a result of seepage from the TSF.

No significant adverse impact to vegetation as a result of seepage from the TSF has occurred. Eighty metres AHD (20 m below ground level) is considered as the level below which groundwater cannot interact with the root zone of plants in the Olympic Dam region. Groundwater levels in the vicinity of the TSF remain below 80 mAHD.

No compromise of current and future land uses on the Special Mining Lease (SML) or adjoining areas as a result of seepage from the TSF.

No compromise of current and future land uses on the SML or adjoining areas has occurred. Groundwater levels in the vicinity of the TSF remain below 80 mAHD and sampling indicates that seepage is being attenuated.

No compromise of the environmental values of groundwater outside the SML as a result of seepage from the TSF.

No compromise of the environmental values of groundwater outside the SML has occurred. Sampling indicates that seepage is being attenuated within the SML, and groundwater levels of bores along the SML are consistent with other regional bores. Seepage modelling has been updated to demonstrate that there are no expected future offsite impacts.

4.2.2 Compliance criteria

Maintain groundwater level (attributable to seepage from the TSF) outside the external perimeter road of TSF Cells 1 to 5 to not higher than 80 mAHD (20 m below ground level).

Groundwater monitoring results indicate that the groundwater level has not reached a level higher than 80 mAHD beneath TSF Cells (refer Figure 7 in section 1.2 – Aquifer Level Drawdown). The maximum groundwater level recorded below the TSF for the current reporting period was 67.28 mAHD at LT67.

All TSF seepage attenuated within the SML, as demonstrated by a numerical geochemical model confirmed by monitoring.

Geochemical modelling was carried out for the Expansion EIS (BHP Billiton Olympic Dam 2009) and demonstrated that all TSF seepage would be attenuated within the SML. This modelling was updated in 2015 (SRK 2015) to account for the current mine configuration (underground only) following the suspension of the Olympic Dam Expansion. Within the timeframe assessed (10,000 years), the modelling results indicate that no impacts on baseline groundwater quality at the mine lease boundary (SML) would be expected as travel times are predicted to be well beyond this timeframe and there is expected to be significant attenuation of pollutants within the SML.

Laboratory analysis of on-site and regional groundwater monitoring bores confirms the attenuation of TSF seepage within the SML. Samples from regional monitoring bores contained analytical concentrations either below limits of reporting, or within concentrations previously reported (see Chapter 1.3 - Aquifer Level Drawdown).

Groundwater levels of bores on the SML boundary are consistent with other regional bores. This seepage attenuation is demonstrated in Figure 17 in section 1.2 - Aquifer Level Drawdown, which shows water levels (AHD) from the perimeter of the TRS decreasing with distance from the TRS towards the SML boundary, to the same level as other regional bores.

4.2.3 Leading Indicators

A measurement of groundwater level outside the external perimeter road of the TSF that exceeds 70 mAHD (30 m below ground level) as a result of seepage.

The leading indicator value was not reached. The maximum groundwater level recorded below the TSF for the current reporting period was 67.28 mAHD at LT67.

A numerical geochemical model trend that indicates that all TSF seepage may not be attenuated within the SML should the trend continue.

No geochemical seepage trend was noted. Laboratory analysis of on-site and regional groundwater monitoring bores, when combined with groundwater level data, confirms the validity of the 2015 geochemical modelling (SRK 2015) findings that all TSF seepage would be attenuated within the SML.

4.2.4 Deliverables (WA 2.1)

A review of the water balance on an annual basis (EPA 31543.500-435).

The water balance for TSF Cells 4 and 5 indicates that evaporation to dispose of unaccounted liquor is approximately 40% of the total inputs. This is comparable to FY17 and FY16. ODC notes that the unaccounted liquor also included seepage from beach areas.

Unaccounted liquor includes input liquor shown in Figure 75 (tailings liquor, rainfall, flushing liquor, and the decrease in supernatant pond inventory) minus liquor retained in tailings (moisture content assumed of 30 % by weight), liquor decanted to evaporation ponds, and estimated seepage from (supernatant liquor) ponds. Flushing liquor is liquor pumped out of the evaporation ponds to the TSF for the purpose of flushing lines and to enhance evaporation.

The total output liquor volume is equal to input liquor volume and is shown in Figure 76. Seepage from pond areas has been calculated based on the average supernatant pond areas for TSF Cells 1 – 5 (23.5 ha) and assumed tailings permeability (2×10^{-8} m/s). Liquor retained in tailings was assumed to be 30 % of the weight of tailings solids deposited. This was based on previous testing of in-situ tailings.

The water balance shows 4 % of liquor input due to rainfall in FY18, with a much drier year (< 50% of average rainfall) compared to 12% in the previous reporting period, which had a much wetter year.

A discussion on groundwater levels in the vicinity of the TSF in FY18 is provided in section 1.2 - Aquifer Level Drawdown.

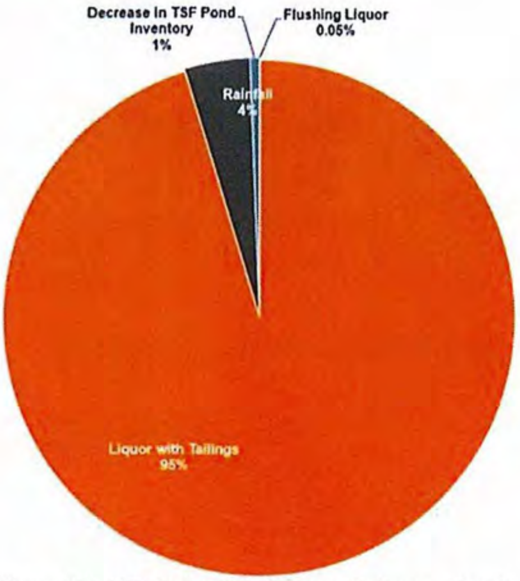


Figure 75: TSF Cells 4 & 5 Liquor Balance – Inputs FY18

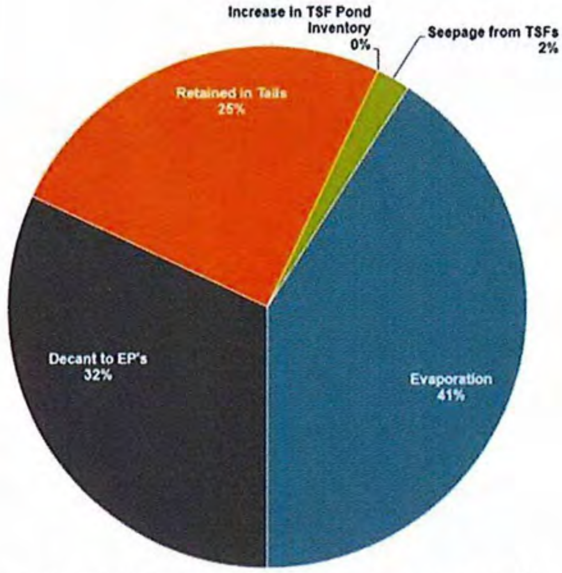


Figure 76: TSF Cells 4 & 5 Liquor Balance – Outputs, FY18

Note: Liquor Inputs [Total 7026 ML]

Note: Liquor Outputs [Total 7026 ML]

4.2.5 Deliverables (WA 2.2)

Monitoring data showing the liquor level in each cell of the EPs.

Figure 77 shows the liquor levels in the evaporation ponds with respect to freeboard limits. Freeboard in the Evaporation Ponds (EPs) consists of allowances for wind, waves and rainfall runoff.

Levels in EP5B have remained low, with the pond in limited service over the period. EP3B was taken out of service to facilitate a wall raise. EP1 and EP2 are close to the limit of their capacity, and were used primarily for evaporation area.

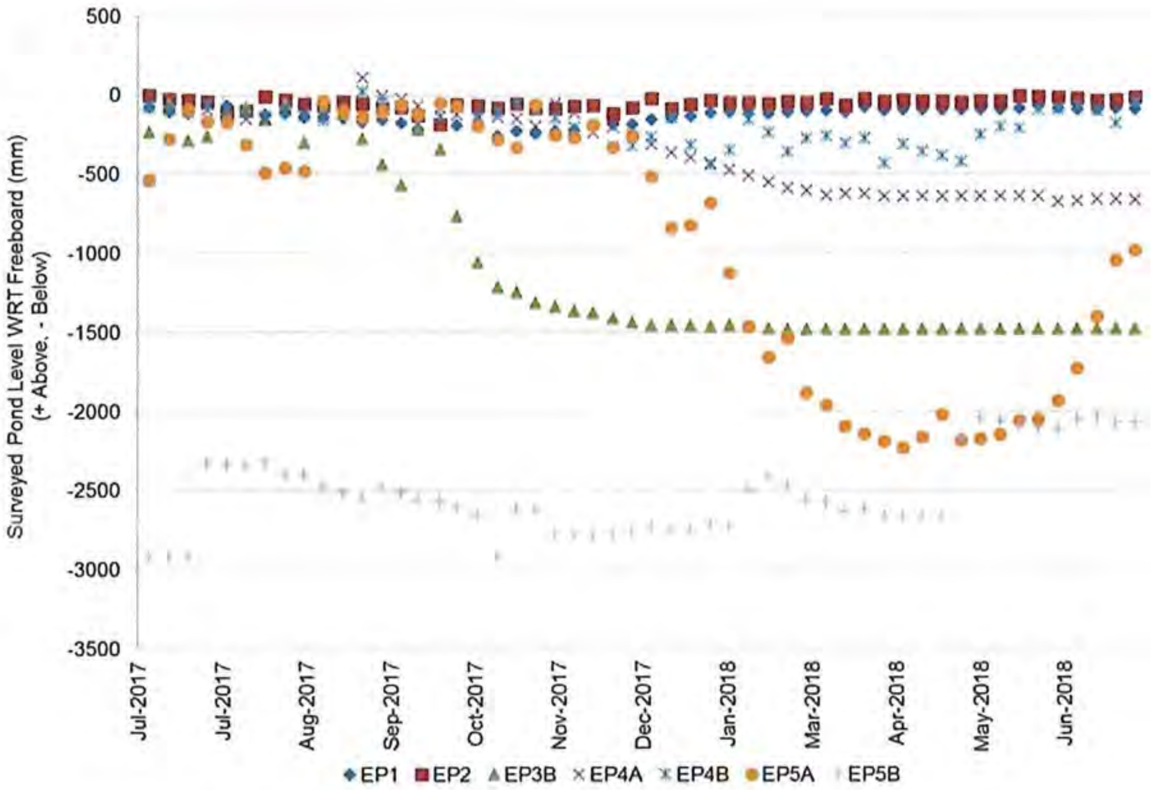


Figure 77: Evaporation Pond Liquor Levels.

Monitoring data showing the overall (solids and liquor) inventory in the EPs.

Figure 78 shows the evaporation pond capacity in relation to the normal maximum operational storage capacity. Additional pond capacity is available as a contingency to allow for large rainfall events.

Reported liquor inventory in the evaporation ponds as a proportion of storage capacity was higher than normal throughout the reporting period. This was due to a variety of factors including reduced capacity resulting from EP3 being out of service from December 2016, and gradual solids accumulation. EP3 will be back in service around the end of calendar year 2018 following completion of the wall raise, and will provide additional volume. This will be offset to a degree by the removal of EP5B from its current limited service by the end of the winter period.

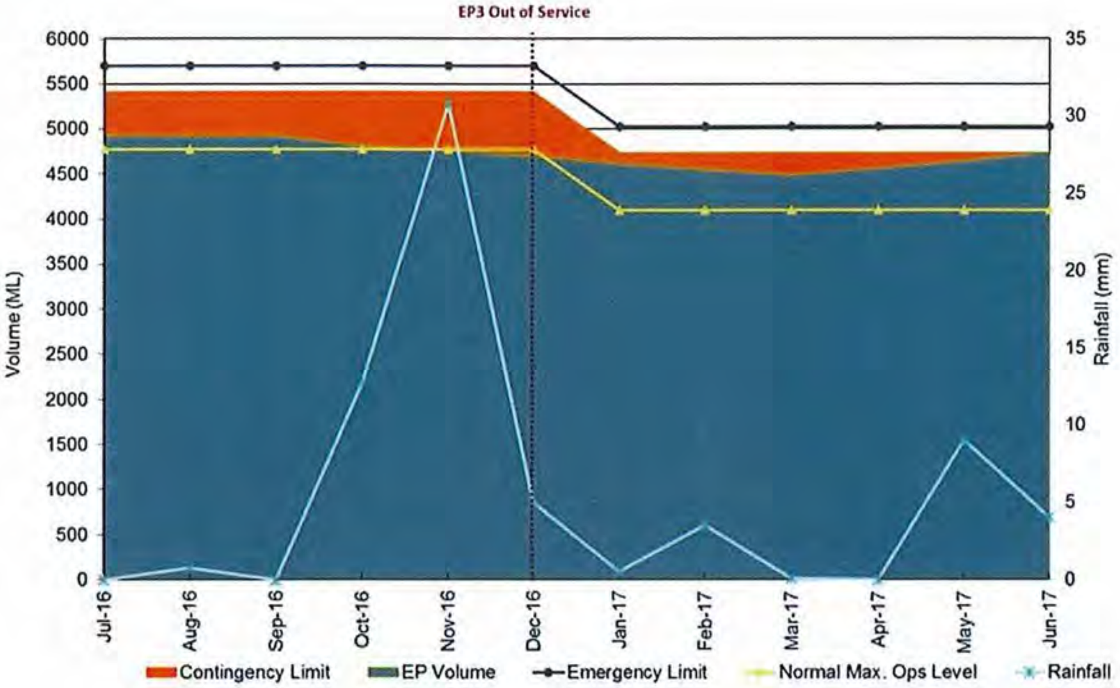


Figure 78: Evaporation pond capacity and rainfall.

Results of a liquor balance for each EP cell.

Figure 79 shows the cumulative evaporation trends for all Evaporation Ponds. The upper and lower bounds have been calculated using the average evaporation rate from all operational cells and applying an estimated error or variation (plus or minus) to the average value.

A liquor balance is performed to highlight cells with potential significant leaks by comparison of the apparent evaporation from each cell of each EP. The comparison is carried out on a monthly basis. The evaporation response for each cell is broadly consistent, demonstrating that significant unexplained losses have not occurred. Variations between each pond can be attributed to usage, and the overall evaporation loss is consistent with previous years.

EP4B showed higher usage last reporting period, attributed to higher usage. This period the evaporation is a similar value to the other ponds. EP5A is showing the highest evaporation, although the magnitude is within historical ranges. With a reduction in use of EP5B, EP5A has been the main transfer pond from TSF5, and consequently inflows and outflows have been higher. Similar to EP4B last period, compounding of errors in measurement is anticipated to increase the margin of error for high use ponds.

Evaporation cells occasionally dry out when the free liquor is evaporated, exposing the surface of the precipitated solids built up in the cell. During these periods a liquor level is not able to be measured and the cumulative evaporation trends level out. Under these circumstances the water balance method is no longer effective in confirming cell integrity. However, as the cell is inactive there is minimal, if any, free liquor available and therefore very little potential for significant seepage from these cells.

EP1 and EP2 were used sporadically during the reporting period. EP3A was out of service for the entirety of the reporting period due to a high level of precipitated solids, while EP3B was removed from service in December for raising. EP5B was in limited use during the period, and will be taken out of service completely after this winter.

Groundwater level data collected in and around the ponds is used as an additional control to detect seepage from the Evaporation Ponds (discussed in more detail in Chapter 1.3 Aquifer level drawdown) and to support the liquor balance calculations.

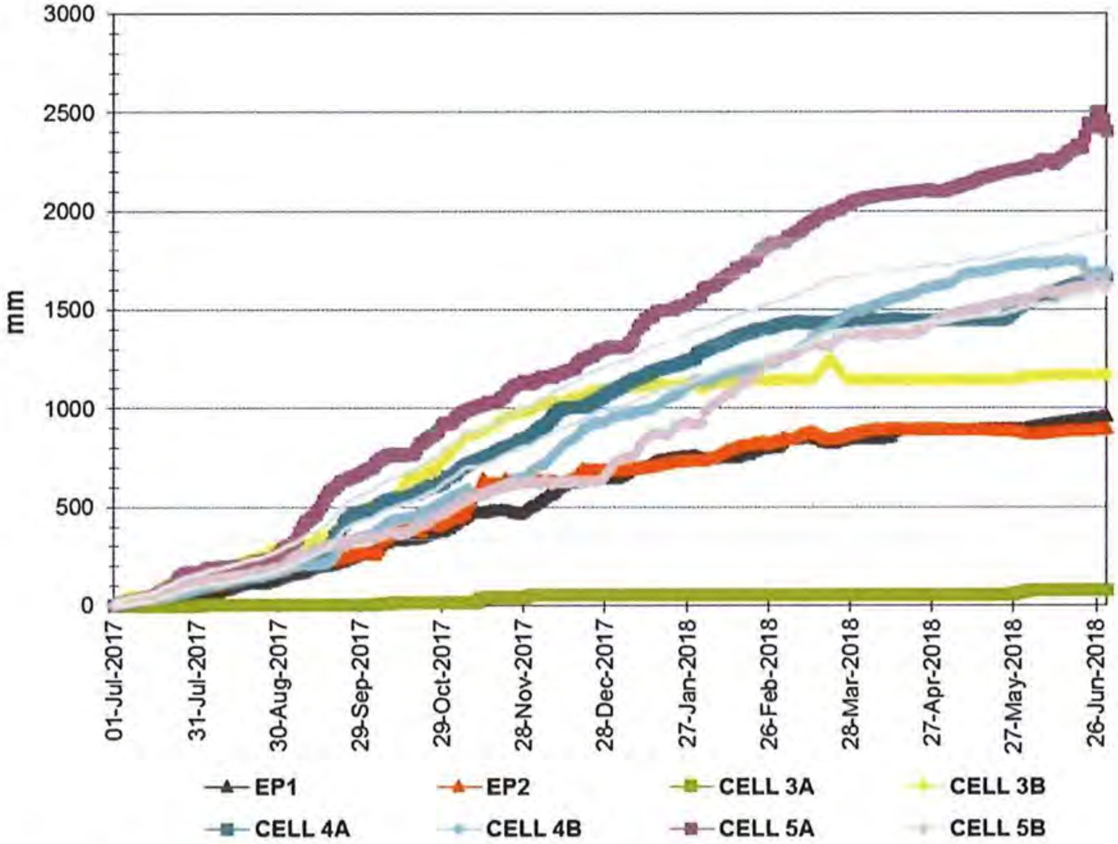


Figure 79: All EP Liquor Balance – cumulative apparent evaporation.

4.2.6 Targets FY18

- None applicable

4.2.7 Action plan FY18

Identify and install additional liquor interception systems as required.

A permanent pumping system was installed along the eastern wall of TSF2 (Locations 17 & 19). This transfers liquor directly to EP2. Previously a temporary system transferred liquor to the location 13 sump.

No new seepage locations were assigned during the period, although two intermittent damp patches are being monitored around TSF5 (midway along the north wall and towards the eastern corner on the south wall).

The installation of the buttress along TSF4 meant that a number of the historical seepages are now covered. The buttress incorporated features to manage seeps, directing any flow to outlet drains.

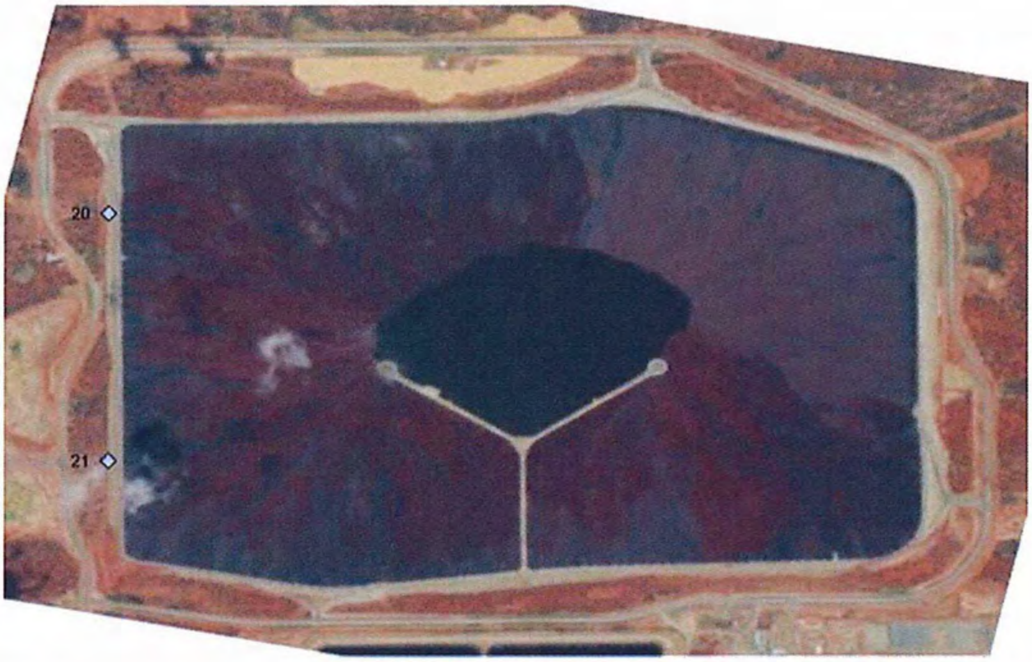
A summary of previously identified locations of interest is shown in Table 21 with locations shown in Figure 80.

Table 21: List of perimeter features.

Location Number	Location	Discovery Date	Summary of Status (FY18)
1	East wall of TSF Cell 1 at the toe	2008	Interception drain, sump and pump to return seepage to the TSF installed. Mostly dry, damp after rain, seepage appears to be slowly extending north. There has been a further decrease in the average daily flow from 6.9 to 5.0 m^3/day over the reporting period.
2	East wall of TSF Cell 1 at the toe and pipe corridor	2008	Liquor intercepted in trench, no change in dampness from previous reporting period. There has been a further decrease in the average daily flow from 5.2 to 4.0 m^3/day over the reporting period.
3	South wall of TSF Cell 1 on the embankment face	Feb 2008	Filter Blanket installed over area. No change from previous reporting period.
4	Adjacent to the south wall of TSF Cell 4	2006	Covered by buttress.
5	Southwest Corner of TSF Cell 4 on the embankment face	2008	Covered by buttress.
6A and 6B	West wall of TSF Cell 4 on the embankment face	2008	Covered by buttress.
7	Intersection of TSF Cell 3 and TSF Cell 4 at toe	Apr 2008	Beneath Cell 3-4 buttress. Flows into sump had been gradually increasing since 2013, however a refurbishment of the dewatering bore in the embankment adjacent has resulted in a reduction in flows.
8	Intersection of TSF Cell 3 and TSF Cell 4 on embankment face	Apr 2008	Beneath Cell 3-4 buttress, similar to other locations, flows have reduced since refurbishment of bore.
9	Toe of the west wall of TSF Cell 3	Apr 2008	Beneath Cell 3-4 Buttress, similar to other locations, flows have reduced since refurbishment of bore.
10	West wall of TSF Cell 4 on the embankment face	2008	Covered by buttress.
11	South wall of TSF Cell 4 adjacent to the toe of the dune – east of decant pipe	2008	Covered by buttress.
12	Cell 2 crest of starter embankment	2009	Damp strips noted, drier in later part of period.
13, 13A and 13B	Cell 1 crest of starter embankment and at toe	2009	Liquor interception trench installed at Location 13A&B. Seepage extending slightly north of 13B beyond the filter blanket. Flows have been higher, with liquor from temporary pump system at location 17 and 19.
14	West wall of TSF Cell 4 at the embankment toe	2009	Covered by buttress.
15	South wall of TSF Cell 4 (East of Location 11)	Jul 2010	Covered by buttress.
16	Northeast corner of Cell 3 (North of Location 12)	Dec 2010	Damp to very damp, drier in later part of the period.
17	East Wall of Cell 2 at the embankment toe (north of Location 13B)	February 2012	Filter blanket installed January 2016 and seepage interception trench constructed June 2017. Area is dry after construction.

18	Eastern side of the north ramp of Cell 4	November 2012	Area covered by filter blanket with seepage collected and drained to a sump via a buried pipeline. Issues with drain noted, drain opened up and will be replaced as part of buttress works.
19	East Wall of Cell 2 at the embankment toe (midway between of Location 12 & 17)	December 2013	Filter blanket installed January 2016 and seepage interception trench constructed June 2017. Area is dry after construction.
20	West Wall of Cell 5 at the embankment toe	June 2015	Damp areas increasing and ongoing water in collection drain chambers and sump. Flow to sump hindered on occasion by issues with drain. Temporary pumping system installed to bypass portions of drain.
21	West Wall of Cell 5 at the embankment toe, south of Location 20	May 2016	Very damp along the toe of the dam, extending in area.
22	North Wall of Cell 3 at the embankment toe	August 2016	Damp patches extending.
23 North and 23 South	East Wall of Cell 3 at the embankment toe	October 2016	Very damp, extent increasing in size.

TSF Cell 5 Seepage Locations



Cell 1-2-3-4 Seepage Locations

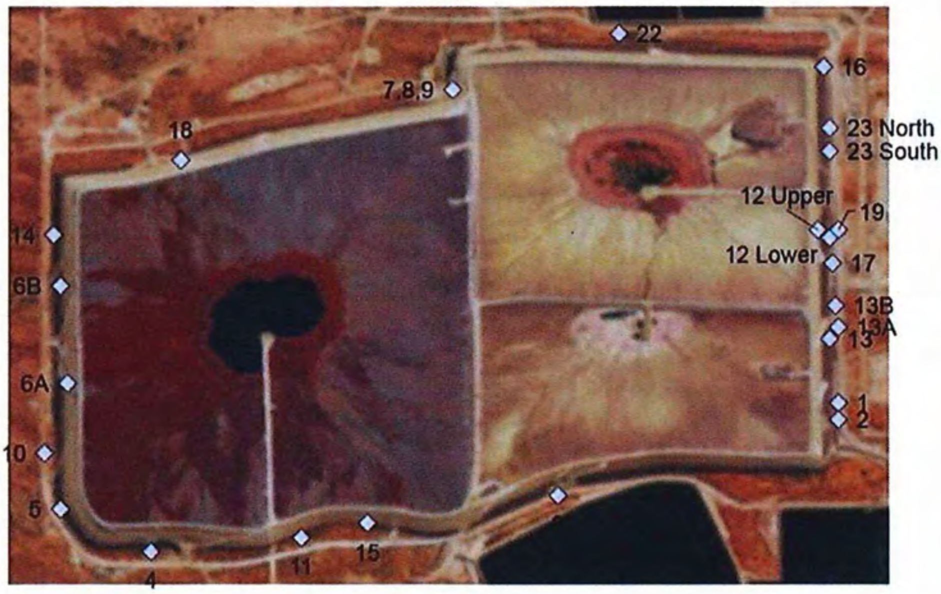


Figure 80: Location of perimeter features.

4.3 Fauna interaction with Tailings Retention System

4.3.1 Environmental Outcome

No significant adverse impacts to listed species (South Australian, Commonwealth) as a result of interactions with the Olympic Dam TRS.

No significant adverse impacts to listed species as a result of interactions with the Olympic Dam Tailings Retention System (TRS) have occurred.

One species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and four species listed under the *National Parks and Wildlife Act 1972* (NPW Act), were observed interacting with the TRS during FY18.

Therefore, it is concluded that there were no significant adverse impacts to South Australian or Commonwealth listed species as a result of interactions with the TRS.

4.3.2 Compliance criteria

No significant adverse impact on the size of an important population of Banded Stilt (*Cladorhynchus leucocephalus*) as a result of interactions with the Olympic Dam TRS. *NOTE: Significant impact is as defined in the Significant Impact Guidelines and greater than predicted in the EIS* (FA 2.3).

One species listed under the EPBC Act was observed within the TRS during FY18. In total, one dead Grey Plover (*Pluvialis squatarola*) was observed during routine weekly monitoring conducted by trained Environment personnel. No additional EPBC listed species were observed opportunistically by TRS technicians. These represent low numbers of recorded individuals for the species.

Two species listed under the NPW Act, the Banded Stilt (*Cladorhynchus leucocephalus*) and the Blue-billed Duck (*Oxyura australis*) were observed within the TRS during FY18. One dead Blue-billed Duck and 22 alive, 1 alive, yet affected and 39 dead Banded Stilts were observed during routine weekly monitoring. An additional 15 live Banded Stilts, one dead Australasian Darter (*Anhinga novaehollandiae*) and two dead Sharp-tailed Sandpipers (*Calidris acuminata*) were observed opportunistically by TRS technicians and Projects Teams during FY18.

Therefore, there was no significant impact on the size of an important population of Banded Stilt as a result of interactions with the TRS.

4.3.3 Deliverables (FA 2.3)

An assessment of fauna activity and losses within the TRS.

An evaluation of the effectiveness of control measures and targets in reducing the number of listed migratory birds lost within the TRS.

During FY18, 44 different bird species and four other animal species were observed during the weekly monitoring of the TRS. A total of 464 live animals were observed throughout the year, with 20 showing signs of being affected by the TRS liquor and 224 dead birds were observed. An increase in confirmed dead animals were observed after high summer rains (Figure 81). It is unclear whether all affected species die as a result of ingesting liquor. The Australian Raven was recorded in the highest numbers during FY18, with a total of 110 recorded.

Overall, there has not been a significant increase or decrease in the number of alive and dead birds observed at the TRS from FY12 to FY18 (Alive: $F_{1,26} = 0.047$ $p = 0.831$; $R^2 = 0.002$; Dead: $F_{1,26} = 0.003$ $p = 0.960$, $R^2 < 0.001$; Figure 82). The variability in the numbers observed is most likely due to environmental factors, such as rainfall (Figure 81).

New controls are still being evaluated prior to undertaking a trial and therefore they cannot currently be analysed for their effectiveness at reducing listed migratory species.

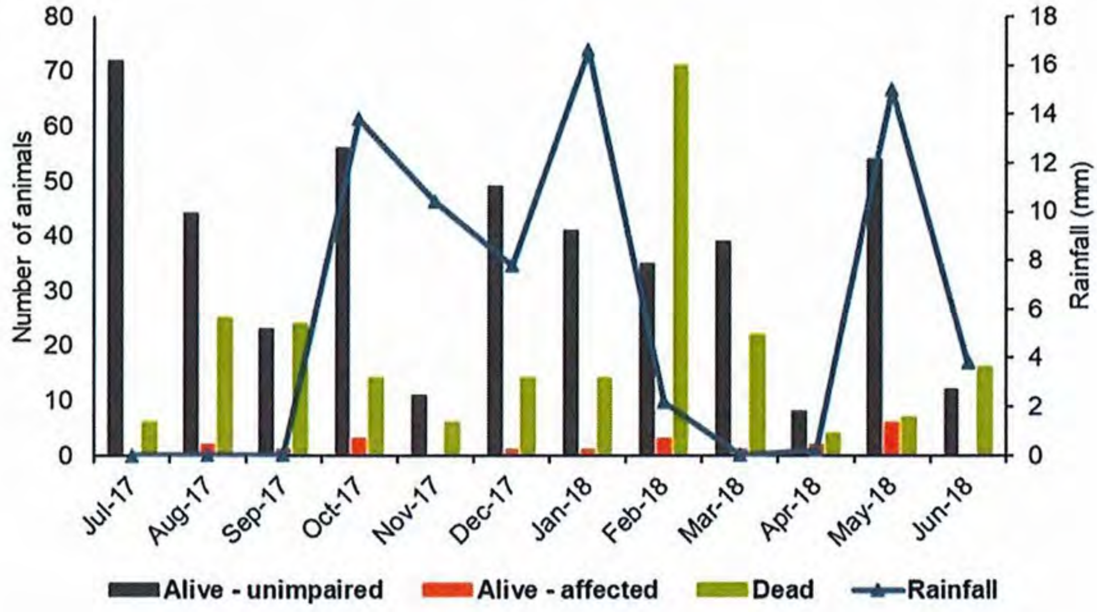


Figure 81: Monthly summary of weekly monitoring for FY18, showing total number of animals recorded as alive, yet unaffected, alive, but affected and confirmed as dead within the TRS. Rainfall data presented are collected from the Roxby Downs weather station.

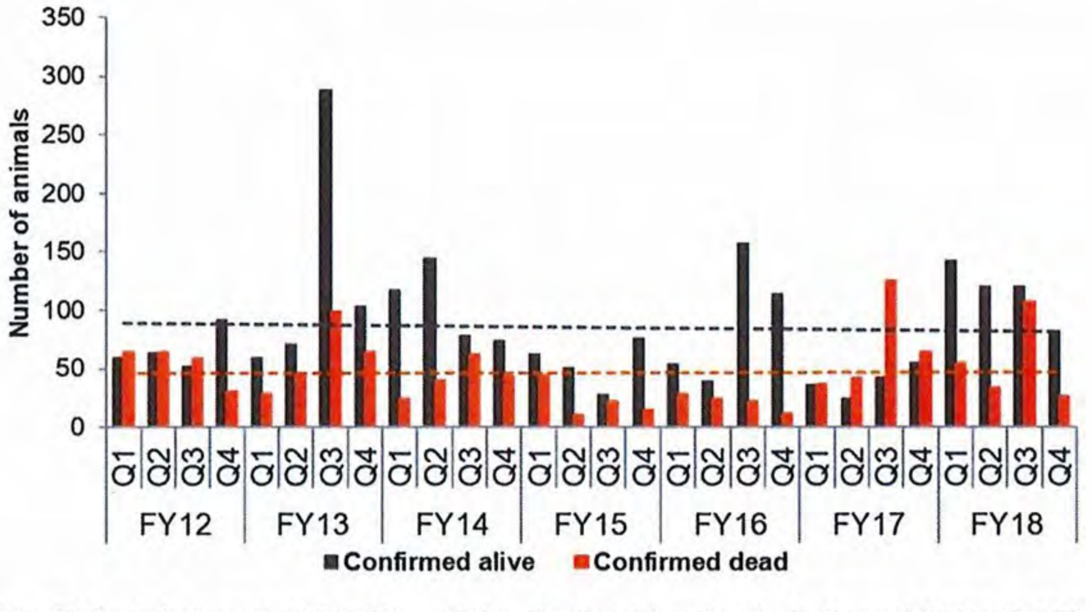


Figure 82: Quarterly summary of all weekly monitoring, showing total number of animals recorded within the TRS. Dashed lines represent linear trends.

All fauna observed opportunistically (i.e. outside formal monitoring sessions) during FY18 are summarised in Figure 83. Opportunistic observations bias towards live animals, especially large flocks, hence more live animals than dead animals are usually observed.

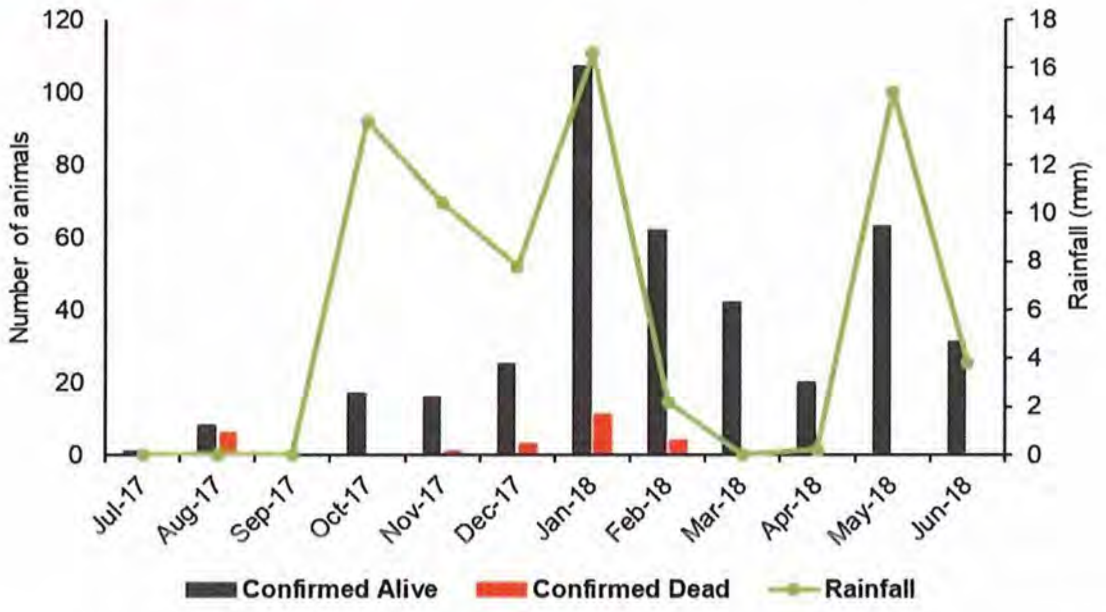


Figure 83: Monthly summary of opportunistic observations for FY18, showing total number of animals recorded within the TRS. Rainfall data presented is collected from the Roxby Downs weather station.

The data presented indicate the number of fauna counted and do not represent total numbers. They are presented as an index only. A number of factors must be considered when interpreting and refining our monitoring and data analyses:

- Birds may be seen and recorded as alive on one day and subsequently may be observed as dead. The total includes both observations, leading to a possible overestimate;
- Scavenging by birds of prey and corvids means that some carcasses may be removed from the system prior to an observation being made;
- Carcasses floating in the liquor may sink and disappear before being recorded; and,
- Some fauna species may leave the system and die elsewhere.

The number of birds recorded as dead at the TRS may represent a small proportion of those that visited. Preventing and deterring visitations by large flocks of birds, particularly Banded Stilts, remains a focus of management efforts at the TRS.

4.3.4 Leading Indicators

- None applicable

4.3.5 Targets FY18

- None applicable

4.3.6 Action plan FY18

Continue investigating and trialling alternative deterrent technologies when they become available.

Research into alternative deterrent technologies will continue in FY19. A summary of deterrents trialled to-date has been compiled and the process has derived a short-list of potential deterrent and offset options to be further explored based on their high feasibility, low cost and unknown effectiveness (e.g., most deterrent options only had anecdotal evidence available). As a result of this process, we have identified three plausible options to investigate further. We have also started discussions with our team in Chile, as Escondida mine faces similar issues. The results of this desk-top review will be used to inform relevant stakeholders of the identified best approaches for managing avian interaction with the TRS.

4.4 Solid waste disposal

4.4.1 Environmental Outcome

No significant adverse impacts as a result of management of solid waste.

The Resource Recovery Centre (RRC) effectively manages solid waste as per the EPA approved Landfill Environmental Management Plan 2016 (LEMP). No evidence of material environmental harm was identified through routine auditing and/or based on the reporting of materials disposed of to the landfill. No significant adverse impacts resulted from the management of solid waste at Olympic Dam during FY18.

4.4.2 Compliance criteria

No site contamination leading to material environmental harm arising from the operation of the Resource Recovery Centre (WA 2.5, 2.6).

Solid wastes that cannot be reused or recycled by the RRC and that are not contaminated are disposed of into the landfill facility. The RRC effectively manages solid waste as per the approved EPA Landfill Environmental Management Plan (LEMP) so that no material environmental harm is caused. Waste is minimised, stored, transported and disposed in a manner that controls the risk of adverse impacts to the environment and communities through implementation and maintenance of a LEMP. No evidence of material environmental harm was identified based on routine auditing and reporting conducted during landfill operations.

4.4.3 Deliverables (WA 2.5)

Records of quantities of general and industrial waste disposed of to landfill.

Records of all general waste disposed of to landfill are maintained by the waste management contractor for the RRC. Total waste delivered to the RRC for FY18 was ~77 969 m^3, of this waste, ~55 254 m^3 was disposed to landfill and 22 714 m^3 was diverted for recycling. This equates to ~29 % of waste diverted from landfill to recycling stockpiles for FY18. Although recycling diverted decreased from 38% to 29% for FY18 considerable effort was made this FY to reduce recycling stockpiles for offsite recycling. FY18 saw an increase in waste disposal from 30 081m^3 to 55 254 m^3 due to the SCM17 shutdown which generated large amounts of waste. Recycling removed from site in FY18 and historical waste data for the RRC is displayed in Table 22 and Table 23, respectively.

Records of quantities of material recovered for reuse and recycling.

All records of reused and recycled materials are maintained by the waste management contractor for the RRC. The total amount of recycling sent off-site for FY18 was ~1 513 tonnes. Table 22 displays the recycling removed from site for FY18.

Table 22: Recycling removed from site FY18.

Recycling removed from site FY18	Quantity	Unit
Copper Cable	150.08	Tonnes
Mill Liners	140.59	Tonnes
Polypipe	148.64	Tonnes
Light Vehicle Tyres	220.95	Tonnes
Scrap steel & stainless steel	793.11	Tonnes
Batteries	14.92	Tonnes
Auctions/electric motors/pump casings/miscellaneous	43.80	Tonnes

Table 23: Historical waste data for Resource Recovery Centre.

Year	Landfill Disposal (m^3)	Waste Oil (L)	Recycled Materials (Tonnes)
2003	30,622	156,300	193
2004	27,348	206,100	617
2005	14,578	152,740	510
2006	45,361	276,580	347
2007	47,964	311,400	685
2008	52,171	288,130	673
2009	40,898	358,000	936
2010	32,980	325,000	1,890
2011	37,511	342,300	1,735
2012	36,291	653,500	2,644
2013 (June)	17,739	157,200	1,248
2014	31, 433	371, 600	1, 232
2015	34, 939	502, 000	3, 073
2016	27, 355	509, 000	2, 651
2017	30, 081	511, 300	1, 957
2018	55, 254	422, 400	1, 513

4.4.4 Deliverables (WA 2.6)

Records of categories, quantities and location of hazardous waste materials disposed of within the SML.

Depending on the type of hazardous or contaminated material, quantities are measured in meters cubed (m^3) or tonnes (t). Records of hazardous waste disposed within the SML is shown in Table 24. Contaminated waste disposed within the SML is discussed in the Radioactive waste chapter 4.5. Disposal of hazardous waste is to the Tailings Storage Facility (TSF). The disposal method ensures material disposed is consistent with tailings density. Process waste that meets the tailings disposal criteria (i.e. not hydrocarbon; caustic or solid) is disposed via bunded areas which are directed to tails disposal. This reduces the amount of waste delivered and buried in the tailings waste finger.

Other hazardous waste removed from site for disposal consists of hydrocarbon waste such as oily rags; grease drums and oil filters and is shown in Table 24.

Records to provide evidence that listed waste is appropriately managed, specifically:

- **that listed waste is stored, contained and treated in a manner that does not cause environmental harm or nuisance or present risks to human health and safety;**
- **that all listed waste storage containers are of a suitable strength and durability, are clearly marked and contain appropriate safety warnings;**
- **that all listed wastes do not contact soils or stormwater, and that measures to prevent and recover spillages are implemented as necessary.**

The waste management contractor is responsible for maintaining hazardous waste management records for the RRC. The location, type and quantity of hazardous waste is recorded in an electronic register, as per all relevant regulations and site procedures. The transport of hazardous waste off-site is documented through the EPA waste transport and tracking system, providing assurance to regulators that wastes are managed appropriately so as not to cause environmental nuisance or present a risk to human health and safety.

ODC complies with the requirements of EPA Licence 1301 pertaining to listed and controlled waste by adhering to the approved Landfill Environmental Management Plan (LEMP), which meets government and ISO 14001 requirements. Spill kits are available at all collection and loading points for listed waste (e.g. Waste Oil Facility and Distribution Centre).

Table 24: Record of hazardous waste disposed within the SML and removed off the SML.

Storage Location	Type of waste	Quantity of Waste	Units
Tailings Storage Facility	Hazardous waste disposed	6338	m^3
Off Site Disposal	Hazardous hydrocarbon waste	422, 400	Litres

4.4.5 Leading Indicators

- None applicable

4.4.6 Targets FY18

Increase at source waste segregation to reduce waste to landfill

All recycling stations across site have colour coded skip bins to assist with segregation at source. This has resulted in approximately 29% diversion of recyclable material from landfill for FY18. An improvement project will be rolled out across site in FY19 which will include site training on recycling and waste management. Additional skip bins will be provided at specific locations to facilitate source segregation.

Reduce recycling stockpiles by 20 %

Approximately 794 tonnes of scrap steel from the steel stockpiles was removed from site in FY18. The stockpiles will continue to be managed to reduce historical waste and the RRC will implement an ongoing strategy to ensure recycling stockpiles are maintained at a small volume going forward.

4.4.7 Action plan FY18

Implement a plan for reducing stockpiles of recyclable material

Further work was progressed this year to reduce stockpiles. Legacy waste stockpiles of scrap steel were specifically targeted in FY18 with ~794 tonnes of steel removed off site for recycling. Polypipe and light vehicle tyre stockpiles were reduced with 148 tonnes of polypipe being removed for recycling and 220 tonnes of light vehicle tyres.

Implement a site wide paper/cardboard recycling programme with bailing and off site removal/recycling

Cardboard skip bins are placed at recycling stations to assist in the segregation of cardboard and paper across site. Removal of cardboard offsite as recycling remains challenging. Upgrades to skip bins and storage areas is being investigated to ensure this material remains in good condition for removal from site as recycling.

4.5 Radioactive waste

4.5.1 Environmental Outcome

No adverse impacts to public health as a result of radioactive waste from ODC's activities (State 34).

BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) has consistently operated in a manner that limits radiation dose to members of the public, from radioactive waste, to less than a small fraction of the International Commission on Radiological Protection (ICRP) 1 mSv/yr limit. As a result, there are no adverse radiation exposure impacts to the public from activities undertaken at Olympic Dam.

No significant adverse impacts to populations of listed species or ecological communities as a result of radioactive waste from ODC's activities (State 34).

There were no significant adverse impacts to populations of listed species or ecological communities as a result of ODC's activities. Monitoring of radiation doses to the public and the deposition of ^{238}U at non-human biota assessment sites is used as an indicator of the potential exposure of listed species to radioactive waste. Deposition of ^{238}U at non-human biota assessment sites was at a level which poses no significant adverse impacts to non-human biota.

4.5.2 Compliance criteria

Radiation doses to members of the public less than 1 mSv/y above natural background (State 34).

The total estimated dose to critical groups of members of the public in FY17 at Roxby Downs Monitoring Site and Olympic Village Monitoring Site contributed by ODC operations was 0.023 mSv and 0.033 mSv respectively, well below the 1 mSv/yr public dose limit and the OD internal constraint of 0.3 mSv/yr.

Deposition of project originated ^{238}U less than 25 Bq/m^2/y at the non-human biota assessment sites.

The average deposition of Uranium-238 at the four monitoring sites was determined to be 3.09 Bq/m^2/y. This is well below the 25 Bq/m2/y compliance criteria.

4.5.3 Deliverables (WA 2.7)

Records of the categories, quantities and location of LLRW and contaminated material disposed of within the SML.

Systems are maintained by ODC that record categories, quantities and location of waste disposed of within the Special Mining Lease (SML), classified as Low Level Radioactive Waste (LLRW) or contaminated waste.

A permanent contaminated waste disposal facility (CWDF) was approved to be constructed adjacent to the Resource Recovery Centre see Figure 84, with the first cell of the facility being constructed in 2017. A contaminated waste management plan explains what waste can be disposed to this area, the specific contamination limit and how to clean, prepare, test and dispose of the waste. Previous to the permanent CWDF being constructed the Radiation Protection branch of the Environmental Protection Authority (EPA) had temporarily approved areas within the SML for the storage of contaminated waste.

Following the approval of the permanent CWDF a project was initiated to decommission these temporary facilities and clean, prepare, test and dispose of the waste as per the approved CWDF Waste Management Plan. The project ensured implementation of cleaning and recycling strategies in order to minimise contaminated waste. The project commenced in May 2017 and was completed ~ October 2017. The project successfully processed 5979 tonnes of waste; of this amount 3007 tonnes, or ~50%, were cleaned, tested and removed off-site for recycling. The remaining 2972 tonnes was tested and prepared for disposal as per the CWDF Plan. Since completion of the project the CWDF has been accepting contaminated waste from operational areas on an ongoing basis. All waste is cleaned and tested and either recycled or disposed of in the CWDF. Table 1 demonstrates contaminated waste disposed since the facility was built.

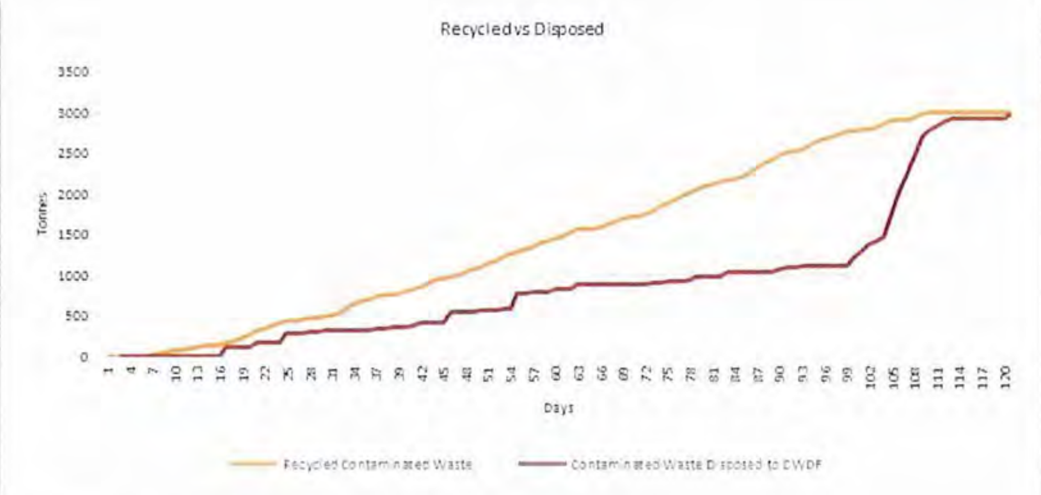


Figure 2: Contaminated Waste disposed and recycled during the project

Table 25: Permanent Contaminated Waste Disposal Facility (CWDF).

Storage Location	Type of waste	FY	Quantity of Waste	Units
CWDF	Contaminated structural equipment	FY17	816	Tonnes
		FY18	2512	Tonnes

4.5.4 Leading Indicators

Indications that a dose constraint of 0.3 mSv/y to members of the public above natural background will be exceeded.

Indications that a reference level of 10 µGy/h for impact on non-human biota above natural background will be exceeded.

No leading indicators were triggered. Doses to members of the public are below Olympic Dam's internal dose constraint of 0.3mSv/yr. Similarly the reference level of 10 µGy/h for impacts on non-human biota have not been triggered.

4.5.5 Targets

Maintain radiation doses as low as reasonably achievable, as assessed through the annual Radiation Management Plan review.

Quarterly ODC radiation monitoring results, radiation dose calculations and occupational hygiene results are presented to the regulatory authorities for review. In addition, an annual adequacy and effectiveness review is completed each year confirming that doses are as low as reasonably achievable.

4.5.6 Action plan FY18

None applicable.

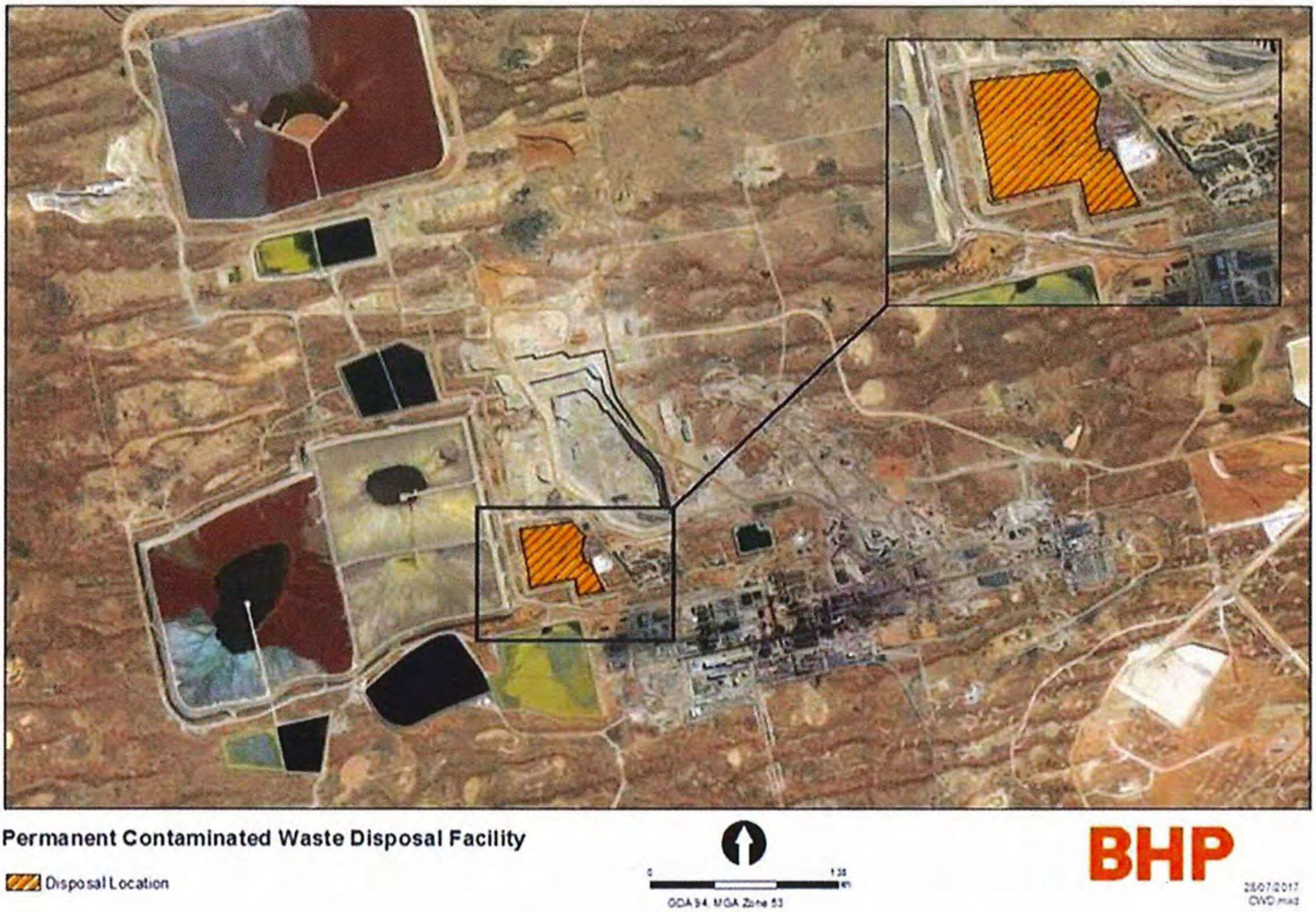


Figure 84: Approved Contaminated Waste Disposal Facility (CWDF).

5 Interaction with communities

5.1 Community interaction

5.1.1 Environmental Outcome

Residents in Roxby Downs, Andamooka and Woomera trust ODC to act in their best interests.

Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is a trusted organisation within its local communities. In addition to this, ODC provides employment to local and regional communities.

5.1.2 Compliance criteria

Community concerns are tracked and all reasonable complaints are addressed where reasonably practical.

ODC has a process to receive and track community concerns through the company's stakeholder engagement management plan. ODC did not receive any community complaints in FY18. One internal complaint from a resident at Olympic Village was referred to the managing contractor, Sodexo.

5.1.3 Deliverables (SE 2.1)

A description of the extent to which residents in Roxby Downs, Andamooka and Woomera trust ODC to act in their best interest (calculated triennially).

Responses to the 2017 Olympic Dam Community Perception Survey indicate that ODC is viewed favourably within its local communities. In addition to this, ODC provides employment to local and regional communities.

5.1.4 Deliverables (SE 2.2)

A description of residents' perceptions about quality of life services and facilities, safety and social fabric in Roxby Downs, Andamooka and Woomera (reported triennially).

ODC undertook a Community Perception Survey in 2017. Perceptions amongst survey participants raised concerns regarding availability of retail stores, cost and reliable access to power, job security and access to increased medical facilities.

5.1.5 Leading Indicators

- None applicable

5.1.6 Targets

A long-term desirable trend towards a minimum housing rental vacancy rate in Roxby Downs of 5 %.

Roxby Downs has experienced a growth in population from contracted FY17 population numbers, with housing rental vacancy currently at 6.23% at the time of this report.

5.1.7 Action Plan FY17

Undertake the triennial Community Perception Survey to monitor local community perceptions of ODC, and of local services and facilities.

The triennial Community Perception Survey was undertaken in 2017 to monitor local community perceptions of ODC, and of local services and facilities. The next survey is scheduled to take place in 2020.

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7 Glossary

ADU	Ammonium diuranate, commonly referred to as Yellowcake.
AE	Monitoring Program – Airborne Emissions
AHD	Australian Height Datum, a measure of elevation referenced from approximate sea level.
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian & New Zealand Environment & Conservation Council.
Aquifer	Porous water bearing formation of permeable rock, sand, or gravel capable of yielding significant quantities of water.
APTS	Acid Plant Tails Stack
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
Bq	Bequerel, a unit of radioactive decay.
$Bq/m^2/y$	Bequerels per cubic meter per year
CEMP	Carbon Emissions Management Plan
Ca	Calcium.
CAF	Cemented aggregate fill.
Closure	Permanent cessation of operations at a mine or mineral processing site after completion of the decommissioning process, signified by tenement relinquishment.
CD1, CD2	Concentrate Dryer 1, Concentrate Dryer 2
$CO_{2\text{-}}e$	Carbon dioxide equivalent
Cu	Copper.
CWDF	Contaminated Waste Disposal Facility.
Domestic Water Use	Water used in the town of Roxby Downs or Olympic Dam Village.
DSD	Department of State Development
EA	Monitoring Program – Environmental Radiation
ED	Effective dose.
EG	Monitoring Program – Energy Use and Greenhouse Gas (GHG) Emissions
ED_D	Effective dose attributable to radionuclides in dust

EEO	Energy Efficiency Opportunities – Federal government legislation
EDP	Environmental Disturbance Permit
EIP	Environmental Improvement Plan
EIS	Environmental Impact Statement.
EMM	Environmental Management Manual
EMS	Environmental Management System. The part of an organisation's management system used to develop and implement its environmental policy and manage its environmental aspects (Standards Australia / Standards New Zealand 2004). Note: A management system is a set of interrelated elements used to establish policy and objectives and to achieve those objectives. A management system includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources.
Environmental Aspect	An element of the organisation's activities or products or services that can interact with the environment (Standards Australia / Standards New Zealand 2004).
Environmental Impact	Any change to the environment, whether adverse or beneficial wholly or partially resulting from an organisation's environmental aspects (Standards Australia / Standards New Zealand 2004).
EPA	Environmental Protection Authority
EPBC Act	Environment Protection & Biodiversity Conservation Act 1999 (Cth).
EPMP	Environmental Protection and Management Program. Describes the environmental management and monitoring activities undertaken by BHP Olympic Dam for the purpose of quantifying any change in the extent or significance of its impacts, assessing the performance of control measures employed to limit impacts, and/or to meet legal and other obligations.
EPP 1994	Environment Protection (Air quality) Policy 1994
EPP 2015	Environment Protection (Water quality) Policy 2015
Evaporation Pond EP	A containment pond to hold liquid wastes to assist with disposal of liquor via evaporation.
FA	Monitoring Program - Fauna
FL	Monitoring Program - Flora
FoS	Factors of Safety
FY	Financial Year
GA	Monitoring Program – Great Artesian Basin
GAB	Great Artesian Basin
GIS	Geographical Information System

GHG	Greenhouse Gas
GW	Monitoring Program – Groundwater
g/m^3	Grams per cubic metre – a measure of dust concentration in air.
Gy/h	Grays per hour – a measure of absorbed radiation dose.
ha	Hectare
ICRP	International Commission on Radiological Protection.
ID	EMP chapter identification
Industrial Water use	Water used in mining or mineral processing operations and excluding domestic water use.
kg CO_2-e	Kilograms of carbon dioxide equivalence – a standard measure of greenhouse gas emissions
kg CO_2-e/t	Kilograms of carbon dioxide equivalence per tonne of material milled – a measure of greenhouse gas emission intensity of ODC.
kL/t	Kilolitres per tonne of ore milled.
kt	Kilotonne
Listed Species	Those species or communities that are listed as threatened or migratory under Commonwealth and/or relevant State or Territory legislation.
LEMP	Landfill Environmental Management Plan
LNAPL	Light Non-Aqueous Phase Liquid
LLRW	Low level radioactive waste
mAHD	Elevation in metres with respect to the Australian Height Datum
mg/Nm^3	Milligrams per normal cubic metre
ML	Megalitres.
ML/d	Megalitres per day.
MP	Monitoring Program. A document which describes the environmental monitoring activities undertaken by ODC for the purpose of quantifying any change in the extent or significance of its impacts, assessing the performance of the control measures employed to limit its impacts, and/or to meet its legal and other obligations.
Mt	Million tonnes
mSv/y	Millisieverts per year – a measure of equivalent radiation dose.
MWDP	Mine water disposal pond
NaCl	Sodium chloride (salt).
NEPM 2011	National Environment Protection Measure. NEPM investigation levels (Health Investigation Level Scenario D: Industrial/Commercial land use; Schedule B1 - National Environmental Protection (2011)

NGER	National Greenhouse and Energy Reporting – Federal government reporting of greenhouse gas emissions and energy use and production
NHB	Non-human biota
Nm^3	Normal metres cubed, referring to volume at standard temperature and pressure
NO_x	Oxides of nitrogen
NPW Act	National Parks & Wildlife Act 1972 (SA)
NVMP	Native Vegetation Management Program
ODC	BHP Billiton Olympic Dam Corporation Pty. Ltd.
OV	Olympic Village, the accommodation camp located at Olympic Dam township
OVMS	Olympic Village Monitoring Site
Pb	Lead
^{210}Pb	An isotope of lead, having mass number 82 and half-life 22.3 years
pH	A measure of acidity and alkalinity
PM_{10}	Particulate matter with an effective aerodynamic diameter less than or equal to 10 µm
$PM_{2.5}$	Particulate matter with an effective aerodynamic diameter less than or equal to 2.5 µm
Po	Polonium
^{210}Po	An isotope of polonium, having mass number 84 and half-life 138.38 day
ppm	Parts per million
PRH	Practical Reference Heads
Ra	Radium.
^{226}Ra	An isotope of radium, having mass number 88 and half-life 1599 years
RDMS	Roxby Downs Monitoring Site
Rehabilitation	The reclamation or repair, as far as practicable, of a facility to an appropriate or agreed state as required by law, or company self-regulation
Rn	Radon. Chemically inert radioactive gaseous element formed from the decay of ^{226}Ra as part of the ^{238}U decay chain
^{222}Rn	An isotope of radon, having mass number of 86 and half-life 3.8235 days
RRC	Resource Recovery Centre
RSF	Rock Storage Facility
SAP	Systems Applications Products

SE	Monitoring Program – Social Effects
SEB	Significant Environmental Benefit
SEIS	Supplementary Environmental Impact Statement
Significant aspect	An environmental aspect that has or can have a significant environmental impact. Significance is determined by risk assessment.
Significant Impact Guidelines	Australian Government, 2009, 'Matters of National Environmental Significance: Significant impact guidelines 1.1, *Environment Protection and Biodiversity Conservation Act 1999*.
SML	Special Mining Lease
SO_2	Sulphur dioxide
SO_4	Sulphate
SW	Monitoring Program – Surface Water
SX	Solvent Extraction
t	Tonnes
TDS	Total dissolved solids
TP	Tapered Piezometers
TRS	Tailings Retention System. Incorporates all elements of the tailings delivery, deposition and storage system and elements associated with the collection and disposal or return of tailings liquor. The TRS includes the Tailings Storage Facility (TSF), Evaporation Ponds and Pipe Corridors including tailings delivery pipelines and liquor pipelines.
TSF	Tailings Storage Facility. Incorporates the tailings deposition and storage system, which currently comprises four storage cells.
Th	Thorium
^{230}Th	An isotope of thorium, having mass number 90 and half-life 7.54×10^4 years.
Total Industrial Water Use	Total water used including high quality (GAB) water and water recovered from other sources including abstraction of local saline water.
TSP	Total Suspended Particulates (dust)
U	Uranium.
^{238}U	The most common isotope of uranium, having mass number 238 and half-life 4.46×10^9 years.
μGy/h	Micro gray per hour
VOC	Volatile organic compound.
VWP	Vibrating Wire Piezometers
WA	Monitoring Program – Waste