Appendix J – Mining Proposal Surface Water Assessment (GHD 2019c)

TALISON LITHIUM

Talison Lithium Australia Pty Ltd

Greenbushes Lithium Mine Expansion

Mining Proposal Surface Water Assessment

February 2019

GHD

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

Executive summary

Background

Talison Lithium Australia Pty Ltd (Talison) is proposing to expand the existing Greenbushes Lithium Mine to increase the production of spodumene ore and lithium mineral concentrate from the operation. The expansion will comprise:

- New infrastructure, including two spodumene processing plants, tailings retreatment plant, tailings storage facility, mine services area, explosive facilities, linear infrastructure (roads and pipelines) and a crushing circuit.
- Merging and expansion of the existing pits; and
- Expansion of the Floyd's waste rock landform (WRL).

A Mining Proposal and a Mine Closure Plan are required for the expanded operations by the Department of Mines, Industry Regulation and Safety (DMIRS), which should be prepared in accordance with their Mining Proposal (2016) and Mine Closure (2015) guidelines.

The Mining Proposal requires a surface water assessment to assess potential risks and impacts to surface water receiving environments associated with the expansion of the Mine..

The scope of this surface water assessment was to characterise surface water quality and flows with respect to sensitive receptors and relevant assessment criteria, undertake a flood risk assessment and identify existing and potential future erosion and sediment control issues.

Surface water characterisation

The site is located on a topographic ridge which divides the site into well defined western and eastern catchments. The mine water supply relies solely on surface water from rainfall and run-off collected in various dams and sumps within the western catchment.

Water within the western catchment is impacted by mine operations. The site Licence (L4247/1991/13) does not permit discharges from the western water circuit and the site Surface Water Management Plan currently establishes operating rules, procedures, and monitoring requirements to ensure these site Licence conditions are met. Water from the western catchment, should it discharge, flows into Norilup Dam, and from there, Norilup Brook and into Blackwood River.

Water within the eastern catchment is primarily impacted by the WRL, and currently drains freely into Salt Water Gully and Hester Brook, and from there into Blackwood River.

The site's hydrology during the expansion is expected to perform similarly to its existing state in that overflows from Cowan Brook may occur in high rainfall years after the installation of water treatment facilities. Discharges will continue to occur from the eastern catchment and dishcharge limits are set in Table 3.4.2 of the operating licence. The receiving environment will thus only receive water from the following sources:

- Dam water seepage from Cowan Brook and Southampton Dams.
- Seepage from Cemetery Dam.
- Discharge/overflows of surface water, and seasonal overflows from the eastern catchments.

The receiving environment that may be impacted by changes to surface water conditions from the proposed expansion include:

- Downstream aquatic systems (water ways, groundwater dependent ecosystems);
- Humans (recreation and consumption); and
- Fauna and livestock (consumption).

Key surface water risks

Storage water levels

Due to the mine's reliance on surface water and the expected increase in water demand and associated water loss (~10% of water drawn for processing is lost to evaporation/infiltration), the likelihood of discharges from the site is expected to reduce. There is a risk that water levels in existing dams may be drawn down to low levels to maintain process water supply which could impact local environments reliant on the dams. Talison is investigating potential water storages to supplement mine water supply.

Streamflow

Discharges from the site may reduce as a result of the increased water demand and water reuse from the expansion. Continued monitoring of any impacts is nonetheless undertaken by Talison via annual ecology surveys of downstream environments and monitoring of flow quantities and quality.

Flood risk

The only area that may present a flood risk to downstream environments is the eastern catchment as a result of the WRL expansion. The high-level flood risk assessment determined that the overall contribution to Hester Brook from the WRL expansion will be negligible as a result of:

- The total area of the eastern catchment remaining unchanged;
- The inherent porous nature of the WRL which will allow for greater water storage capacity and hence mitigate any peak flow events.

It is noted that the flood risk assessment undertaken assumes that dam break analysis will be undertaken separately and existing and proposed drainage systems and water storages on site are designed to accommodate their appropriate design storm event.

Water quality

Water quality in the mine's western water circuit has been declining, however management measures have sufficiently controlled discharges of poor quality water from the site's western water circuit, in line with Licence water quality limits.

Surface water from the existing WRL reports higher concentrations of lithium, sulfate and nickel, compared to other undisturbed areas of the eastern catchment, however these concentrations are noted to be below relevant guideline values, and have stabilised or decreased since 2002. Nonetheless, expansion of the WRL presents a risk of increased downstream impacts from the site's eastern catchments. Should water quality from the eastern catchments begin to deteriorate, consideration should be given to establishing infrastructure to intersect and return drainage from the eastern catchments to mitigate any impacts. It is noted that Talison is investigating such infrastructure primarily to supplement the mine's water supply.

Arsenic and lithium concentrations are expected to reduce within the mine water circuit as a result of the water treatment plant being commissioned (due 2019), and continued use of arsenic remediation units.

Continued monitoring of any impacts is undertaken by Talison via annual ecology surveys of downstream environments along with monitoring of flow quantities and quality.

Erosion and sedimentation

Clearing and construction of the TSF4, WRL and MSA will result in disturbed surfaces that pose a risk of erosion. Proposed water collection infrastructure will intersect sediment draining from the WRL in the eastern catchment, while toe drains serve to mitigate any erosion issues on the TSF4. Erosion and Sedimentation Control (ESC) procedures are incorporated as aspects of a number of site specific procedures and will mitigate impacts during clearing, construction and operation of these structures. No specific ESC plan exists for the site.

Recommendations

The following recommendations will serve to either mitigate any impacts from the aforementioned risks, or provide sufficient monitoring to ensure actions can be taken prior to impacts occurring:

- The SWMP should be updated to accommodate proposed infrastructure and associated operating rules, monitoring and maintenance requirements.
- Flows from Carters catchment should be monitored, as planned.
- Discharges from Norilup Brook Dam should be monitored prior to and throughout expansion.
- Additional surface water sampling locations should be established at Clear Water Dam, TSF4, TSF4 toe drain, and Walgorup Creek.
- Continued annual ecology surveys should be undertaken to monitor water quality impacts on downstream receptors.
- A survey of landholders adjacent to Salt Water Gully and Hester Brook should be undertaken to understand existing and potential future water uses.
- An ESC Plan should be developed for the site to reconcile ESC sources, maintenance and treatment measures.

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Abbreviations

ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
AHD	Australian Height Datum
BoM	Bureau of Meteorology
CGP	Chemical Grade Plant
COPC	Contaminant of Potential Concern
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environment Regulation
ESC	Erosion and Sediment Control
GAMG	Global Advanced Metals Greenbushes
GDE	Groundwater Dependant Ecosystem
LIDAR	Light Detection and Ranging
MSA	Mine Services Area
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
SRS	Seepage Recovery Sump
SWG	Salt Water Gully
SWL	Surface Water Level
SWMP	Surface Water Management Plan
TGP	Technical Grade Plant
Talison	Talison Lithium Australia Pty Ltd
TSF	Tailings Storage Facility
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WA	Western Australia
WIR	Water Information Reporting
WRL	Waste Rock Landform

1. Introduction

1.1 Background

GHD is preparing environmental approval applications to support the proposed expansion of the Talison Lithium Australia Pty Ltd Greenbushes Lithium Mine (the Mine) to increase the production of spodumene ore and lithium mineral concentrate. A Mining Proposal and a Mine Closure Plan are required for the expanded operations by the Department of Mines, Industry Regulation and Safety (DMIRS), which should be prepared in accordance with their Mining Proposal (2016) and Mine Closure (2015) guidelines.

The Mining Proposal requires a surface water assessment to assess potential risks and impacts to surface water receiving environments associated with the expansion of the Mine.

1.2 Purpose of this report

This report presents the methodology and outcomes of the surface water assessment. This includes documentation of the baseline conditions of surface water at the site prior to expansion, and an assessment of potential impacts to environmental receptors from changes to surface water conditions due to the mine expansion. The report also provides recommendations for the monitoring and mitigation measures that will be necessary during and after the expansion with respect to changing surface water conditions.

1.3 Scope of work

The following tasks provide the scope of work for this surface water assessment:

- Acquisition and desktop review of data and information including meteorology, elevation, geology, land use, hydrogeology, hydrology, water quality and sediment.
- Surface water quality characterisation with respect to sensitive receptors and relevant assessment criteria to highlight trends, gaps and potential environmental impacts.
- Definition of current prevailing streamflow/stormwater discharge conditions from the site through an assessment of historical streamflow data.
- Flood risk assessment quantifying potential future streamflow/stormwater discharge conditions from the site based on changes to site catchment areas.
- Assessment of the surface water – groundwater interactions occurring at the site with reference to the hydrogeological assessment (GHD, 2018c).
- Identification of existing erosion and sediment control issues and the likely changes that could arise through implementation of the mine plan and the potential risks of these changes on the receiving environment.

1.4 Outline of the mine expansion

Talison Lithium Australia Pty Ltd (Talison) is proposing to expand the existing Greenbushes Lithium Mine, to increase the production of spodumene ore and lithium mineral concentrate from the operation. The mine is located in the Shire of Bridgetown – Greenbushes immediately south of the Greenbushes town site, approximately 250 km south of Perth and 80 km south east of Bunbury in Western Australia.

The Greenbushes region is recognised as the longest continuously operated mining area in WA, with mining of tin having commenced in 1888. Tin, tantalum and lithium mining have all occurred throughout the history of mining activity in the area. The current Greenbushes Lithium Mine has been operated as a modern open cut, hard rock operation on a continuous basis since 1983, with both tantalum and spodumene (lithium) ores being extracted and processed.

The expansion involves the:

- merging and expansion of three existing open pits,
- extension of the Floyds Waste Rock Landform (WRL),
- establishment of a new tailings storage facility to accommodate increased tailings production, and
- construction and operation of new infrastructure including:
  - a new Mine Services Area,
  - explosive facilities,
  - a new crushing circuit,
  - linear infrastructure including an access road,
  - two new spodumene processing plants, and
  - a tailings retreatment plant.

The mining rate will increase to an annual average of approximately 16 million bank cubic metres (Mbcm) as a result of the expansion and may reach up to 25 Mbcm. Processing of the ore is expected to produce approximately 2.8 million tonnes of lithium mineral concentrate per annum.

Talison is seeking environmental approval for the proposed expansion under Parts IV and V of the WA *Environmental Protection Act 1986*, the *Mining Act 1978*, and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

1.5 Scope and limitations

This report has been prepared by GHD for Talison Lithium Australia Pty Ltd and may only be used and relied on by Talison Lithium Australia Pty Ltd for the purpose agreed between GHD and the Talison Lithium Australia Pty Ltd as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Talison Lithium Australia Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Talison Lithium Australia Pty Ltd, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.6 Structure of the report

This report is structured to provide the following:

- **Section 2** - Overview of the proposed mining expansion and a high-level review of potential risks
- **Section 3 –** Overview of existing site characteristics
- **Section 4 –** Site hydrological assessment
- **Section 5** – Erosion and sedimentation assessment
- **Section 6** – Preliminary risk assessment
- **Section 7** – Conclusions and Recommendations

2. Summary of mine operations

2.1 Site setting and existing operations

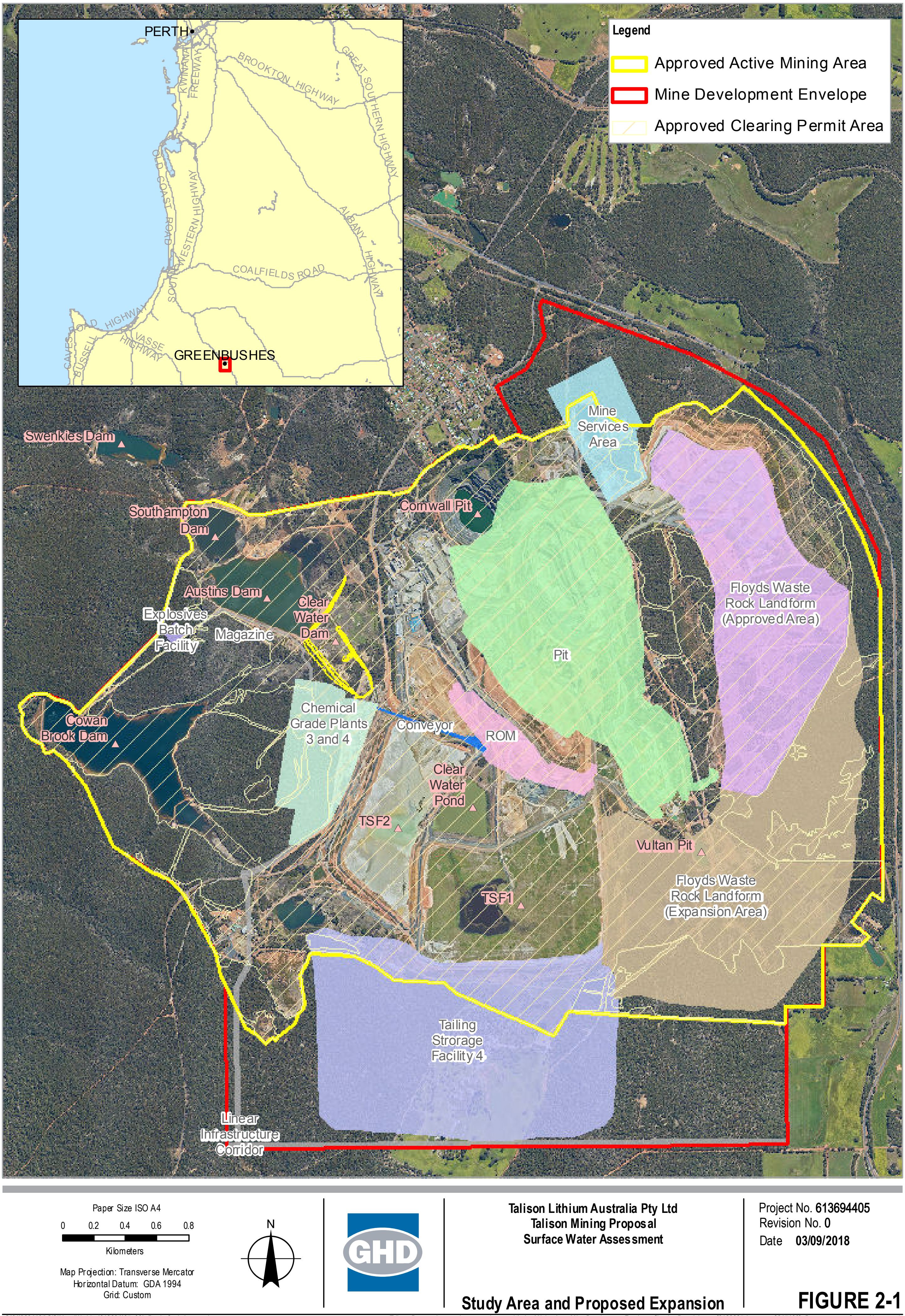
The mine area is located within the Shire of Bridgetown – Greenbushes immediately south of the Greenbushes town site, approximately 220 km south of Perth and 80 km south east of Bunbury, as shown in **Figure 2-1**.

The existing mining operation is situated on four mining tenements and two general purposes tenements held by Talison. The main ore body is orientated north-northwest to south-southeast and lies along a ridgeline that rises to approximately 300 m AHD. The method of extraction is open-pit using drill and blast, and load and haul that removes the hard rock and is subsequently crushed and processed. There are two lithium processing plants in use, a technical grade plant and chemical grade plant. Processed tailings are stored in two above ground tailings storage facilities (TSF1 and TSF2). Currently, TSF2 is the only tailings storage facility in use, with TSF1 inactive.

Waste rock from mining excavations is stored in the Floyds Waste Rock Landform (WRL), situated on the eastern boundary of the active mining area. Waste rock is also temporarily stored in the IP waste dump, prior to relocation to the Floyd's WRL. There has been progressive rehabilitation of the WRL over the duration of the mine's life and this is expected to continue up to and post closure.

The Cornwall Pit and Cornwall North Pit are operated by Global Advanced Metals Greenbushes (GAMG). The GAMG open pit and the underground operations are in care and maintenance, at the time of writing, with selected infrastructure utilised by Talison whilst tantalum mining operations are not active. Shared use of infrastructure by Talison and GAMG, inclusive of the water circuit infrastructure, is managed under a shared services agreement.

Talison operates the Site under DWER Licence L4247/1991/13, which stipulates conditions for the prevention, reduction or control of emissions and discharges to the environment, and associated monitoring and reporting requirements. Three amendments have been filed for this Licence, the most recent of which commenced on 12 March 2018 and expires 13 December 2026. This Licence is for Category 5 - *Processing or beneficiation of metallic or non-metallic ore*.



Talison Lithium Australia Pty Ltd
Talison Mining Proposal
Surface Water Assessment

Project No. 613694405
Revision No. 0
Date 03/09/2018

Study Area and Proposed Expansion

FIGURE 2-1

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Talison: Proposed expansion areas, Approved Active Mining Area, Mine Development Envelope, Clearing Permit Area - 20180625, Imagery - 20171002. Data source: . Created by: swoods

2.1.1 Existing site hydrology

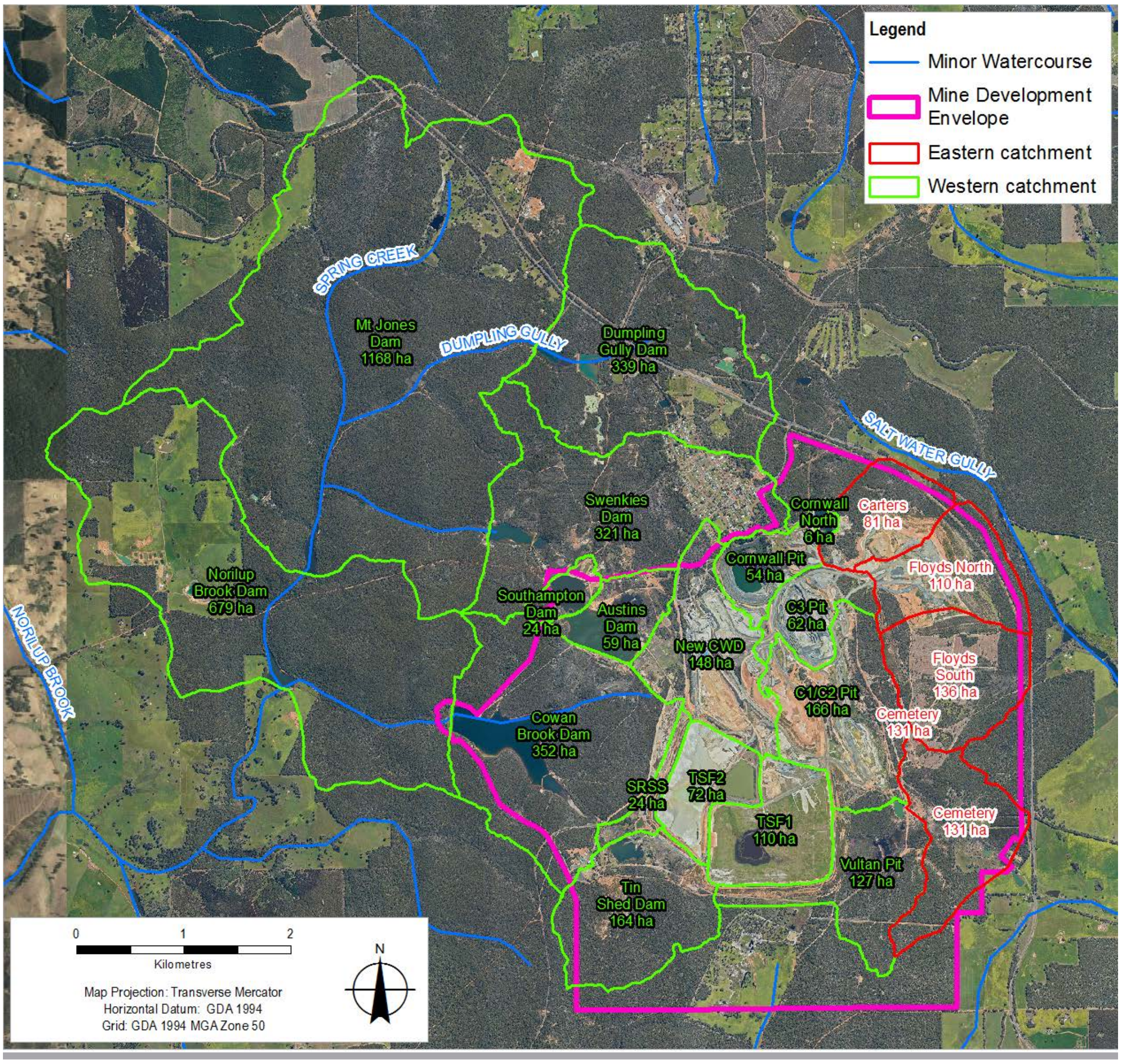
Rainwater falling within the mine water circuit that does not seep into the groundwater system or evaporate is directed into one of the onsite storages, and recycled within the mine water circuit as per the SWMP.

Figure 2-2 illustrates the extent of the existing site water circuit[1]. The circuit is split into two distinct areas by the Donnybrook-Bridgetown Shear zone ridgeline. For the purpose of this assessment these areas are referred to as the "western catchment", and "eastern catchment", as described below:

Western Catchment – Area west of ridgeline, located within Norilup Brook sub-catchment.

Eastern Catchment – Area east of ridgeline, contained within Hester Brook sub-catchment.

Water within the western catchment is not permitted to discharge via overflows. Any discharges that do occur will reach Norilup Dam, and from there into Norilup Brook. From the eastern catchment, water discharges directly into Salt Water Gully and then Hester Brook. Both the western and eastern catchments ultimately discharge into Blackwood River.



Data source: GHD: Catchments - 20180424; Talison: Imagery - 20171002, Active Mining Area - 20180625, Mine Development Envelope - 20180625; GA: Watercourse - 20060613.
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Figure 2-2 Existing catchment areas

[1] Catchment boundaries were delineated from June 2017 LIDAR data provided by Talison.

2.2 Proposed mine expansion

Talison is proposing to expand the mine to increase the production of spodumene ore and lithium mineral concentrate from the operation. The expansion will increase throughput at the Greenbushes operation from the current approved production rate of 4.7 Mtpa to 9.5 Mtpa of spodumene ore to produce up to 2.8 Mtpa of lithium mineral concentrate. Lithium mineral concentrates from the operation will continue to be transported to the Ports of Bunbury and Fremantle (limited volumes) for export as per current arrangements. The concentrates will also supply the Tianqi Lithium Process Plant under construction in Kwinana and the Albemarle Lithium Process Plant proposed for construction in the Kemerton Strategic Industrial Area north of Bunbury.

The approved boundary for the mining operation (Mine Development Envelope) will expand from the current 1,591 ha area to 1,989 ha, as shown in **Figure 2-1**. Approximately 68.5% of the Mine Development Envelope has already been disturbed as a result of the extensive history of mining within the area, as well as forestry, water storage and supply, surrounding agriculture activities and edge effects from the town of Greenbushes. The existing mining operation is located predominately within the Greenbushes State Forest (State Forest 20) with the surrounding region comprising the State Forest, agricultural properties, tree plantations and urban environment (Greenbushes town site).

The expansion will involve the merging and expansion of three existing open pits, extension of the Floyds waste rock landform, development of additional water catchment dams within the Floyd's waste rock landform catchment, establishment of a new tailings storage facility to accommodate increased tailings production, and construction and operation of new infrastructure including a new Mine Services Area, explosive storage facilities, a new crushing circuit and two new processing plants.

2.2.1 Changes to site hydrology

The site's hydrology is expected to perform similarly to that described in Section 2.1.1 as, although new pumps and drainage systems will be established, water will nonetheless continue to be managed and retained on site, with discharges only occurring from the eastern catchment. The following key changes to the overall circuit are nonetheless expected:

- The characteristics (rate, volume and quality) of water discharging from the eastern catchment and into Salt Water Gully;
- The quality of water within the western water circuit; and
- The quantity of water captured and retained within the site water circuit as a result of:
  - Additional harvesting and recycling of rainfall/runoff in TSF4 and the Mine Services Area (MSA);
  - Reduced infiltration within existing site catchment area due to establishment of additional hardstand areas, particularly within the CGP3 and CGP4 areas;
  - Dewatering of Cornwall Pit for mining purposes; and
  - Infill of waste rock into Vultan Pit.

2.3 Summary of potential surface water risks

Areas within and downstream of the mine operations may be impacted as a result of changes to the site's hydrology as described in the section prior. To this end, a high-level summary of potential hydrological risks is provided in the following sections. Further detail is provided in **Section 6** in the form of a preliminary risk assessment.

2.3.1 Water supply

The mine is supplied primarily by surface water from rainfall and run-off collected in various dams and sumps within the western water circuit. Groundwater is not abstracted, and the limited groundwater available is sourced from groundwater seepage into the pits.

Due to the mine's reliance on surface water and the expected increase in water demand and associated water losses (~10% of water drawn for processing is lost to evaporation/infiltration), the likelihood of discharges from the site is expected to reduce (GHD, 2017). However, there is a risk that water levels in existing dams may be drawn down to low levels to maintain process water supply which could impact local environments reliant on the dams.

It is also noted that the overall site catchment area will increase. Talison is investigating potential water storages to supplement mine water supply.

2.3.2 Surface water flow

The proposed mining operations may impact existing downstream environmental flows through reduction of discharge quantities from the eastern and southern boundaries. Discharge of surface water has been completely restricted from the western water circuit since the most recent Licence amendment conditions (March 2018) which do not permit discharges to occur from Southampton Dam, nor Cowan Brook Dam. A review of these conditions is expected post commissioning of the on-site water treatment plant. Reduced discharge has the potential to impact the ecological function of downstream environments.

2.3.3 Water quality

Contaminants of potential concern (CoPCs) identified for the Site include a number of metals and metalloids, pH, and salinity. Of these, the key parameters of concern include lithium and arsenic due to their historically high and increasing concentrations observed throughout the water circuit.

Runoff from the expanded WRL has the potential to impact the ecological function of downstream environments, particularly as a result of increased sediment loads and increased concentrations of CoPCs.

Stormwater within the western catchment will continue to be captured and retained within the western water circuit. No discharges from Southampton Dam and Cowan Brook Dam (i.e. from the western water circuit) are permitted, as specified by the current site Licence. As a result, water quality within the site water circuit may worsen due to the continued reuse of the water, and continued and accelerated liberation of CoPCs resulting from the increased mining rate. However, to reduce the key CoPCs (lithium and arsenic), Talison operates arsenic remediation units as required by the Site Licence, and is also installing a water treatment facility to reduce lithium concentrations within the water circuit. It is noted that a review of the no discharge condition from Cowan Brook Dam is expected post commissioning of the on-site water treatment plant.

The poor water quality that is likely to be present within the proposed TSF4 presents a risk due to potential seepage and/or spillage of water to downstream environments. The TSF4 will be designed to prevent and/or capture and return seepage, and accommodate significant storm events. It will also be operated to ensure suitable freeboard and contingency are available to accommodate significant storm events.

The relocation of reagents presents the risk of leakage or spillage during transportation. All chemicals and reagents will be handled and stored in accordance with existing site procedures, and according to the information provided on the products MSDSs. Site personnel will have access to safety equipment essential for the correct handling of chemicals and reagents, and be trained in safe handling and spillage clean-up procedures for the different chemicals and reagents. Similarly, explosives will be stored in a proposed dedicated magazine, and operated in accordance with Dangerous Goods regulations.

Ecology surveys are carried out annually to monitor any impact of water quality on downstream receptors as per Licence condition 4.1.1 in Licence L4247/1991/13. It is noted that Talison have begun investigating options to capture and return drainage from the eastern catchment primarily to supplement the mine's water supply, and to mitigate any impacts should they occur.

2.3.4 Erosion and sedimentation

Erosion and sedimentation from cleared areas, waste landforms and stockpiles within the site have the potential to:

- Accumulate sediments within water storage bodies leading to reduced water storage capacity and increased risk of overflows and/or water supply shortage;
- Accumulate sediments within downstream tributaries, leading to a change in streamflow conditions and/or an increase in turbidity that may impact existing ecological conditions; and
- Reduce structural integrity of landforms and increase risk of failure.

An erosion and sedimentation assessment has been prepared as a component of this Surface Water Assessment (refer **Section 5**).

3. Existing site characteristics

3.1 Climate

A meteorological station has been operated by Talison on the site since 2004. The station measures rainfall, wind speed and direction, temperature, solar radiation, barometric pressure and relative humidity. Data from the station have been provided from 1 January 2013 to 31 December 2017. Equipment at the station is serviced and calibrated to Compliance Monitoring Services, however are not NATA certified. To this end, data from this station have been compared with data from the Greenbushes Bureau of Meteorology (BoM) Station (Station 009552), extracted from the SILO Patched Point Dataset over the same period.

The on-site meteorological station exhibits ~180 mm less rainfall over a five year period compared to the SILO Dataset, however the average discrepancy is -0.1 mm, which is clearly illustrated in **Figure 3-1**. Both stations are therefore considered representative of the mine site.

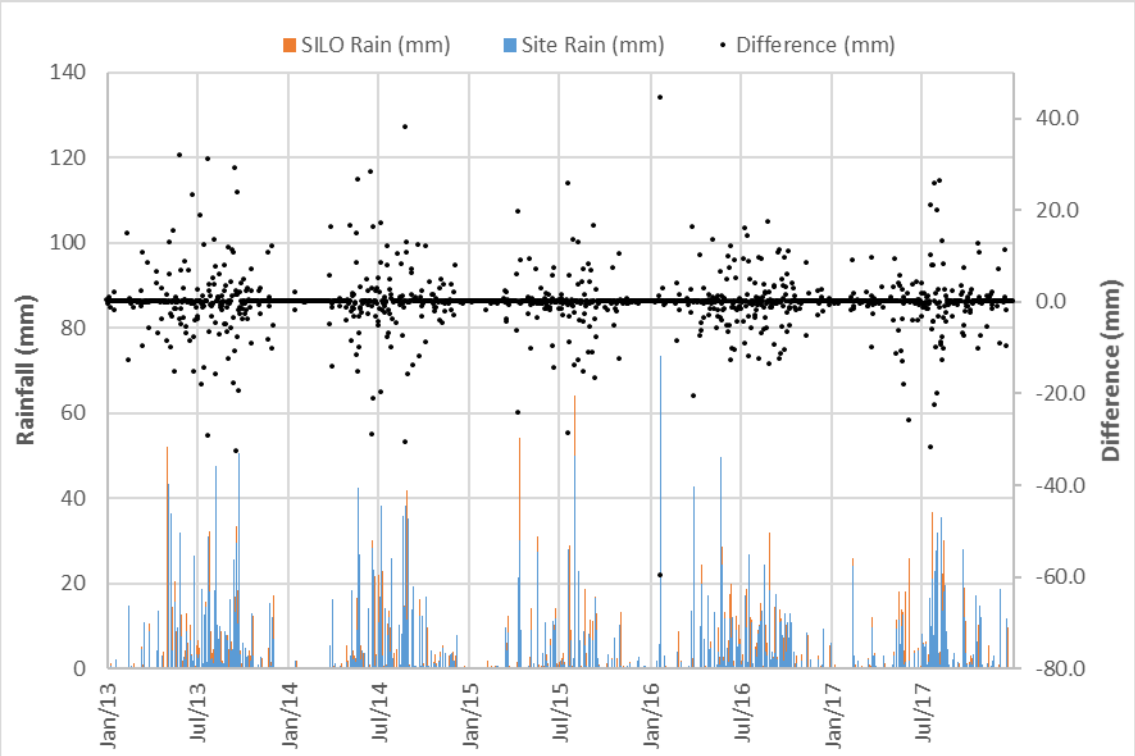

Figure 3-1 Meteorological station rainfall comparison

Data dating back to 1900 at the BoM Station (Station 009552) were extracted from the SILO Patched Point Dataset. A time series of historical annual rainfall data is depicted in **Figure 3-2**, and a summary of the rainfall and pan evaporation statistics provided in **Table 3-1**. These data show monthly variability in rainfall, temperature and pan evaporation, **Figure 3-3**.

The mean total annual rainfall for the period 1900 – 2017 is 926 mm, more than the mean total for the last 20 years of 813 mm. The majority of the rainfall occurs during winter, with the exception of some high rainfall events occurring as summer storms.

Table 3-1 Climate statistics for Station 9552 (1990 to 2017)

Statistic	Annual rainfall (mm)	Annual pan evaporation (mm)
Average (1900 – 2017)	926	1271
Average (1997 – 2017)	813	1276
Maximum	1687	1457
Minimum	472	1157

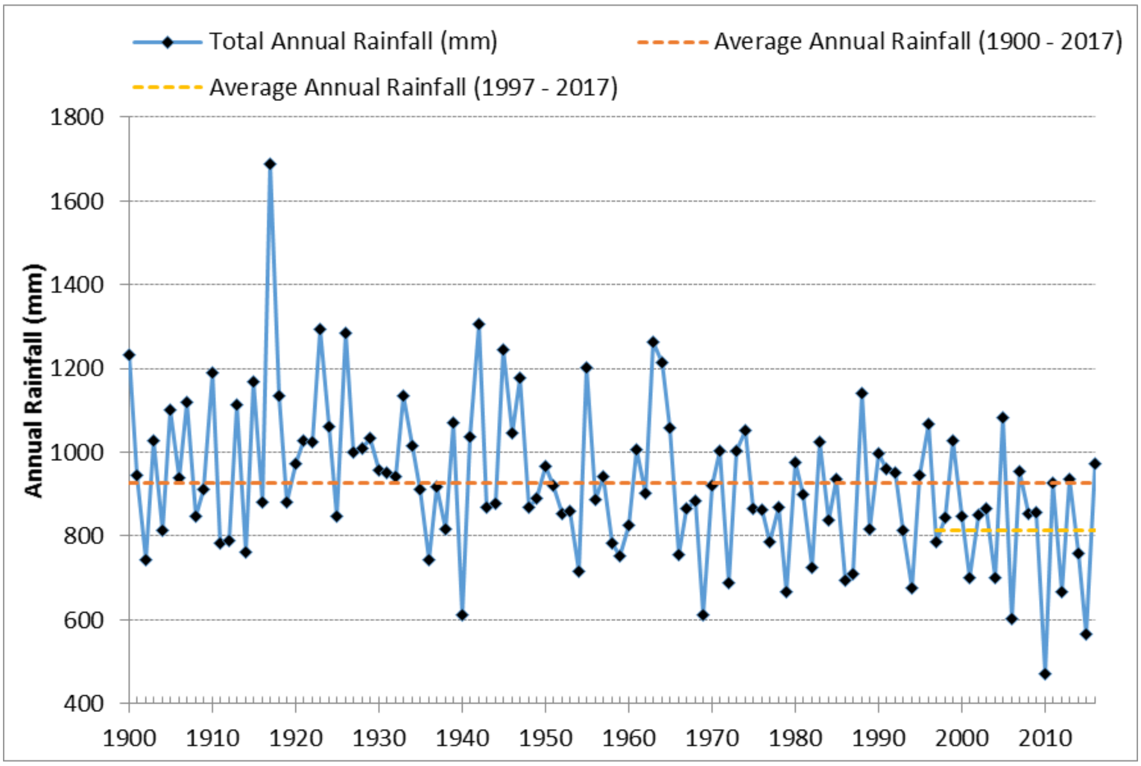

Figure 3-2 Annual rainfall data for Station 009552

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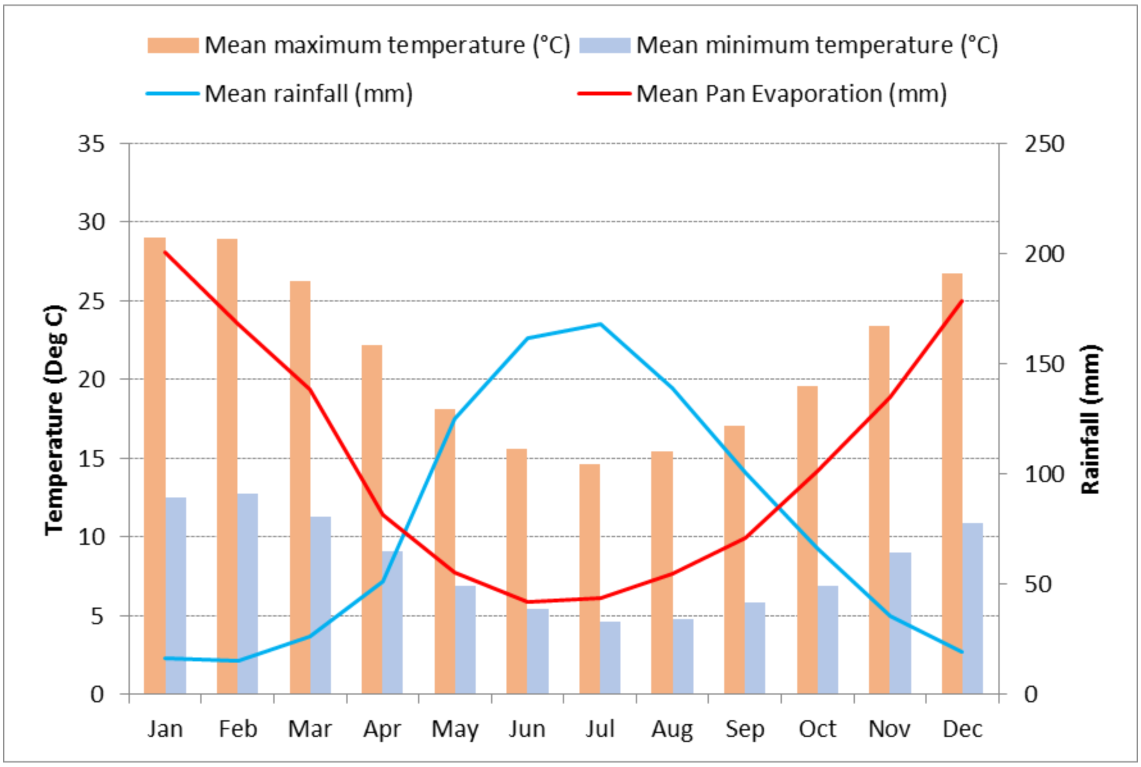


Figure 3-3 Greenbushes monthly climate data for Station 009552

3.2 Topography

The mine site is situated on the Darling Plateau at around 300 m AHD, **Figure 3-4**. A wide ridgeline crosses the mine site from the Greenbushes Town (~310 m AHD) towards the south-east (~270 m AHD), and intersects the open pits (~300 m AHD). Areas west of the ridgeline include the lithium processing plant area, TSFs, Cowan Brook Dam, Southampton Dam, and Austins Dam, which ultimately drain to Norilup Brook. East of the ridgeline includes the Floyds WRL ,which ultimately drain to Hester Brook. Site topography is captured in **Figure 3-4**.

3.3 Hydrology

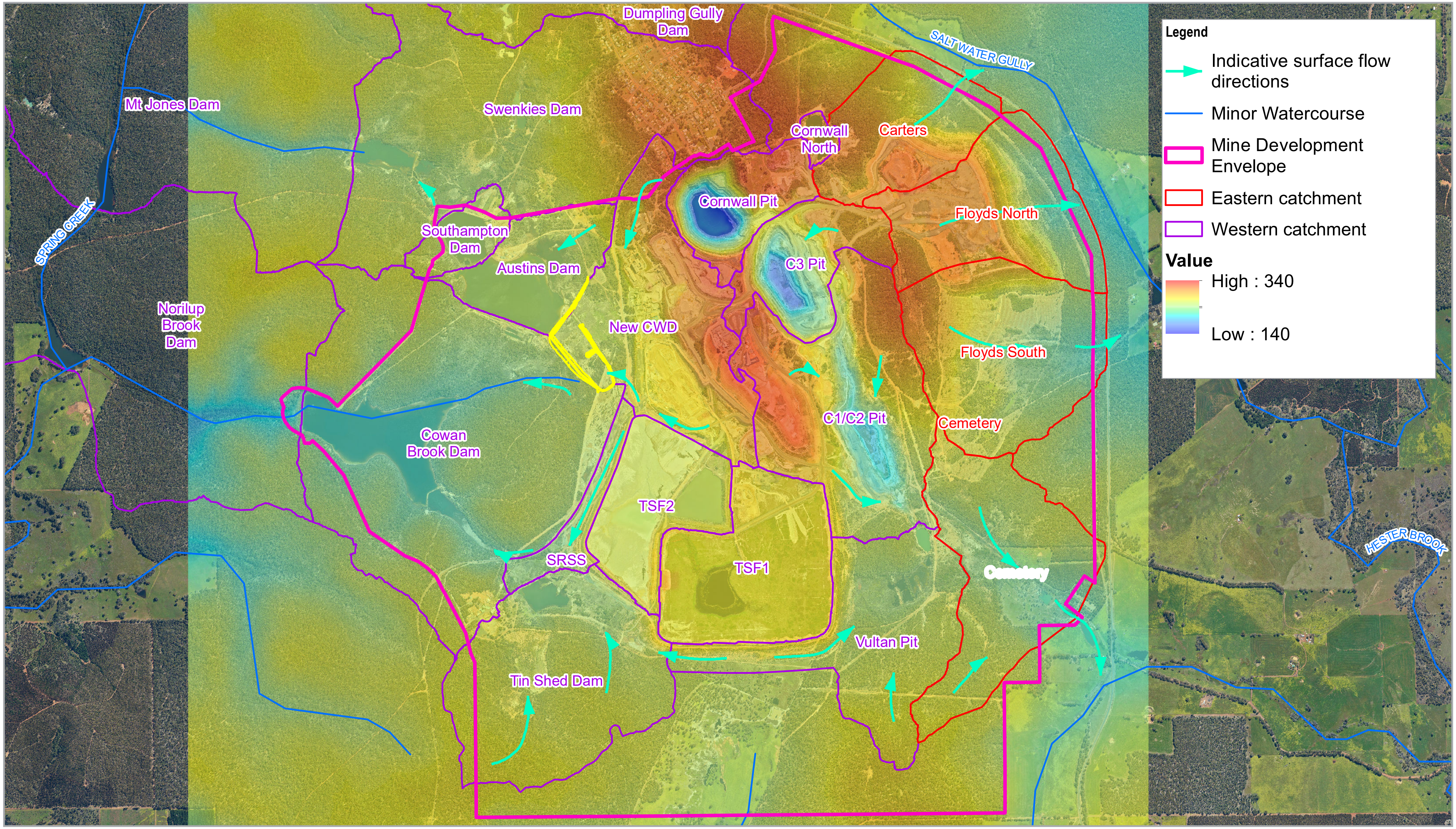
3.3.1 Catchment areas and drainage

The existing site catchment areas are illustrated in **Figure 2-2**. Catchments have been delineated based on available LIDAR[2] and survey data[3] (refer **Figure 3-4**), as well as publicly available 5 m contour data[4]. Catchments were reviewed against aerial imagery (October 2018) and realigned where necessary.

The total site catchment area is currently 18.2 km^2, with 75% of this contributing to Norilup Brook sub-catchment to the west, and 25% contributing to Hester Brook sub-catchment to the east. Both sub-catchments flow towards the Blackwood River which discharges to the Hardy Inlet in Augusta.

[2] LIDAR data obtained in June 2018.
[3] Survey data obtained in June 2017.
[4] Sourced from Landgate, November 2011.

The Blackwood River catchment is ~13, 720 km^2 of which the Norilup Brook and Hester Brook sub-catchment areas make up 0.4% and 1.4%, respectively, while the site catchment area makes up 0.1% of the total.



Paper Size ISO A4

0 0.25 0.5 0.75 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Talison Lithium Australia Pty Ltd
Mining Proposal
Surface Water Assessment

Project No.
Revision No. **0**
Date **06/02/2019**

Topography and Indicative Flow Directions

FIGURE 3-4

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Data source: GHD: Indicative Flow Directions - 20180903, Catchment Areas - 20180424, Topography - 20180621; GA - Watercourse - 20060613; Talison: Approved Active Mining Area - 20180625, Imagery - 20171002..
Created by: cahardie

3.3.2 Site water circuit

Runoff within the site western catchment area is currently directed into various storages within the mine and recirculated where possible within the processing system, in accordance with the mine's Surface Water Management Plan.

The current and proposed lithium process plants are located on the west side of the active pits. The lithium plant is supplied water from Southampton Dam and Clear Water Pond, with Clear Water Pond being the primary supply.

The open cut mine is situated at the top of the catchments feeding Norilup Brook and Hester Brook, and as it sits on the divide, it does not have a significant catchment. The open cut mine has the capacity to store any rainfall event.

The existing plant site has a sub-surface system of drains that directs storm water to concrete sumps where settling of solids occurs. Water is pumped back into the site water circuit from these sumps. Heavy rainfall results in overflows of the sumps to the new Clear Water Dam.

Water is stored in a series of dams and pit voids within the active mine site. During winter overflow periods, excess water within the western sub-catchment is directed towards the Cowan Brook Dam, which overflows to Norilup Brook and subsequently, the Blackwood River. Licence conditions (Improvement condition 4.1.1, IR5 of Table 4.1.1, Licence L4247/1991/13) specify that no overflows are to occur from Cowan Brook Dam and Southampton Dam.

No storages are currently located within the mines eastern sub-catchment.

As far as practicable, all water in the TSFs is pumped back to the Clear Water Pond (CWP) for reuse in mineral processing. Seepage from the TSFs is collected via toe drains and sumps for return to the process water circuit. This is applicable at the western and southern toe of TSF2, and the eastern and southern toe of TSF1.

Water levels and quality are monitored throughout the water circuit as discussed in **Section 4**. Existing volumes and site storage capacity totals approximately 5,200 ML excluding the pit voids, and is summarised in the following section.

3.3.3 Water storage characteristics

The water storage bodies are summarised in **Table 3-2**, and their locations indicated in **Figure 2-1**. Other minor water storages exist, but are not noted here, including the seepage recovery sumps and historic mining voids in the eastern sub-catchment. Cornwall Pit and Vultan Pit are currently being used as water storages.

Surface water levels within Cowan Brook Dam and Southampton dam are monitored as part of the SWMP. Water levels in the storages are managed through pump operating rules which are adapted to reflect changing requirements based on the mine development and natural rainfall.

Table 3-2 Surface Water Storage

Storage	Capacity (ML)	Catchment (km^2)
Austins Dam	1,066	2.1
Clear Water Dam	493	1.5
Cornwall Pit	1,000	0.5
Cowan Brook Dam	3,224	3.5
Mt Jones Dam	173	11.7

Storage	Capacity (ML)	Catchment (km^2)
Norilup Dam	128	6.8
Swenkies Dam	200	3.3
Southampton Dam	321	0.2
Tin Shed Dam	182	1.7
Vultan Pit	260	127.0
Total	**9,872**	**158.0**

3.4 Geology

The site area lies within the Archaean Yilgarn Craton. The Yilgarn craton extends from Wiluna in the north and coastal Western Australia in the south and forms 10% of the Australian continent. The Site is located on the Balingup Metamorphic Belt that of which is the southern portion of the Western Gneiss Province, one of the 4 divisions of the Yilgarn Craton.

The Greenbushes deposit consists of a main rare-metal zoned pegmatite with numerous smaller pegmatite dykes and pods footwall to the main body. The main pegmatite and its subsidiary dykes and pods are concentrated within shear zones on the boundaries of granofels, ultramafic schist and amphibolites. The pegmatite body is 3 km in length, up to 300 m wide, strikes north to north-west and dips moderately to steeply west/south-west (Talison, 2014).

3.5 Hydrogeology

Hydrogeological assessments completed by GHD in 2014 and 2018, identified the predominant underlying hydrogeology of the site, and inferred flow directions of shallow aquifers..

The hydrogeological setting is on Archaean host rocks which act as a low yielding groundwater resource. The dominant base flow below the site occurs within the Archaean host rocks which are comprised of leached clays and lateritic caprock before grading into bedrock at depth. Dolerite dykes, faulted geological contacts and faults within the aquifer have the potential to form preferential flow paths within the bedrock (GHD 2014).

A deep saprolitic aquifer underlies the bedrock aquifer which comprises of laterite and surface leached clays which grade into oxidised bedrock at further depth. This aquifer profile has slow water recovery due to the low hydraulic conductivity of the profile’s clays (GHD 2014). As such, groundwater is not abstracted from within the mine site operational boundary and therefore is not incorporated in the management of water use for the mine.

The shallow aquifer has largely been exploited for mineral and metal mining that has occurred through dredged sands (GHD 2014). The shallow aquifer is up to 20 m thick and is inferred as incised into the underlying deep aquifer layer. Geology of the shallow aquifer is variable across the site and has a combination of quartz-dominant sands closer to surface and silty and clayey sands further at depth. There are portions of the site as identified by borelogs that have a thin sand horizon present between the shallow and deep aquifers (GHD 2014).

Groundwater levels in the bedrock aquifer are not clearly delineated for flow direction or depth below ground level. Groundwater levels for the site from 1997 to present day present the range of RL 217.9 mAHD and RL 331.5 mAHD.

Section 4.6 describes interactions between surface water and groundwater.

4. Site hydrological assessment

4.1 Overview

The site hydrological assessment comprises four main activities:

- Determination of the baseline hydrology of Hester Brook, Blackwood River and Site contributions to these waterways;
- An assessment of the suitability of existing streamflow monitoring from the Site;
- An assessment of surface water – groundwater interactions occurring within and immediately beyond the Site boundary; and
- An assessment of flood risks based on changes to land-use and catchment areas.

4.2 Mine water supply

Reliance on rainfall and stormwater runoff as the primary supply source requires efficient management of water supply to maintain required volume and quality for processing and environmental requirements.

The latest water balance assessment (GHD 2018b) incorporates key changes of the proposed mine expansion, including:

- Increased production rates resulting from the new CGP3/4 plants;
- Retreatment of tailings from TSF1, and inclusion of new thickener;
- Inclusion of new storage infrastructure (TSF4);
- Mine pit and WRL expansions; and
- Catchment land use changes resulting from the above.

The model is based on a number of assumptions that aim to optimise water reuse within the mine water circuit. It also incorporates predicted make-up water from Mt Jones Dam.

The model indicates that whilst the overall site catchment area will increase, water management will need to remain an important performance indicator for the mine. Supply shortfalls are predicted to occur by 2025.

As a result, there is a risk that water levels in existing dams may be drawn down to low levels to maintain process water supply which could impact local environments reliant on the dams as well as immediate downstream environments.

4.3 Streamflow

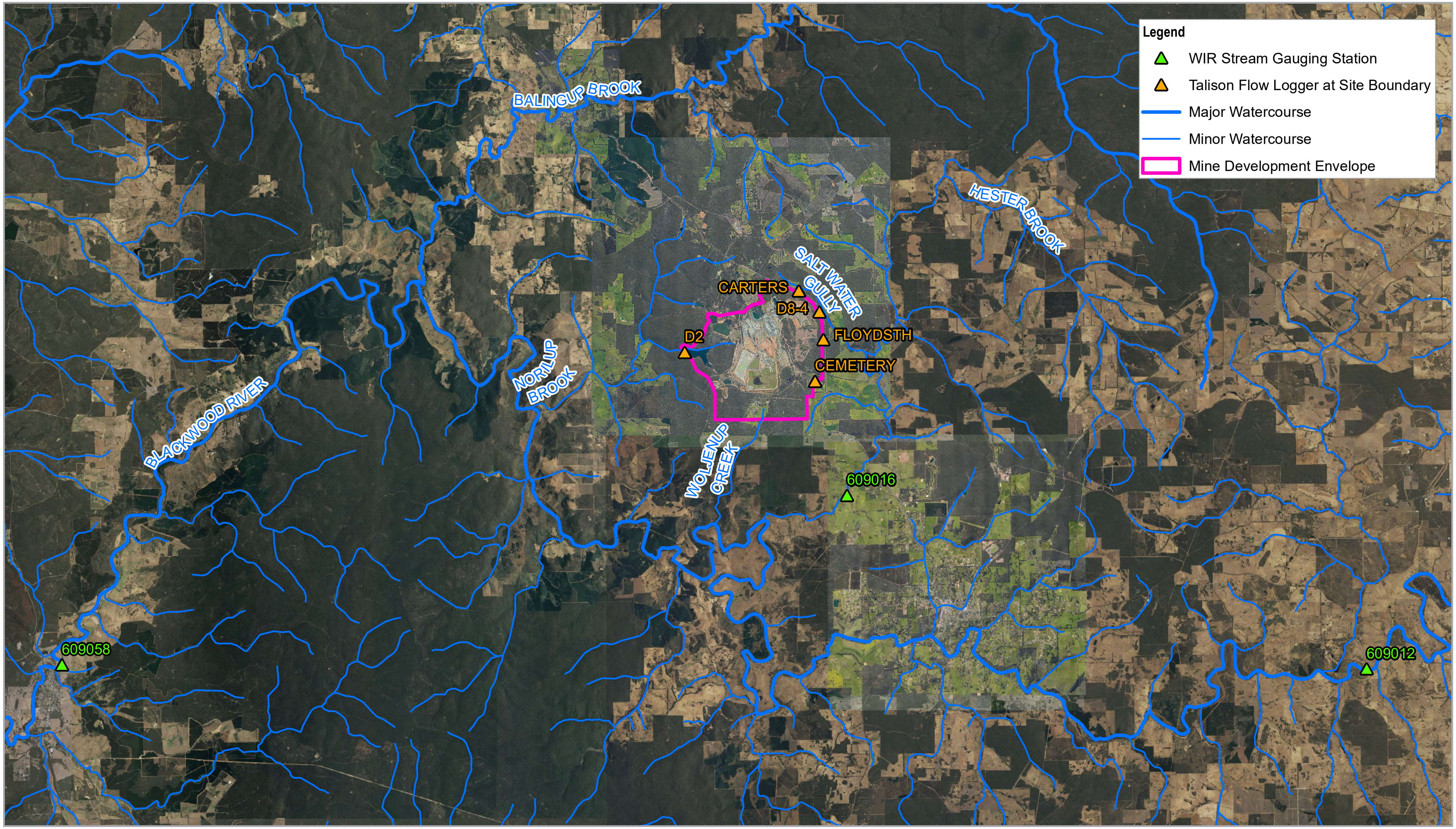
4.3.1 Existing monitoring

Continuous streamflow logging is undertaken by Talison at six locations within the mine water circuit, of which three are located at discharge points from the site's eastern boundary, and one from the site's western boundary at Cowan Brook Dam, as depicted in **Figure 4-1**.

Discharge from Cowan Brook Dam has not been permitted since the most recent Licence amendment (12 March 2018), and no discharges have occurred during this period, and as such data from this dam are not analysed further.

Data from the three gauging stations on the eastern boundary have been collated and analysed to describe prevailing streamflow conditions discharging from the Site's eastern boundary. These data were analysed against data from the nearest streamflow gauging stations both upstream and downstream of the Site obtained from DWER's Water Information Reporting (WIR) database.

A new gauging station "Carters" is proposed to be installed by Talison to monitor flows leaving the northern end of the WRL and into Salt Water Gully. This monitoring station will result in the capture of all streamflow discharging from the Site's eastern boundary.



1:200,000 at ISO A4

0 1.5 3 6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Talison Lithium Pty Ltd
Talison Mining Proposal
Surface Water Assessment

Surface Water Flow Gauging Stations

Project No. **613694405**
Revision No. **0**
Date **22/01/2019**

FIGURE 4-1

G:\61\3694405\GIS\Maps\Working\6135774_006_Fig4-1_RevA_GaugingStations_A4Landscape.mxd
Print date: 22 Jan 2019 - 12:24

Data source: Talison: Talison Monitoring Sites - 20180406, DWER: WIR Stations - 20180409; Imagery - 20171002; GA: Watercourse - 20060613 . Created by: cahardie

4.3.2 Analysis

The annual average flows from each relevant gauging station are provided in **Table 4-1**. The contribution of streamflow from Norilup Brook to Blackwood River is also provided in this table, which has been calculated via a rainfall-runoff model which yielded a mean annual flow of 7.2 GL (Talison, 2015).

Figure 4-2 to **Figure 4-7** depict the daily volume (blue) and flow duration curves (pink) for the above gauging stations.

The flows in Blackwood River are an order of magnitude greater than Hester Brook, two orders of magnitude greater than Norilup Brook, and three magnitudes greater than the likely total flows discharging from the site's eastern boundary (assuming discharge from Carters catchment is of a similar order of magnitude to Floyds North).

Hester Brook and Blackwood River flow perennially. Floyds North also exhibits perennial flows, which is likely attributable to the increased water holding capacity of the WRL within Floyds North, and subsequent slow release of water as base flow throughout the year. Cemetery Dam and Floyds South only flow seasonally.

The Floyds North catchment demonstrates significantly greater flows than that of the Floyds South catchment, despite their similar catchment areas. This observation is discussed in further detail as part of the flood risk assessment in **Section 4.4**.

Table 4-1 Flow gauging stations

Name	Station ID	Data Source	Location	Easting (m)	Northing (m)	Data range	Average Annual Flow (GL)
Winnejup	609012	WIR	Blackwood River, upstream, ~24 km southeast of site	436639	6239848	22/05/1980 – 03/07/2018	236.1
Hester Hill	609016	WIR	Hester Brook, downstream, ~4 km southeast of site	416589	6246548	28/03/1983 – 01/08/2005	19.6
Caravan Park	609058	WIR	Blackwood River, downstream, ~28 km southwest of site	386290	6240012	12/06/2001 – 07/07/2018	283.8
N/A (Simulation)	N/A (Simulation)	N/A	Norilup Brook, discharge into Blackwood River	N/A	N/A	N/A	7.2
Floyds North	D8-4	Talison	Site boundary – discharge from Floyds North (into Salt Water Gully)	415529	6253631	31/05/2013 – 01/04/2018	0.2
Floyds South	FLOYDSTH	Talison	Site boundary – discharge from Floyds South (into Salt Water Gully)	415677	6252552	31/05/2013 – 01/04/2018	0.02
Cemetery Dam	CEMETERY	Talison	Site boundary –discharge from Cemetery catchment (into Hester Brook)	415347	6250952	04/06/2017 – 30/06/2018	0.07

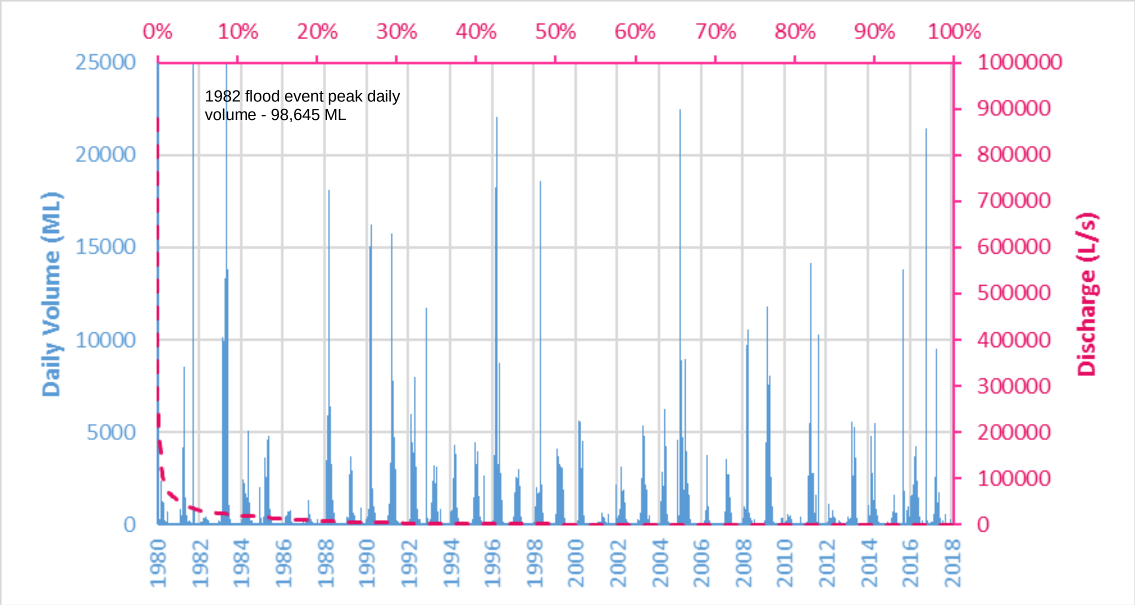


Figure 4-2 Blackwood River upstream streamflow (609012)

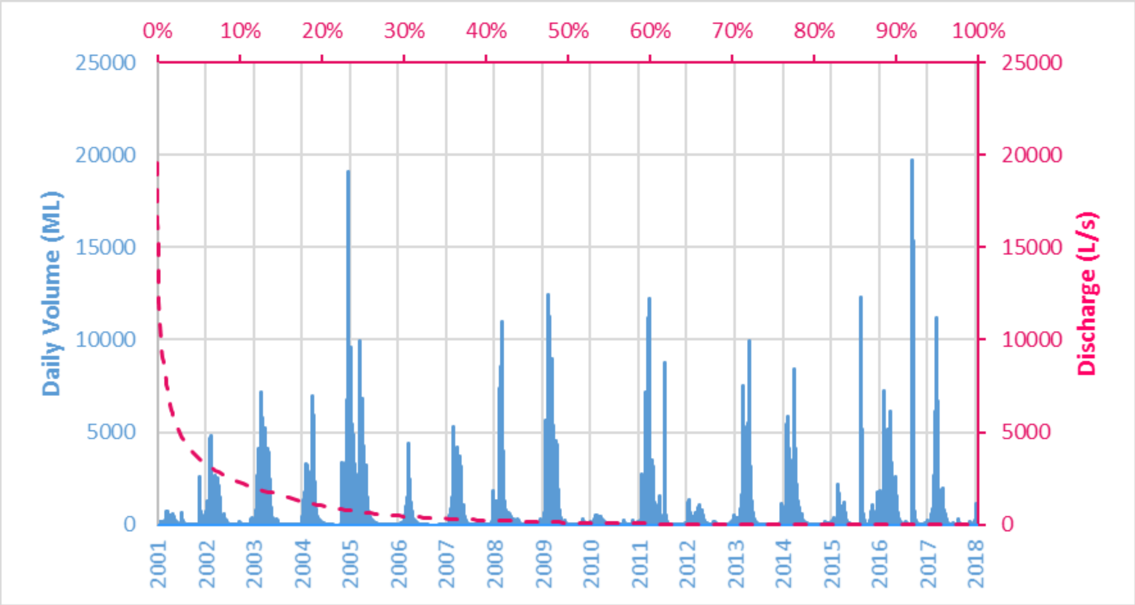


Figure 4-3 Blackwood River downstream streamflow (609053)

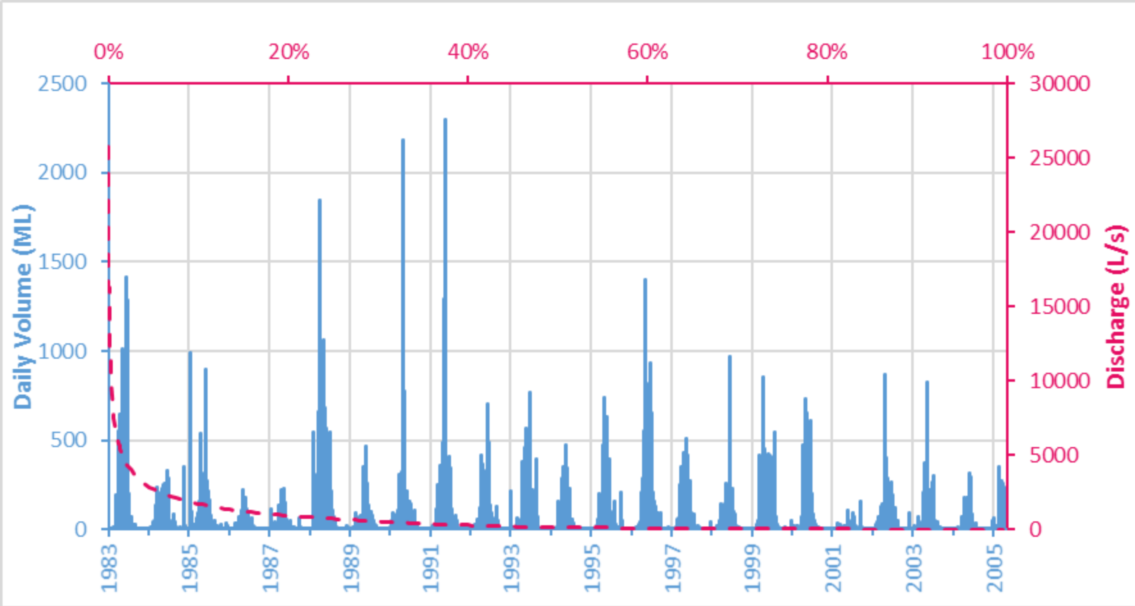


Figure 4-4 Hester Brook downstream streamflow (609016)

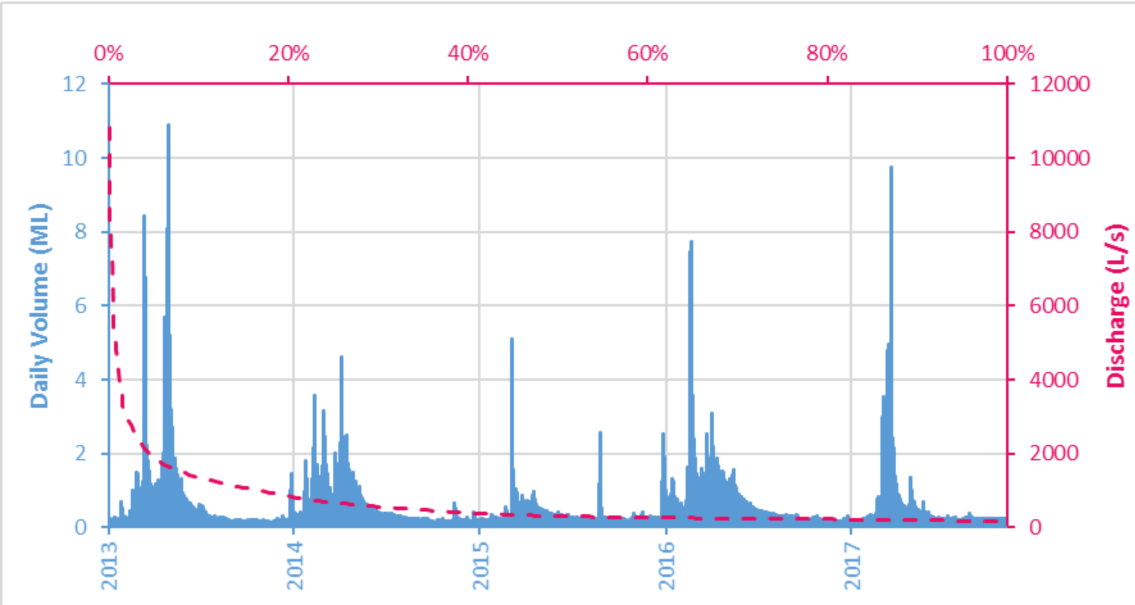


Figure 4-5 Floyds North streamflow (D8-4)

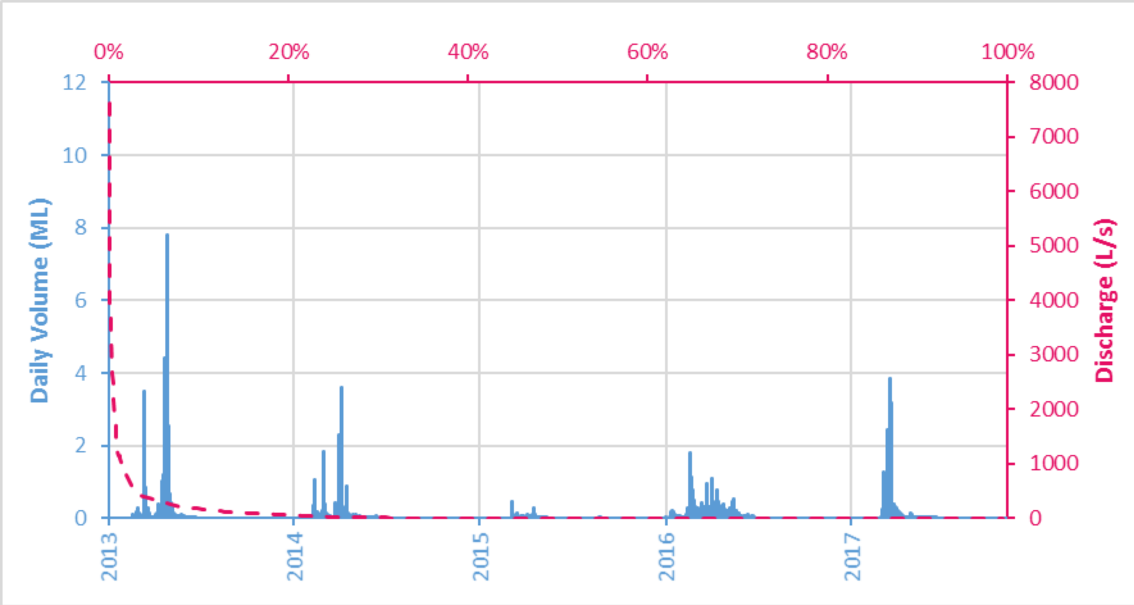


Figure 4-6 Floyds South streamflow (FLOYDSTH)

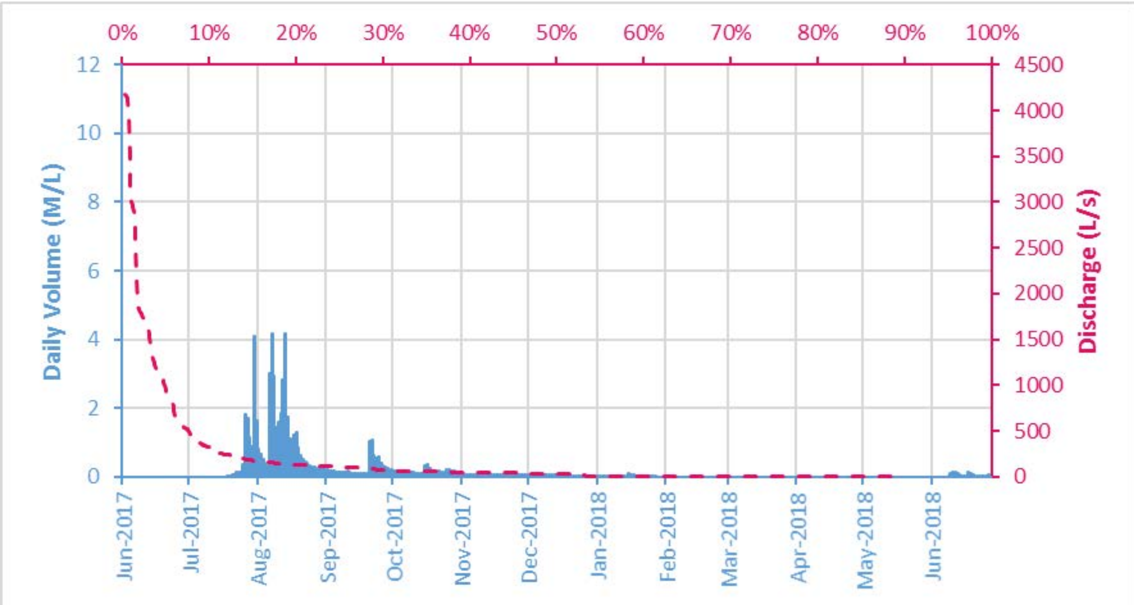


Figure 4-7 Cemetery streamflow (CEMETERY)

4.3.3 Streamflow monitoring recommendations

With consideration to the existing monitoring and subsequent analysis discussed in sections above, and with the likely changes resulting from the mine expansion, the following streamflow monitoring recommendations are proposed to better understand changes that may occur from the expansion, and allow for appropriate action to be taken should streamflow changes cause significant disruption to existing downstream environments:

- Any uncontrolled overflows from Southampton Dam and Cowan Brook Dam should continue to be monitored and reported as required by Licence conditions.
- Monitoring of discharges from Norilup Brook Dam should be undertaken prior to the expansion and continued throughout the expansion to understand changes in downstream flow conditions.
- Monitoring of flows from the Carters catchment should proceed as planned.

- Continued annual ecological surveys.

Furthermore, further investigation/characterisation of previous mine workings in the Floyds South sub-catchment may provide a better understanding of the low streamflows observed at Floyds South.

4.4 Flood risk assessment

4.4.1 Overview

Of the key changes to the mine water circuit resulting from the mine expansion described in **Section 2.2**, the only area in which changes to flow conditions may present a risk to downstream environments beyond the mine tenement is from the eastern catchment as a result of the WRL expansion.

The land use in the Floyds South and Cemetery catchments will change over time as the WRL progresses. Specifically, the land use in these catchments will evolve from being similar to that currently seen in Floyds South (i.e. predominantly regrowth on a disturbed mining area) to that currently seen in the Floyds North catchment (i.e. predominantly waste rock). Although further dumping will occur in the Floyds North catchment, the land use is unlikely to change significantly (albeit the soil/rock water storage capacity may increase).

Typically, the porous nature of a WRL allows for increased storage capacity and hence will act to mitigate streamflow during storm events so it is unlikely that the WRL will increase flood risk. However, available streamflow monitoring data from Floyds North (predominantly waste rock) and Floyds South (predominantly regrowth on a disturbed mining area), suggests that the WRL may result in increased streamflows (refer **Section 4.3.2**). As such, a high-level analysis of the potential change in streamflow conditions from the eastern catchment into Hester Brook has been undertaken.

It is noted that this flood risk assessment assumes that:

- Existing and proposed drainage systems and water storages on site are designed to accommodate the required design storm event; and
- Dam break flood analysis of any new storages will be conducted separately to this assessment.

4.4.2 Changes to catchment areas and drainage

At its largest, the total catchment area contributing to the site (including areas external to the Mine) will have increased by ~559 ha, to a total 4437 ha. Existing catchment areas are depicted in **Figure 3-4**, while the expected catchment areas upon completion of the expansion are shown in **Figure 4-8**. Harvesting and reuse of rainfall and runoff into the TSF4 and MSA are the key changes resulting in the aforementioned increase.

Furthermore, the following factors are also expected to increase the overall water harvesting capacity of the site:

- Reduced infiltration from hardstand areas at the proposed MSA and CGP3/4 areas; and
- Increased harvesting of groundwater within the Pit from 7 L/s to 25 L/s by 2028, as determined by the mine dewatering assessment (GHD 2018d).

Waste rock deposition and progression of the WRL will not change catchment areas reporting to the east of the dump since, although runoff will be retained on the dump, seepage and discharge through the dump will be according to the natural underlying catchments (i.e. catchment areas remain, but hydrology changes).

Table 4-2 compares the notable catchment area changes from existing conditions to those on completion of the mine expansion. The internal catchments of the various sumps within the CGP1/2 production areas have been incorporated as part of the new CWD catchment in this table.

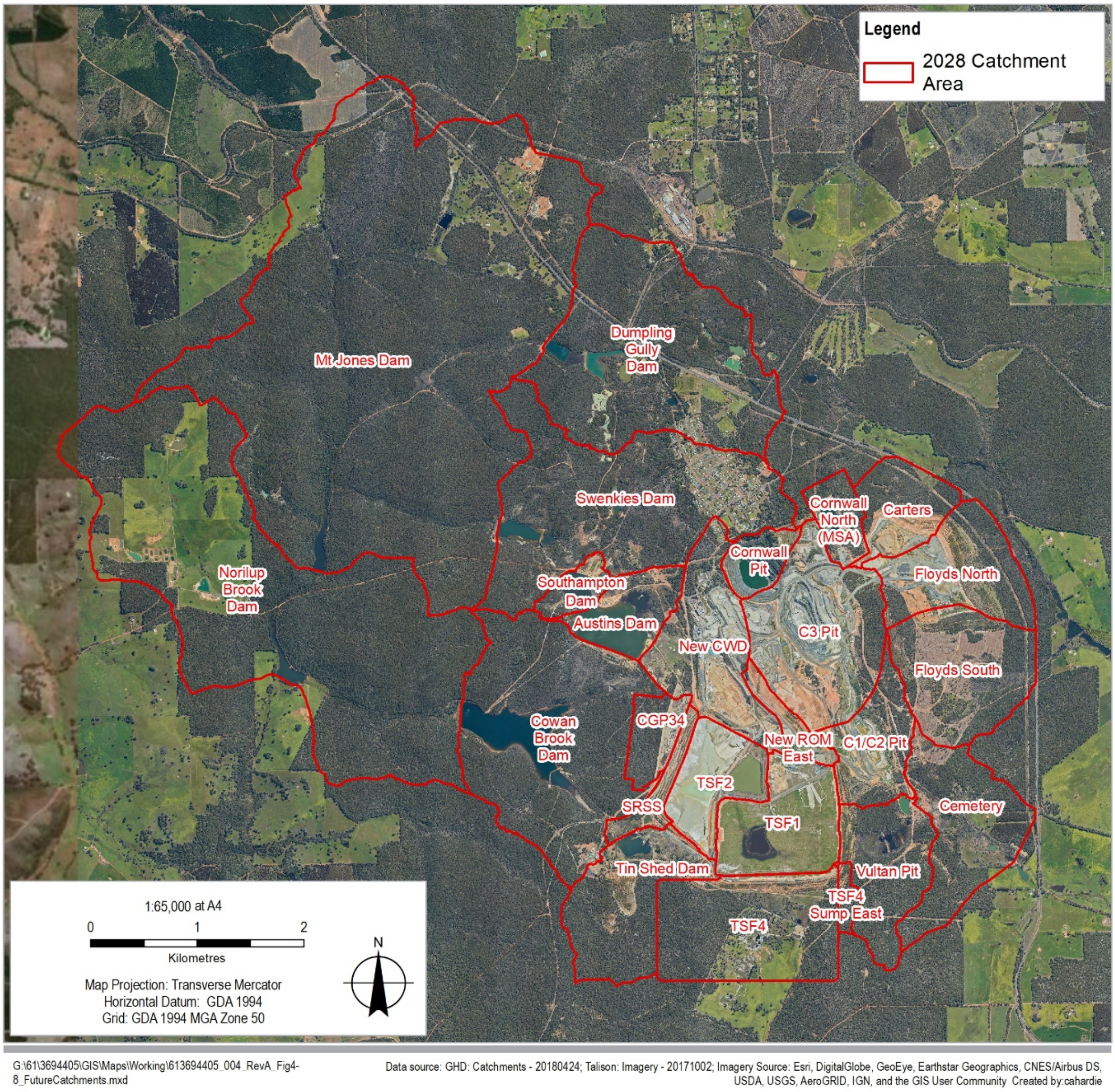


Figure 4-8 Catchment areas after mine expansion

Table 4-2 Key catchment area changes

Storage	Existing catchment area contributing to site (ha)	Catchment area on completion of mine expansion (ha)
C1/C2 Pit	166	75
C3 Pit	62	178
Carters (FS1)	0	81
Cemetery (FS4)	0	131
CGP3/4	0	36
Cornwall Pit	54	31
Cowan Brook Dam	352	317
Floyds North	0	110
Floyds South	0	136
CWD	133	126
CGP3 ROM	0	23
Tin Shed Dam	154	113
TSF4	0	167
TSF4 Sump East	0	10
Vultan Pit	127	97
Total (above catchments only)	1057	1626
Total (all catchments, including pits)	**3879**	**4437**

4.4.3 Streamflow analysis

Waste rock deposition and progression of the WRL will not change catchment areas reporting to the east of the dump since, although runoff will be retained on the landform, seepage and discharge through the landform will be according to the natural underlying catchments (i.e. catchment areas remain, but hydrology changes).

To this end, the streamflow assessment in **Section 4.3.2** has been extrapolated to reflect the aforementioned landuse changes and consistent catchment areas, as shown in **Table 4-3**. This table summarises key annual streamflow statistics[5] from the eastern catchment and the nearest downstream Hester Brook gauging station catchment.

[5] From available full calendar years, with the exception of Cemetery Dam in which only ~10 months of data is available

The streamflows from the Floyds South and Cemetery catchments are calculated based on the rainfall-runoff efficiency of the Floyds North catchment to provide an indication of streamflow conditions from these catchments when the WRL is complete. This analysis therefore assumes that the existing Floyds North catchment is representative of the completed WRL conditions within the Floyds South and Cemetery catchments.

Table 4-3 indicates that the percentage contribution of the three catchments both individually and combined upon completion of the WRL is likely to be negligible (up to 3.7% of total Hester Brook flows) compared to the Hester Brook catchment streamflow at the nearest gauging station.

Table 4-3 Streamflow statistical comparison

Catchment	Existing Conditions							Adopting Floyds North Rainfall-runoff efficiency	
	Catchment Area (ha)	Period Analysed	Ave Annual Rainfall (mm)	Ave Total Annual Runoff (m^3)	Ave Total Annual Runoff (mm)	Rainfall-runoff Efficiency	% of Hester Brook Contribution	Ave Total Annual Runoff (m^3)	% of Hester Brook Contribution
Floyds North	110	01/01/2014 - 31/12/2017	771	213,101	193.7	25.13%	1.092%	213,101	1.09%
Floyds South	136	01/01/2014 - 31/12/2017	771	23,199	17.1	2.21%	0.119%	263,270	1.35%
Cemetery Dam	131	04/06/2017 - 30/06/2018	771	170	0.1	0.02%	0.001%	253,812	1.30%
Eastern Catchments Combined (Excl. Carters)	377	01/01/2014 - 31/12/2017	771	N/A	N/A	N/A	N/A	730,183	3.74%
Hester Brook (Station 609016)	17,644	01/01/1984 - 31/12/2004	866	19,519,554	110.6	12.8%	100.0%	N/A	N/A

4.4.4 Conclusion

Although historical streamflow conditions suggest that the WRL results in increased base and peak flows, it is anticipated that the change to the overall contribution to Hester Brook will be negligible as a result of:

- The total area of the eastern catchment remaining unchanged; and
- The inherent porous nature of the WRL which will allow for greater water storage capacity and hence mitigate any peak flow events.

4.5 Surface water quality characterisation

4.5.1 Adopted trigger values and limits

Licence conditions

The current operating Licence for the Site is the DWER Licence L4247/1991/13, held by Talison. Three amendments have been filed for this Licence, the most recent of which commenced on 12 March 2018 and expires 13 December 2026. This Licence is of Category 5 - *Processing or beneficiation of metallic or non-metallic ore*.

Ambient surface water quality monitoring locations specified in the Licence include Austins Dam, Cowan Brook Dam, Norilup Dam and Southampton Dam, and their locations are depicted in **Figure 4-9**. The ambient surface water quality limits as stipulated in the Licence predominantly apply to Norilup Dam, with limits for pH also specified at Austins, Cowan Brook, and Southampton Dams, as summarised in **Table 4-4**.

Table 4-4 Ambient surface water quality limits (Table 3.4.2: L4247/1991/13)

Monitoring location	Parameter	Unit	Limit	Comments
Norilup Dam	Arsenic	mg/L	0.01	-
	Cadmium	mg/L	0.002	-
	Chromium (VI)	mg/L	0.05	-
	Copper	mg/L	2	-
	Lithium	mg/L	7	2015/2016 & 2016/2017 reporting period
			5	2017/2018 – 2019/2020 reporting periods
			3	2020/2021 – 2021/2022 reporting periods
			2	2022/2023 – 2025/2026 reporting periods
	Manganese	mg/L	0.5	-
	Nickel	mg/L	0.02	-
	Uranium	mg/L	0.017	-
Norilup Dam Southampton Dam Austins Dam Cowan Brook Dam	pH	pH units	6-9	-

Guideline Trigger Values

The following additional surface water quality parameters have been identified as potential contaminants of concern from point source emissions, and require monitoring as part of the site's Licence:

- pH;
- Salinity;
- Lithium;
- Arsenic;
- Cadmium;
- Chromium;
- Copper;
- Manganese;
- Nickel; and
- Uranium.

In addition to these, sulfate and nitrates are also considered as part of this assessment as sulfates are an indicator of tailings/process water and nitrates are also an indicator of mine activities (possible explosive residue).

These parameters and their associated guideline trigger values are summarised in **Table 4-5**. The following guidelines are considered applicable to downstream receptors from the Site:

- The *Australian Drinking Water Guidelines* (NHMRC, HRMMC, 2011) which is a health and aesthetic guideline for:
  - NHMRC Health guideline values (hereafter referred to as '*ADWG 2011 Health'); and*
  - NHMRC Recreational Guidelines (hereafter referred to as '*ADWG 2011 Aesthetic');*
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (NWQMS, 2010) for:
  - Agricultural irrigation water for long-term use (hereafter referred to as '*ANZECC 2000 LT Irrigation'*);
  - Slightly to moderately disturbed freshwater eco-systems for a 95% level of protection (hereafter referred to as '*ANZECC 2000 FW 95%'*); and
  - Agriculture Livestock drinking water quality (hereafter referred to as '*ANZECC 2000 Livestock'*)

Due to the potential for multiple trigger values being present, where the guidelines or Licence present two or more varying concentration levels, the lowest value has been nominated as the adopted trigger value.

Table 4-5 Guideline Trigger Values

Analyte	Unit	ANZECC (2000) Long Term Irrigation	ANZECC (2000) Livestock	ANZECC (2000) Fresh Water 95%	ADWG (2011) Health	ADWG (2011) Aesthetic
Arsenic	mg/L	0.1	0.5-5	13-24	0.01	-
Cadmium	mg/L	0.01	0.01	0.2	0.002	-
Chromium CR (VI)	mg/L	0.1	1	1	0.05	-
Copper	mg/L	0.2	0.4-5	1.4	2	1
Lithium	mg/L	2.5	-	-	-	-
Manganese	mg/L	0.1	-	1900	0.05	0.1
Nickel	mg/L	0.2	1	11	0.2	-
Nitrate	mg/L	-	400 - 1500	700	50	-
Sulfate	mg/L	-	1000-2000	-	500	250
Total Dissolved Solids (TDS)	mg/L	1000-2000	2000-5000	-	-	600
Uranium	mg/L	0.01	0.2	-	0.017	-

4.5.1 Existing water quality monitoring

Surface water quality is monitored at 60 surface water sites, a subset of which is reported to the DWER as part of the site's Licence conditions. Talison submit a review of impacts of the mining operation on the hydrology of the Greenbushes area to DWER, DBCA and DMIRS through an Annual Environmental Report.

Table 4-6 and **Table 4-7** summarise the offsite monitoring stations (beyond the proposed expanded development area), and onsite locations, respectively. **Figure 4-9** illustrates the locations of these stations and highlights the locations specified as part of licence monitoring requirements.

The monitoring frequency at each location varies from weekly, six-monthly, to quarterly, with the Licence conditions stipulating six-monthly to quarterly monitoring for the various parameters in **Table 4-4**.

Table 4-6 Offsite surface water sampling locations

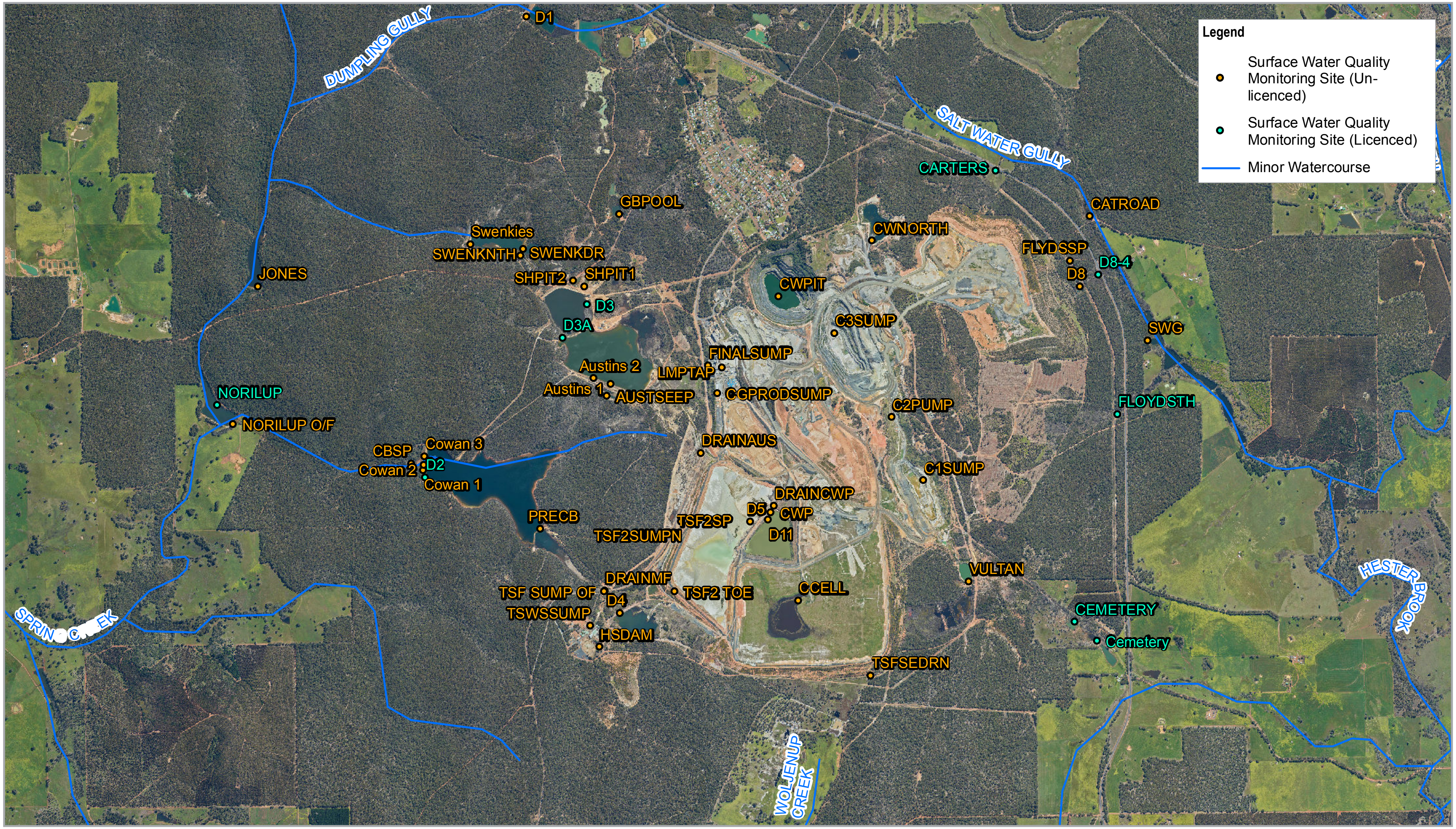
Location ID	Location	Easting	Northing	First sample date	Latest sample date	Number of samples
BLACKWD	Blackwood River downstream	404,263	6,252,614	2002	2018	121
BLKWDBT	Blackwood River upstream	419,978	6,240,976	2015	2018	32
BLKWDSH	Blackwood River between Norilup & Hester Brook	404,138	6,247,913	2015	2018	32
CARTERS	Carters	414,734	6,254,432	1997	2017	61
CATROAD	Salt Water Gully	415,463	6,254,081	1997	2018	70
CEMETERY	Cemetary	415,347	6,250,952	2006	2008	62
D1	Dumpling Gully	411,113	6,255,623	1997	2018	140
D8	Floyds North	415,388	6,253,541	1997	2018	270
D8-4	Floyds North	415,529	6,253,631	1999	2018	163
FLOYDSTH	Floyds South	415,678	6,252,553	2012	2017	30
FLYDSSP	Floyds North	415,310	6,253,738	2009	2018	26
GBPOOL	GB Pool	411,832	6,254,098	2006	2018	49
HESTER	Hester Brook	417,334	6,247,869	2005	2018	58
JONES	Mt Jones	409,039	6,253,538	1998	2018	82
NORILUP	Norilup	408,727	6,252,624	1998	2018	579

Location ID	Location	Easting	Northing	First sample date	Latest sample date	Number of samples
NORILUP SH RD	Norilup Brook Downstream	406,680	6,251,308	2009	2017	128
PRE NORILLUP	Norilup Upstream	409,084	6,252,379	2009	2015	138
SWENKDR	Swenkes Drain	411,068	6,253,775	2014	2018	40
Swenkies	Swenkes	410,681	6,253,864	1998	2018	233
SWENKNTH	Swenkes	411,090	6,253,826	2014	2018	41
SWG	Salt Water Gully	415,912	6,253,122	1997	2018	224

Table 4-7 Onsite surface water sampling locations

Location ID	Location	Easting	Northing	First sample date	Latest sample date	Number of samples
C1SUMP	C1	414,178	6,252,045	2012	2018	69
C2PUMP	C2	413,933	6,252,532	2006	2018	135
C3SUMP	C3	413,494	6,253,180	1997	2018	171
CBSP	Cowan West	410,227	6,252,174	2002	2017	56
CCELL	TSF1	413,214	6,251,117	1997	2017	173
CGPRODSUMP	CG1	412,586	6,252,717	2012	2018	59
CWNORTH	Cornwall Pit East	413,781	6,253,893	2004	2018	154
CWP	CWP	413,001	6,251,796	1997	2018	609
CWPIT	Cornwall Pit	413,058	6,253,464	1997	2018	180
D11	CWP	412,979	6,251,739	1997	2018	263
D2	Cowan Brook Dam	410,331	6,252,067	1997	2018	335
D3	Southampton	411,581	6,253,401	1997	2018	931
D3A	Austins	411,392	6,253,143	1997	2018	857
D4	Tin Shed Dam	411,837	6,251,021	1997	2018	427

Location ID	Location	Easting	Northing	First sample date	Latest sample date	Number of samples
D5	TSF2	412,843	6,251,726	1997	2018	843
D16	C3Sump	413,492	6,253,185	1997	2011	143
DRAINAUS	Austins Drain	412,459	6,252,253	2004	2018	690
DRAINMF	Seepage Recovery Sump South	411,719	6,251,193	2006	2018	141
FINALSUMP	CG1	412,515	6,252,927	2012	2018	49
HSDAM	Horseshoe Dam	411,679	6,250,758	1998	2018	299
LMPTAP	Process Plant	412,624	6,252,915	2005	2018	147
PRECB	Cowan Brook Dam	411,222	6,251,670	2006	2018	134
TSF2SP	TSF2	412,267	6,251,636	2006	2017	122
TSF2SUMPN	Seepage Recovery Sump North	412,305	6,251,725	2013	2017	47
TSF SUMP	Seepage Recovery Sump South	411,713	6,251,187	2011	2018	227
TSF SUMP OF	Seepage Recovery Sump South	411,713	6,251,187	2009	2018	157
TSFEDRN	TSF1	413,769	6,250,536	2009	2018	77
VULTAN	Vultan	414,526	6,251,265	1997	2018	201



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0 0.3 0.6 0.9 1.2

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Talison Lithium Pty Ltd
Talison Mining Proposal
Surface Water Assessment

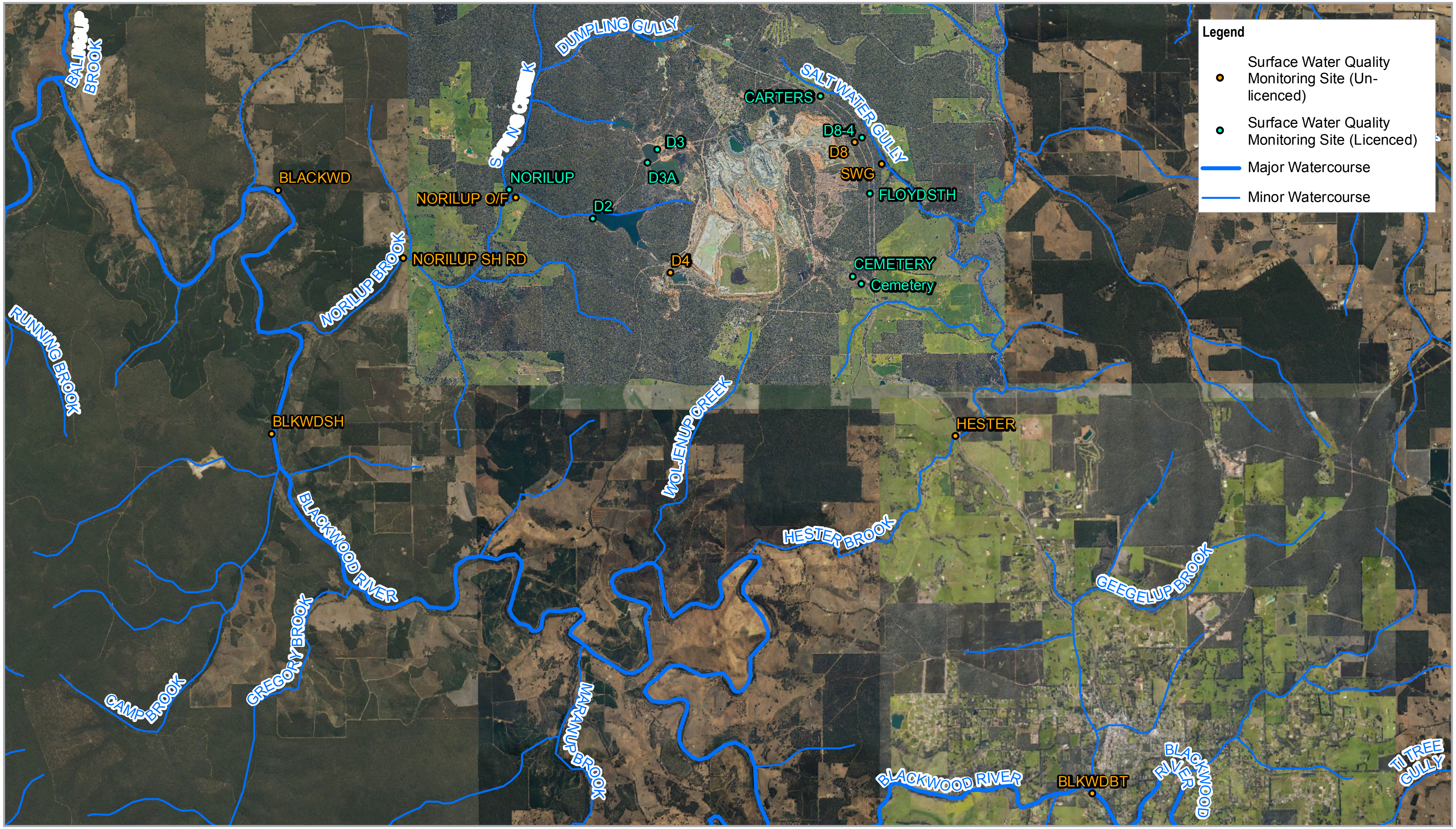
Project No. 613694405
Revision No. 0
Date 10/08/2018

Surface Water Quality On-site Monitoring Locations

FIGURE 4-9

G:\61\3694405\GIS\Maps\Working\6135774_006_Fig5-10_RevA_SurfaceMonitoringSites.mxd
Print date: 10 Aug 2018 - 12:03

Data source: Talison: Monitoring Sites - 20180406, Imagery - 20171002; GA: Watercourse - 20060613 . Created by: swoods



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0 0.75 1.5 2.25 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

Talison Lithium Pty Ltd
Talison Mining Proposal
Surface Water Assessment

Surface Water Quality Monitoring Sites

Project No. **613694405**
Revision No. **0**
Date **10/08/2018**

FIGURE 4-10

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Print date: 10 Aug 2018 - 11:01

Data source: Talison: Monitoring Sites - 20180406, Imagery - 20171002; GA: Watercourse - 20060613 . Created by: swoods

4.5.2 Water quality analysis

Water quality from discharge points from the Site have been compared against water quality in watercourses both upstream and downstream of the Site. These monitoring locations are summarised in tables to follow, and herein referred to as the "key monitoring locations" with relation to this surface water assessment.

Figure 4-11 to **Figure 4-27** illustrate the water quality data collated over time for the above monitoring parameters, while the following subsections provide a brief analysis of this data against the water quality guidelines and limits described in **Section 4.5.1**.

Monitoring sites with four or more data points are included in this analysis.

pH

The range of pH as identified in the ANZECC and ADWG guidelines is 6.5-8.5. Ranges and trends at key sampling locations are summarised in **Table 4-8**. The recorded pH for emissions to the western and eastern catchments are shown in **Figure 4-11** and **Figure 4-12**, respectively.

The following key observations are noted with respect to pH:

- pH has remained within the required licence condition range of 6-9 at the relevant dams, though has been increasing since 2008.
- pH at key locations of the mine water circuit generally range between 8 – 9.
- Western catchment discharges are generally within the range of 7.5 – 8.5.
- pH from the Eastern catchment is generally within the range of 7 – 9, though appear less stable than that from the western catchment, noting that exceedances have periodically occurred in SWG Downstream, SWG Upstream, Cemetery, and Carters.
- pH from the site's western catchment discharges are higher than those downstream in the Blackwood River.
- pH from the site's eastern catchment discharges are within the range reported in Blackwood River upstream and downstream.

Acid Metalliferous Drainage studies (GHD 2016, 2018d) assessed the potential for acid drainage as a result of the chemical composition of the mine tailings and waste rock. The reports indicate that the tailings and ore body have low acid producing potential with low sulfidic concentrations.

Table 4-8 Key historical pH statistics

Water course	Location ID	pH range	Ave pH	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	6.76-9.83	7.83	No trend
SWG Upstream	CATROAD	5.2 - 9.6	7.81	No trend
Floyds North	D8-4	6.81	8.12	Stable
Floyds South	FLOYDSTH	6.44-7.63	6.86	Stable
SWG Downstream	SWG	6.94 - 9.37	8.38	No trend
Cemetery	CEMETERY	8-9	8.18	No trend

Water course	Location ID	pH range	Ave pH	Trend
Hester Brook	HESTER	6.89 – 8.91	7.71	Stable
Blackwood Upstream	BLKWDBT	7.3 – 8.4	7.87	No trend
Blackwood Intermediate	BLKWDSH	7.3 – 8.3	7.84	Increasing
Western Catchment – Within mine water circuit				
Austins Dam	D3A	6.67-9.5	8.3	Stable
Southampton Dam	D3	6.91-9.06	8.11	Increasing
Cowan Brook Dam	D2	6.4-9.6	8.10	Increasing
Western Catchment - Site Discharges into Norilup Brook				
Noriliup Dam	Norilup	6.89-9.49	8.15	Increasing
Norilup Dam Discharge Point	Norilup O/F	7.32-8.94	8.07	No trend
Blackwood River Downstream	BLACKWD	7.2 -8.2	7.86	Stable

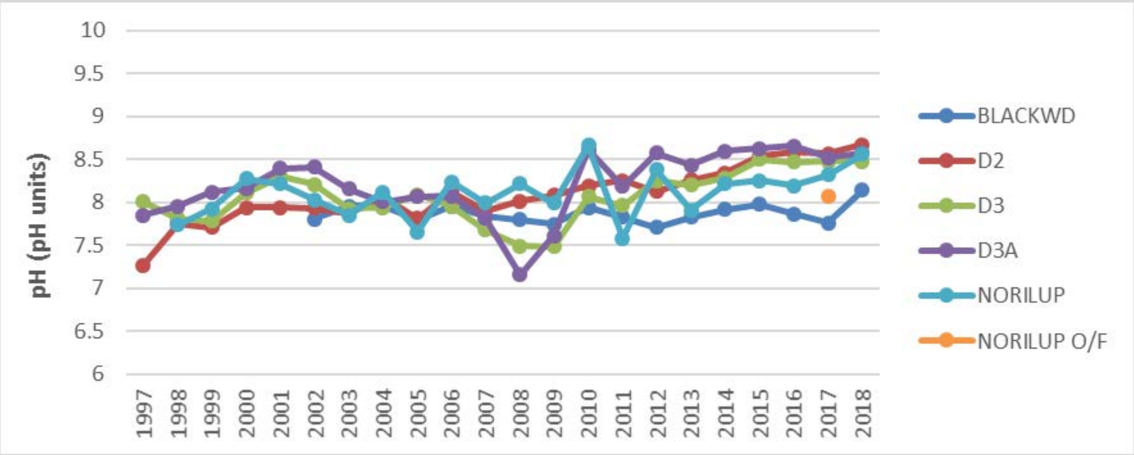


Figure 4-11 Western catchment – average annual pH concentrations

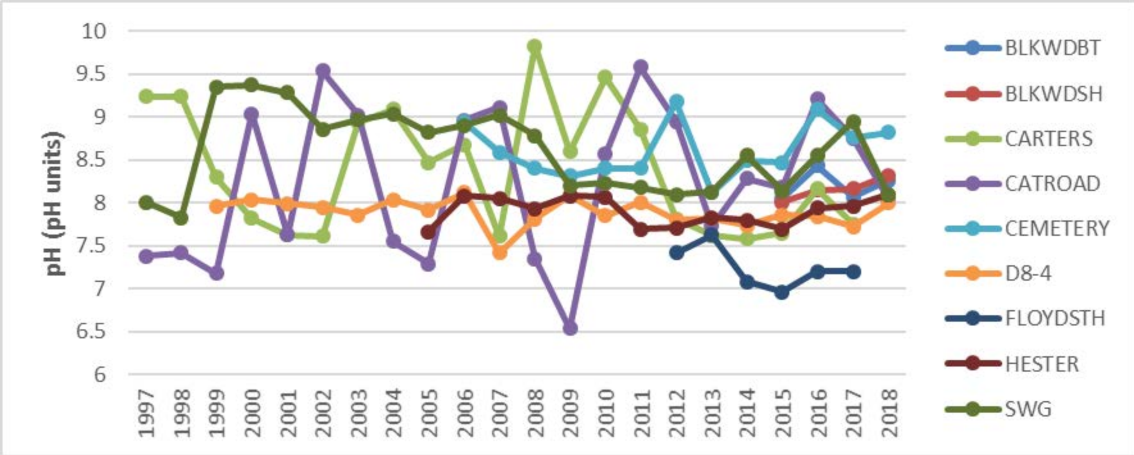


Figure 4-12 Eastern catchment – average annual pH concentrations

Nitrate

Nitrate can be sourced from the site as a residual of blast reagents. The adopted nitrate trigger values range from 50 mg/L (AWDG Health) to 1500 mg/L (ANZECC Livestock). Ranges, averages and trends at discharge locations and at relevant upstream/downstream sites are summarised in **Table 4-9**. Average annual nitrate data at these locations is also illustrated in **Figure 4-13** and **Figure 4-14** respectively.

The following key observations are noted:

- Discharges from the Floyds North (WRL) catchment exhibit elevated nitrate concentrations, however these have steadily decreased from an annual average of ~150 mg/L in 2002 to just over 10 mg/L in 2017. Concentrations since 2006 have not exceeded the lowest adopted trigger value (50 mg/L), though are still higher than all other discharge points from the site. Elevated concentrations from this catchment are consistent with recent data from July 2018 from a shallow bore (WRD_N) nearby.
- Salt water gully downstream of the Floyds North catchment also exhibits elevated nitrate concentrations, however these remain below adopted trigger values.
- All other discharge points report low nitrate concentrations (<10 mg/L)

Table 4-9 Key historical nitrate statistics

Water course	Location ID	Nitrate range (mg/L)	Ave nitrate (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.2 – 55.0	6.0	Stable
SWG Upstream	CATROAD	0.2 – 2.0	4.0	Stable
Floyds North	D8-4	0.5 – 300.0	50.1	Decreasing
Floyds South	FLOYDSTH	0.2 – 0.8	0.3	Decreasing
SWG Downstream	SWG	0.2 – 71.0	0.8	Decreasing

Water course	Location ID	Nitrate range (mg/L)	Ave nitrate (mg/L)	Trend
Cemetery	CEMETERY	0.2 – 2.1	0.8	Stable
Hester Brook	HESTER	0.2 – 11.0	1.1	Stable
Blackwood Upstream	BLKWDBT	0.2 – 5.1	0.9	Stable
Blackwood Intermediate	BLKWDSH	0.2 – 1.8	0.6	Stable
Western Catchment – Within mine water circuit				
Austins Dam	D3A	0.2 – 10.2	2.1	No trend
Southampton Dam	D3	0.2 – 7.1	1.1	No trend
Cowan Brook Dam	D2	0.1 – 1.6	0.5	No trend
Western Catchment - Site Discharges into Norilup Brook				
Norilup Dam	Norilup	0.2 – 5.4	1.6	No trend
Norilup Dam Discharge Point	Norilup O/F	-	-	No trend
Blackwood River Downstream	BLACKWD	0.2 – 7.6	1.1	No trend

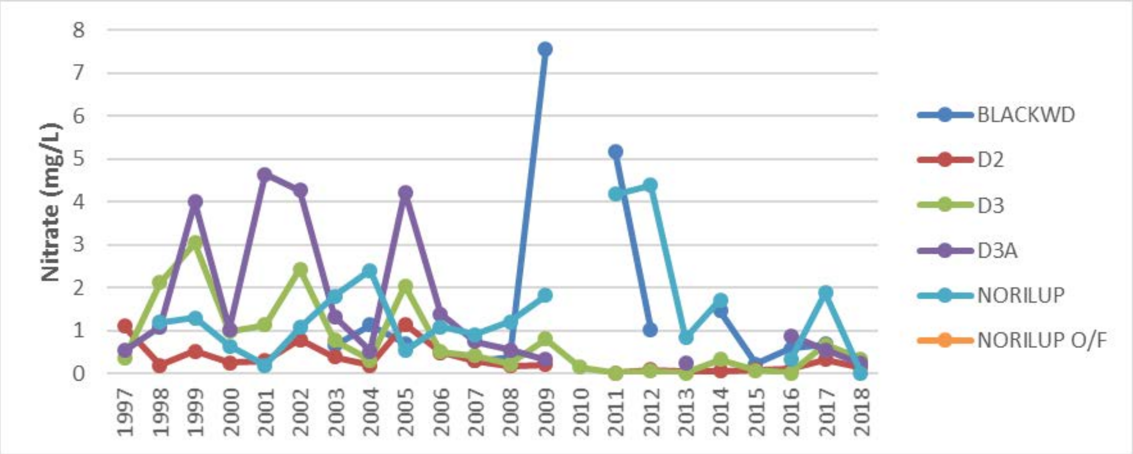


Figure 4-13 Western catchment – average annual nitrate concentrations

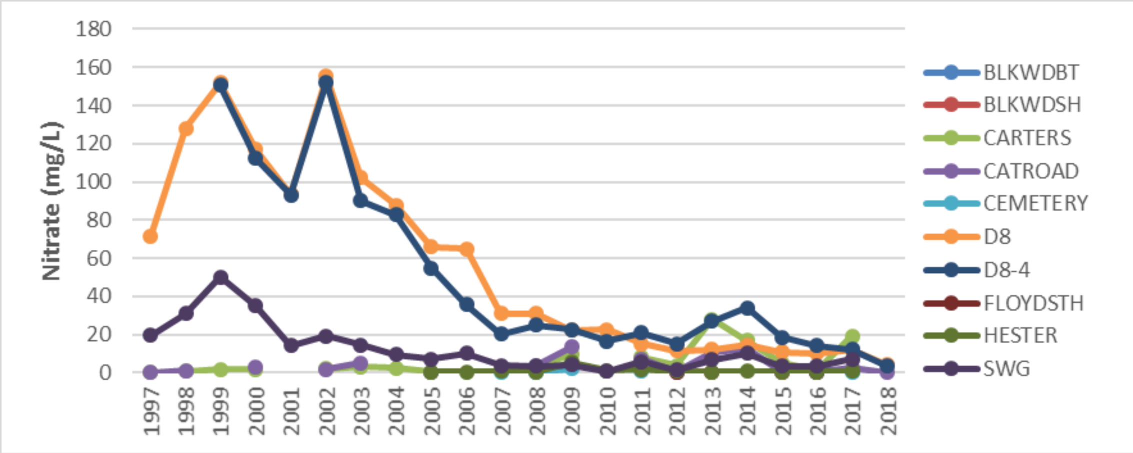


Figure 4-14 Eastern catchment – average annual nitrate concentrations

Sulfate

Sulfates can originate from the weathering of sulphidic rocks contained within the pits during the mining process. Adopted sulfate guidelines range from 250 mg/L (ADWG Aesthetic) to 2000 mg/L (ANZECC Livestock). The recorded concentrations of sulfate discharging from the western and eastern catchments, and at relevant upstream/downstream sites are shown in **Figure 4-15** and **Figure 4-16** respectively.

Ranges and trends at key sampling locations are summarised in **Table 4-10.**

The following key observations are noted:

- Sulfate has remained below adopted guideline levels for western catchment discharges and below the upper limit for the ANZECC guidelines for eastern catchment discharges.
- Sulfate concentrations in SWG are higher downstream of the site, indicating that SWG may be impacted by discharges from the site. Similar (albeit higher) sulfate concentrations are recorded from the existing WRL catchment (Floyds North) compared to SWG downstream of the site.
- Western catchment discharges are typically between 50 - 280 mg/L, noting that exceedances of the ADWG guidelines have not occurred after 2013. These discharges are lower than those recorded in downstream Blackwood River.
- Sulfate concentrations within the mine circuit are typically between 50-280 mg/L with an increasing trend from 2015.
- Discharges from key mine site locations are lower than the upstream and downstream concentration in the Blackwood River

Table 4-10 Key historical sulfate statistics

Water course	Location ID	Sulfate range (mg/L)	Ave Sulfate (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	4 - 500	115	Increasing
SWG Upstream	CATROAD	13 - 150	55	Stable
Floyds North	D8-4	481 - 1220	960	Stable

Water course	Location ID	Sulfate range (mg/L)	Ave Sulfate (mg/L)	Trend
Floyds South	FLOYDSTH	16 - 123	62	Increasing
SWG Downstream	SWG	170 - 1350	730	Stable
Cemetery	CEMETERY	18 - 118	38	No trend
Hester Brook	HESTER	21 - 200	85	Decreasing
Blackwood Upstream	BLKWDBT	134 - 299	210	Increasing
Blackwood Intermediate	BLKWDSH	119 - 276	182	Increasing
Western Catchment – Within mine water circuit				
Austins Dam	D3A	108 - 363	210	Increasing since 2015
Southampton Dam	D3	24 - 345	193	Increasing since 2015
Cowan Brook Dam	D2	35 - 230	107	Decreasing since 2010
Western Catchment - Site discharges and downstream				
Norilup Dam	Norilup	16 - 113	51.5	Decreasing
Norilup Dam Discharge Point	Norilup O/F	16 - 41	24	No trend
Blackwood River Downstream	BLACKWD	85 - 303	164	Increasing

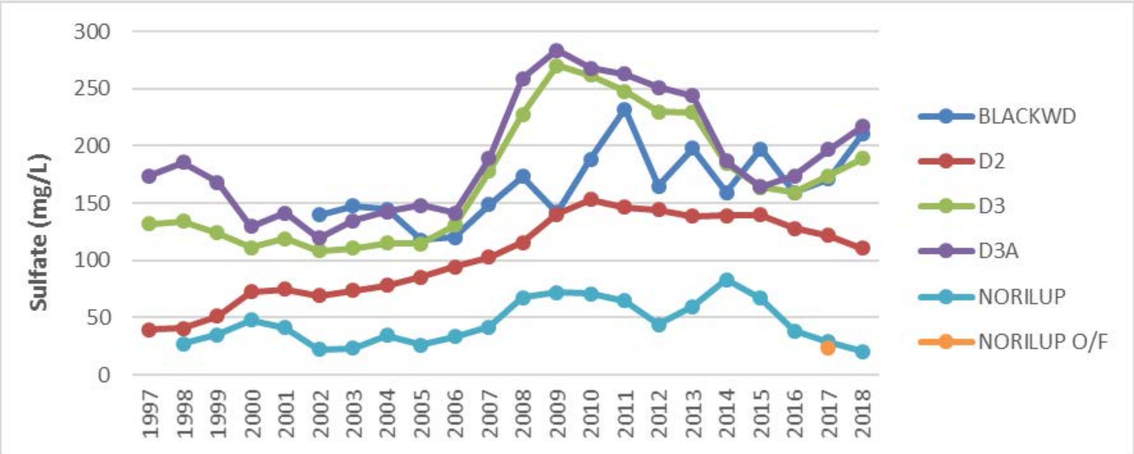


Figure 4-15 Western catchment – average annual sulfate concentrations

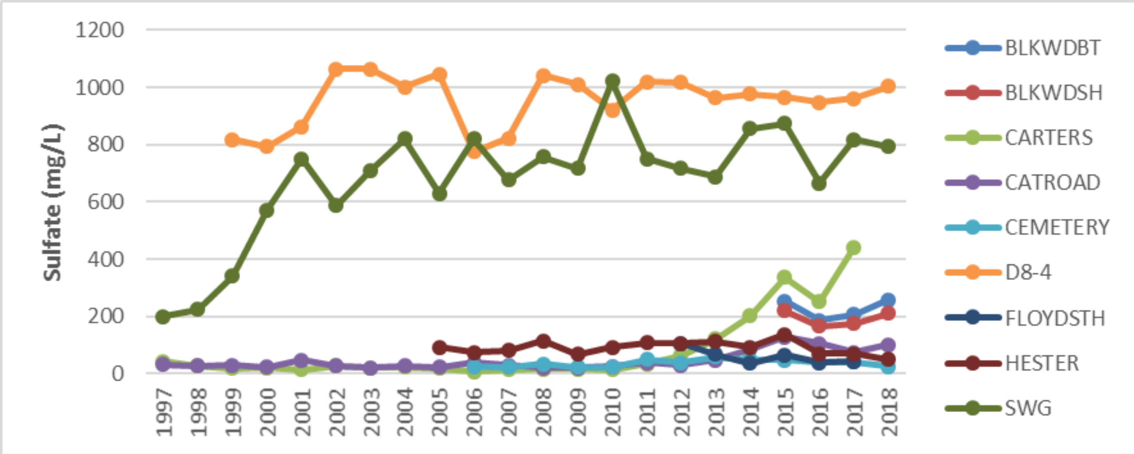


Figure 4-16 Eastern catchment – average annual sulfate concentrations

TDS

TDS concentrations are typically used as a representation of salinity. Past studies have identified that the salinity levels for the Hester Brook have been elevated to a level that has restricted irrigation and human consumption. The adopted salinity guidelines range from 600-5000 mg/L.

Trends for the western catchment and the eastern catchment are shown in **Figure 4-17** and **Figure 4-18** respectively. Key trends are summarised in **Table 4-11**.

The following key observations are noted:

- TDS discharges from the eastern catchment are typically below 2,500 mg/L, which generally exceeds the ANZECC long term irrigation guideline (1000 - 2000 mg/L), though remains below ANZECC livestock guidelines (2000 – 5000 mg/L).
- Discharges from the western catchment are generally lower than the ANZECC guidelines (i.e. <1000 mg/L), though are higher than the ADWG Health guidelines of 60 mg/L.
- All discharges from the site report significantly lower TDS concentrations than those in upstream and downstream Blackwood River.

Table 4-11 Key historical TDS statistics

Water course	Location ID	TDS range (mg/L)	Ave TDS (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	197-1380	627	Increasing
SWG Upstream	CATROAD	237-2180	755	Slight decrease 2011-2018
Floyds North	D8-4	865-2700	2095	Stable
Floyds South	FLOYDSTH	461-6680	2427	Stable

Water course	Location ID	TDS range (mg/L)	Ave TDS (mg/L)	Trend
SWG Downstream	SWG	535-3030	1763	Stable
Cemetery	CEMETERY	283-1860	855	Stable
Hester Brook	HESTER	730-2720	1716	Stable
Blackwood Upstream	BLKWDBT	3200-9420	6297	No trend
Blackwood Intermediate	BLKWDSH	2960-8520	5362	No trend
Western Catchment – Within mine water circuit				
Austins Dam	D3A	518-1220	828	Decreasing
Southampton Dam	D3	190-1160	803	Decreasing
Cowan Brook Dam	D2	572-1100	807	Stable
Western Catchment - Site Discharges into Norilup Brook				
Noriliup Dam	Norilup	309-1360	774	Decreasing
Norilup Dam Discharge Point	Norilup O/F	-	-	No trend
Blackwood River Downstream	BLACKWD	2580-13040	5220	No trend

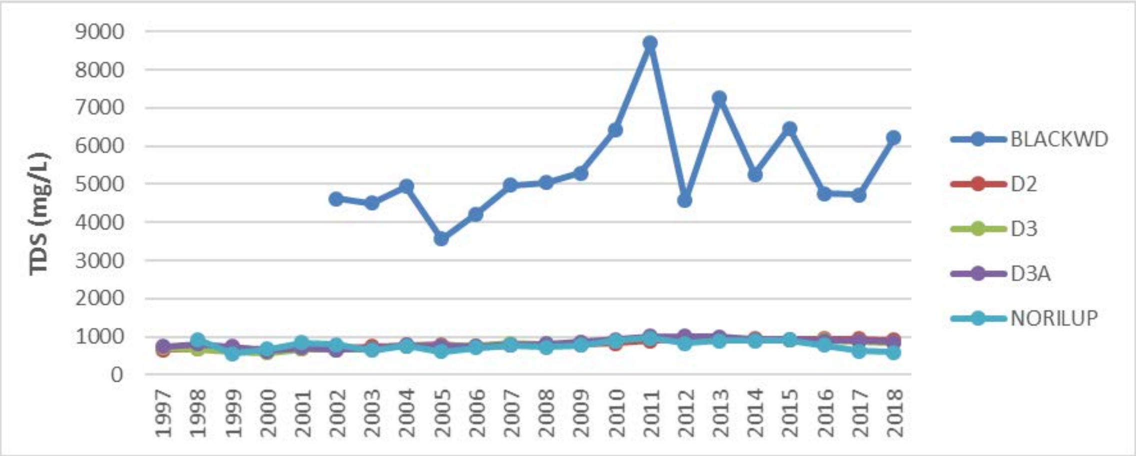


Figure 4-17 Western catchment – average annual TDS concentrations

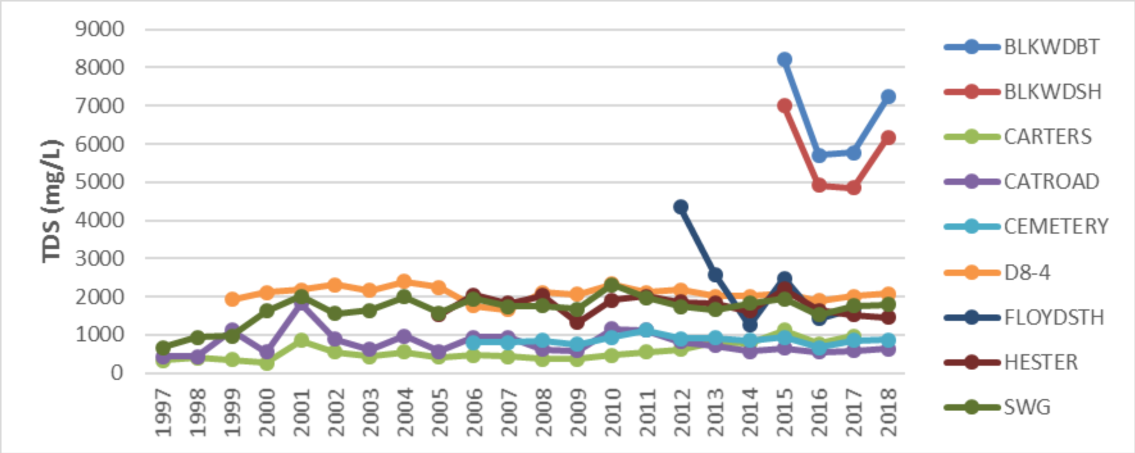


Figure 4-18 Eastern catchment - average annual TDS concentrations

Arsenic

Arsenic is a by-product of Lithium processing and from weathering of arsenic sulphide minerals and native arsenic in the pits. The site Licence specifies a limit for arsenic of 0.01 mg/L in Norilup Dam. The guideline values for arsenic are also 0.01 mg/L for the ADWG 2011 Health criteria. The other trigger values are an order of magnitude higher with the range of 0.1-24 mg/L.

Two arsenic remediation units were installed by Talison in 2013 and are required to operate almost continuously as required under the site Licence amendment of 2016. Water from the Clear Water Pond is continuously recirculated through these units. Another unit was installed by GAMG in early 2015. Since the licence amendment, arsenic concentrations have indicated a decreasing trend since 2016.

Figure 4-19 and **Figure 4-20** displays the trends for arsenic in the western and eastern catchments respectively. Key trends for Arsenic are summarised in **Table 4-12**.

The following key observations are noted:

- Arsenic concentrations in Norilup Dam have remained below Licence conditions (0.01 mg/L) since 2015, though exceedances were consistently reported in the dam prior to this when no Licence conditions were in place.
- Arsenic within the western water circuit (Austins and Southampton Dam) are elevated at up to (0.17 mg/L), and exceed the ANZECC LT irrigation (0.1 mg/L) and ADWG (0.01 mg/L) guidelines.
- An increasing trend in arsenic in these dams was observed from 2009 to 2014, though appear to have stabilised/decreased since then. This is likely related to the aforementioned arsenic remediation at Clear Water Pond.
- No guideline exceedances were reported for arsenic from the eastern catchment after 2003, with values ranging between 0.001 and 0.005 mg/L.

Table 4-12 Key historical arsenic statistics

Water course	Location ID	Arsenic range (mg/L)	Ave Arsenic (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.001-0.03	0.006	Decreasing
SWG Upstream	CATROAD	0.001-0.04	0.005	Decreasing
Floyds North	D8-4	0.001-0.060	0.010	Decreasing
Floyds South	FLOYDSTH	0.001-0.006	0.003	No trend
SWG Downstream	SWG	0.001-0.060	0.005	Stable
Cemetery	CEMETERY	0.001-0.013	0.002	Stable
Hester Brook	HESTER	0.001-0.009	0.001	Stable
Blackwood Upstream	BLKWDBT	0.001-0.004	0.001	Stable, Increase 2017-2018
Blackwood Intermediate	BLKWDSH	0.001-0.008	0.001	Stable, slight increase 2018
Western Catchment – Within mine water circuit				
Austins Dam	D3A	0.005-0.020	0.010	Decreasing since 2014
Southampton Dam	D3	0.001-0.220	0.060	Increasing
Cowan Brook Dam	D2	0.001-0.080	0.010	Decreasing
Western Catchment - Site Discharges into Norilup Brook				
Norilup Dam	Norilup	0.001-0.080	0.010	Stable
Norilup Dam Discharge Point	Norilup O/F	-	-	No trend
Blackwood River Downstream	BLACKWD	0.001-0.107	0.010	Stable

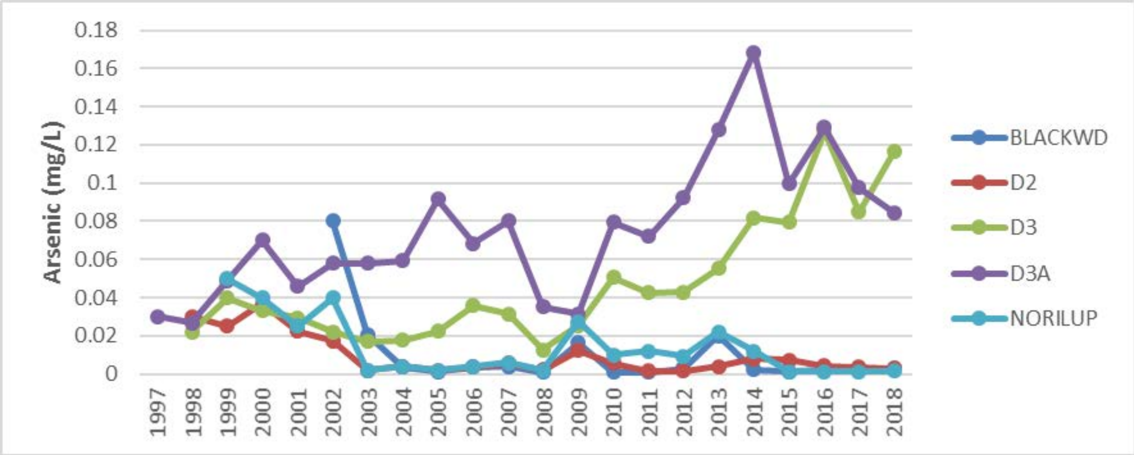


Figure 4-19 Western catchment – average annual arsenic concentrations

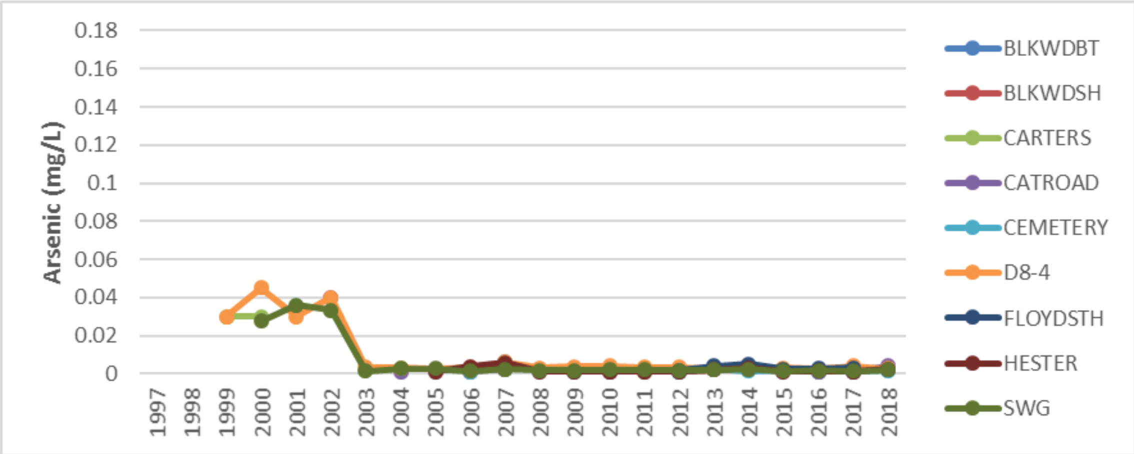


Figure 4-20 Eastern catchment – average annual arsenic concentrations

Cadmium

Cadmium has generally been reported below laboratory limits of reporting (0.005 mg/L), with sporadic detects. Detected concentrations have remained below the site licence limits at Norilup Dam (0.002 mg/L) since they were established, with the last detected concentration of 0.01 mg/L measured in 2001. Cadmium is otherwise not considered to be an issue, given the infrequency of detected concentrations, and generally low concentrations of detected concentrations.

Copper

A copper concentration limit of 2 mg/L is specified for Norilup Dam as per the Licence conditions. ANZECC guidelines specify a guideline range of 0.2 - 1.4 mg/L, while ADWG guideline values range between 1 - 2 mg/L. No exceedances of the guidelines and limits have been measured at any of the key locations assessed, with concentrations typically reported below the laboratory LOR (0.01 mg/L). Copper is therefore not considered to be an issue for the site.

Chromium (VI)

Chromium (VI) has been sampled for external sampling points only. Although tested in the bi-annual sampling suites, in April and October, results have been detected as below the limit of reporting concentration (<0.001 mg/L) at all key monitoring locations. Chromium is not considered to be an issue, given it has not been detected in any of the key monitoring locations.

Manganese

The site Licence stipulates a limit of 0.5 mg/L for manganese concentrations in Norilup Dam. The ANZECC (2000) guideline for short term irrigation specifies a guideline value of 10 mg/L.

Manganese concentrations for the western and eastern catchment are displayed in **Figure 4-21** and **Figure 4-22** respectively. Key discharge trends are summarised in **Table 4-13.**

The following key observations are noted:

- The Licence limits have not been exceeded for Norilup Dam.
- The ADWG (health) (0.05 mg/L) and ANZECC (LT irrigation) (0.01 mg/L) guidelines for manganese are consistently exceeded by eastern and western catchment discharges, but are also exceeded at upstream locations in Blackwood River.
- Floyd South has historically reported higher concentrations of manganese (averaging 0.61 mg/L) compared to other discharge points.

Table 4-13 Key historical manganese statistics

Water course	Location ID	Manganese range (mg/L)	Ave Manganese (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.002-0.177	0.04	Stable
SWG Upstream	CATROAD	0.009-0.390	0.07	Stable
Floyds North	D8-4	0.019-0.224	0.10	Stable
Floyds South	FLOYDSTH	0.046-3.100	0.61	No trend
SWG Downstream	SWG	0.007-0.910	0.11	Decreasing
Cemetery	CEMETERY	0.008-0.500	0.10	No trend
Hester Brook	HESTER	0.030-1.000	0.17	Increasing
Blackwood Upstream	BLKWDBT	0.024-0.349	0.09	Stable

Water course	Location ID	Manganese range (mg/L)	Ave Manganese (mg/L)	Trend
Blackwood Intermediate	BLKWDSH	0.022-0.195	0.06	Stable
Western Catchment – Within mine water circuit				
Austins Dam	D3A	0.001-0.040	0.01	Spike in 2008, Decreasing (2008-2012) Increasing (2012-2018)
Southampton Dam	D3	0.002-0.810	0.08	Increasing
Cowan Brook Dam	D2	0.001-0.254	0.02	Stable
Western Catchment - Site Discharges into Norilup Brook				
Norilup Dam	Norilup	0.001-0.306	0.05	Stable
Norilup Dam Discharge Point	Norilup O/F	0.016-0.056	0.03	No trend
Blackwood River Downstream	BLACKWD	0.016-0.880	0.11	No trend

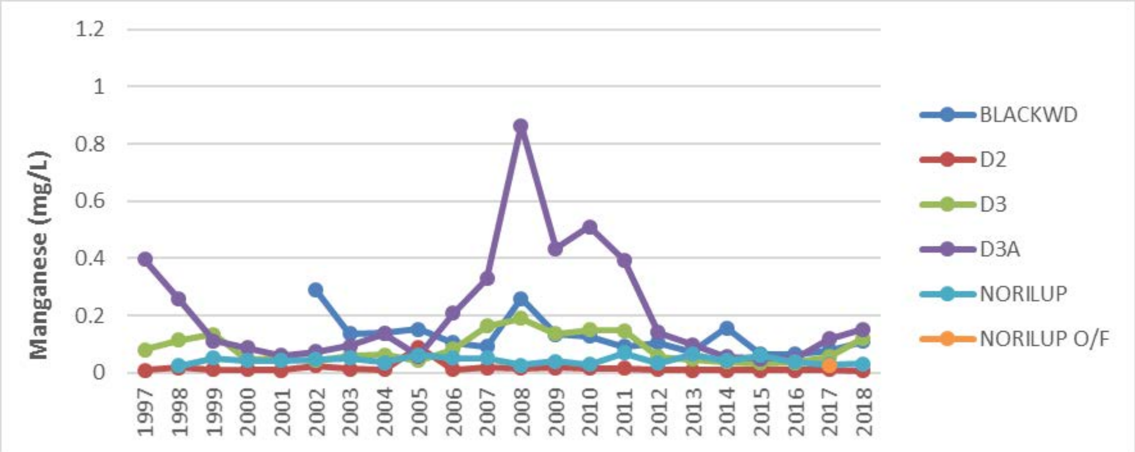


Figure 4-21 Western catchment – average annual manganese concentrations

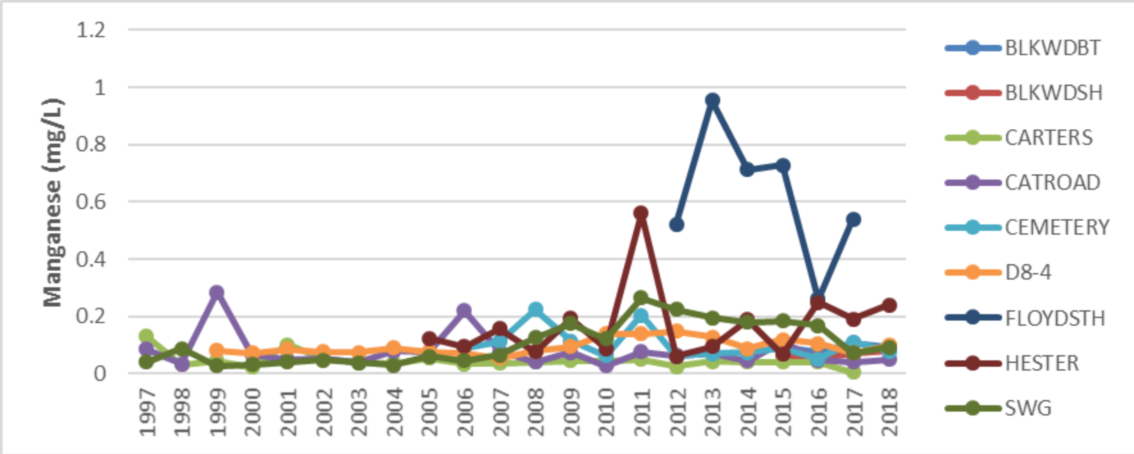


Figure 4-22 Eastern catchment – average annual manganese concentrations

Lithium

The current licence identifies that in the absence of an ANZECC guideline limit for lithium that the current discharge value be set at incremental decreasing concentrations from 2015 – 2022, with the current limit applicable being 5 mg/L.

Lithium trends are summarised in and the western and eastern catchment trends are presented in **Figure 4-23** and **Figure 4-24** respectively.

The following key observations are noted:

- Lithium concentrations in Norilup Dam have consistently met the decreasing Licence condition limits.
- An increasing trend in lithium concentrations is observed within the mine water circuit from 2002, though Cowan Brook Dam has decreased since 2016.
- Lithium concentrations in SWG are higher downstream of the site, indicating that SWG may be impacted by discharges from the site. Similar (albeit higher) lithium concentrations are recorded from the existing WRL catchment (Floyds North) with respect to concentrations in SWG downstream of the site.

Table 4-14 Key historical lithium statistics

Water course	Location ID	Lithium range	Ave Lithium	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.01-0.3	0.04	Slight increase
SWG Upstream	CATROAD	0.01-0.06	0.01	Stable
Floyds North	D8-4	0.57-1.8	1.3	Stable
Floyds South	FLOYDSTH	0.01-0.26	0.04	Decreasing
SWG Downstream	SWG	0.19-1.8	0.92	Stable, fluctuating (0.19-1.8)

Water course	Location ID	Lithium range	Ave Lithium	Trend
Cemetery	CEMETERY	0.0015-0.05	0.02	Stable
Hester Brook	HESTER	0.01-0.05	0.03	Stable
Blackwood Upstream	BLKWDBT	0.-0.01	0.01	No trend
Blackwood Intermediate	BLKWDSH	0.01-0.02	0.01	Slight decrease
Western Catchment – Within mine water circuit				
Austins Dam	D3A	3.6-14.2	9.78	Increasing
Southampton Dam	D3	0.14-13	8.82	Increasing
Cowan Brook Dam	D2	0.02-7.7	3.94	Increasing (decreasing 2016-2018)
Western Catchment - Site Discharges into Norilup Brook				
Norilup Dam	Norilup	0.01-5.4	1.35	No trend (1997-2014), Decreasing (2014-2018)
Norilup Dam Discharge Point	Norilup O/F	0.05-0.51	0.17	No trend
Blackwood River Downstream	BLACKWD	0.01-0.13	0.03	No trend

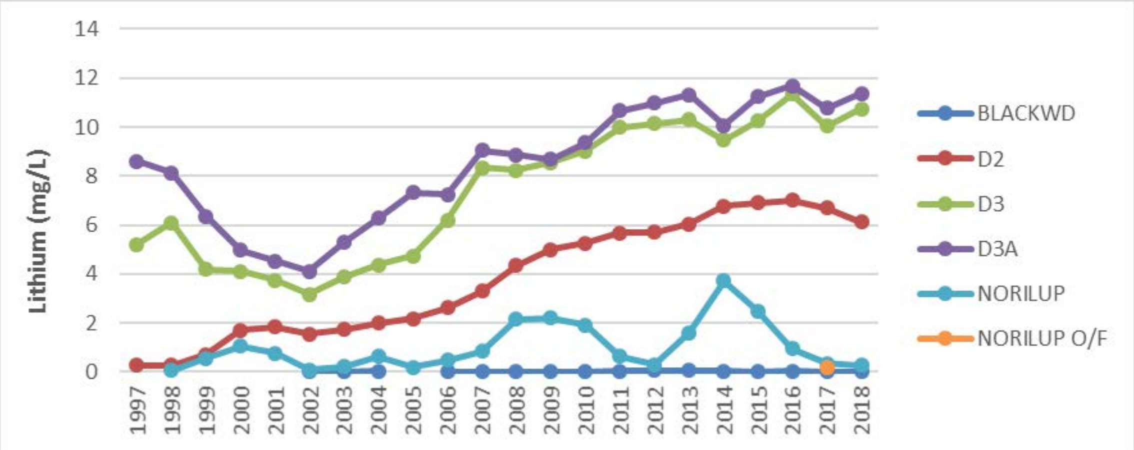


Figure 4-23 Western catchment – average annual lithium concentrations

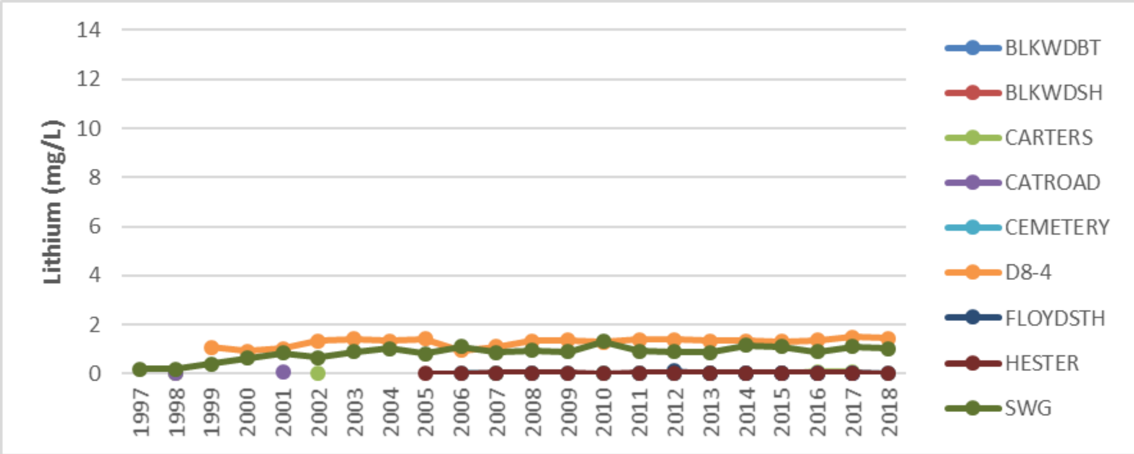


Figure 4-24 Eastern catchment – average annual lithium concentrations

Nickel

The Licence conditions for Nickel concentrations for Norilup Dam are 0.02 mg/L. The ANZECC guidelines for nickel range between 0.2 – 11.0 mg/L. The ADWG guidelines have a trigger value of 0.2 mg/L.

The recorded nickel emissions for the western and eastern catchments are shown in **Figure 4-25** and **Figure 4-26** respectively. Data trends are summarised in **Table 4-15**.

The following key observations are noted:

- Nickel concentrations have remained below the required Licence condition and guideline values in all key areas.
- Nickel discharges at key locations in the mine circuit are typically between 0-0.012 mg/L.
- Eastern catchment discharge are typically between 0-0.015 mg/L with the exception of Floyds North (D8-4) where the concentration range is typically between 0.02-0.04 mg/L.

Table 4-15 Key historical nickel statistics

Water course	Location ID	Nickel range (mg/L)	Ave Nickel (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.001-0.016	0.01	No trend
SWG Upstream	CATROAD	0.006-0.01	0.01	No trend
Floyds North	D8-4	0.007-0.06	0.03	Decreasing
Floyds South	FLOYDSTH	0.001-0.01	0.01	Decreasing
SWG Downstream	SWG	0.005-0.02	0.01	Stable
Cemetery	CEMETERY	0.001-0.01	0.01	Decreasing
Hester Brook	HESTER	0.006-0.01	0.008	Decreasing

Water course	Location ID	Nickel range (mg/L)	Ave Nickel (mg/L)	Trend
Blackwood Upstream	BLKWDBT	-	-	No trend
Blackwood Intermediate	BLKWDSH	0.005	0.005	No trend
Western Catchment – Within mine water circuit				
Austins Dam	D3A	0.001-0.04	0.01	Decreasing
Southampton Dam	D3	0.001-0.02	0.007	Decreasing
Cowan Brook Dam	D2	0.001-0.015	0.007	Stable
Western Catchment - Site Discharges into Norilup Brook				
Norilup Dam	Norilup	0.005-0.013	0.008	Decreasing
Norilup Dam Discharge Point	Norilup O/F	0.005	0.0055	No trend
Blackwood River Downstream	BLACKWD	0.005-0.01	0.0079	Stable

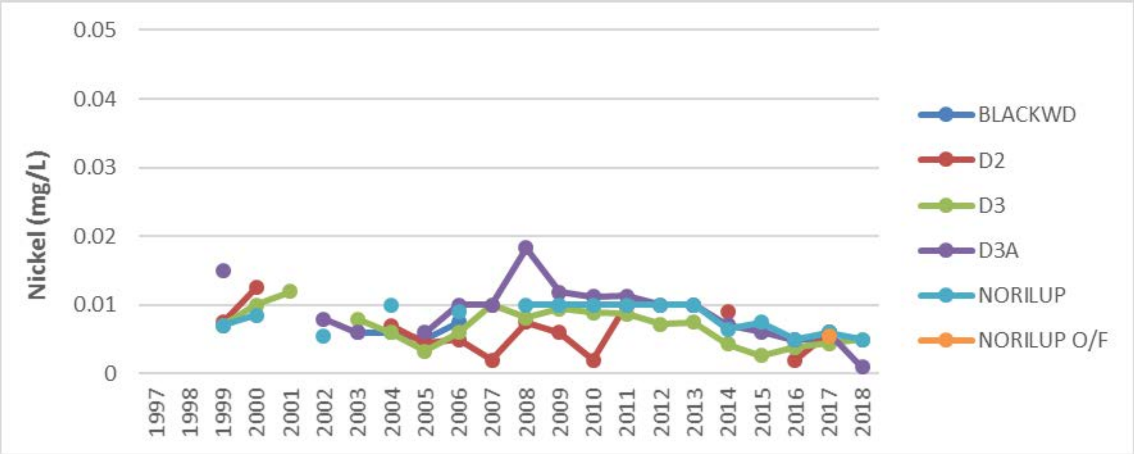


Figure 4-25 Western catchment – average annual nickel concentrations

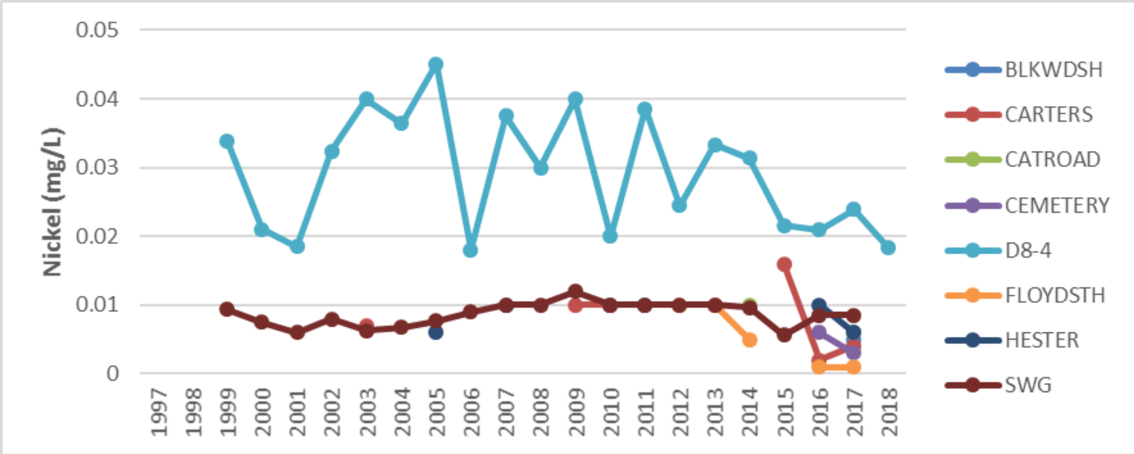


Figure 4-26 Eastern catchment – average annual nickel concentrations

Uranium

A limit of 0.017 mg/L is specified by the site Licence for uranium concentrations at Norilup Dam. The ANZECC guidelines present a range of 0.01 – 0.2 mg/L and the ADWG health guideline has a trigger value of 0.017 mg/L for uranium. Where data is available and above laboratory LORs, the key historical annual average uranium concentrations for the western catchment are displayed in **Figure 4-27**. Data trends are summarised in **Table 4-16**.

The following key observations are noted

- Uranium concentrations have typically been below laboratory LOR (<0.1 mg/L) at site discharge locations, and in Blackwood River upstream and downstream of the site.
- Sporadic detects of uranium have been reported from the eastern catchment (Floyds North and in SWG). Floyds North exceeded the ADWG trigger value in 2008 with no further exceedances. SWG Downstream detects have exceeded the ADWG guideline in 2008 and 2010.
- Uranium concentrations within key storages in the mine water circuit have exceeded the ADWG and ANZECC guideline, with Southampton Dam reporting concentrations around 3 mg/L.

Table 4-16 Key historical uranium statistics

Water course	Location ID	Uranium range (mg/L)	Ave Uranium (mg/L)	Trend
Eastern Catchment – Upstream to downstream				
Carters	CARTERS	0.1	0.1	No trend
Floyds North	D8-4	0.001-0.2	0.1	No trend
SWG Downstream	SWG	0.1	0.1	No trend
Blackwood Intermediate	BLKWDSH	0.01-0.02	0.01	No trend
Western Catchment – Within mine water circuit				

Water course	Location ID	Uranium range (mg/L)	Ave Uranium (mg/L)	Trend
Austins Dam	D3A	0.004-5	2.26	Decreasing
Southampton Dam	D3	0.003-15	3.33	Spike in 2001 (9.9 mg/L), decreasing (2001-2008) Increasing (2010-2017)
Cowan Brook Dam	D2	0.01-1	0.45	No trend

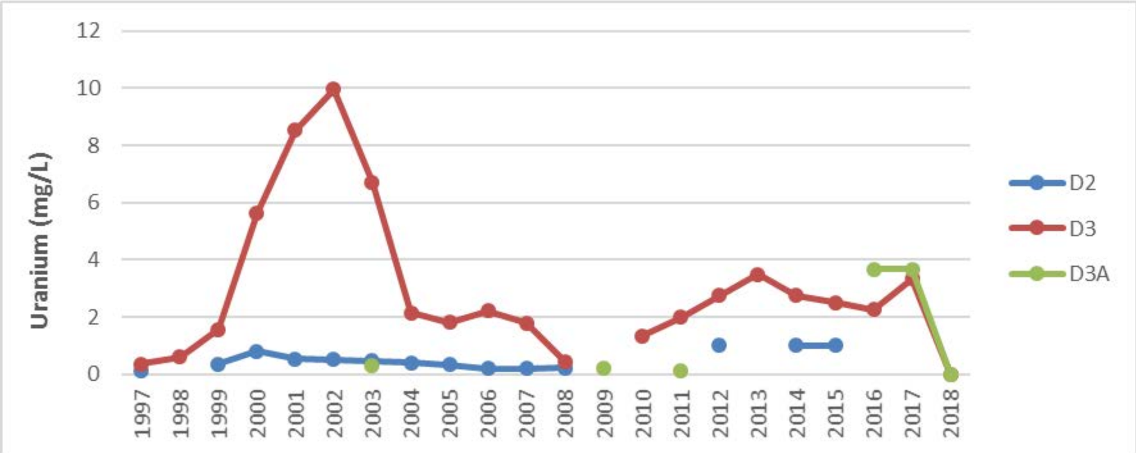


Figure 4-27 Western catchment – average annual uranium concentrations

4.5.3 Water treatment and water balance modelling

Lithium

A new treatment plant is being commissioned to specifically target the removal of lithium and the improvement of overall water quality within the active mine water circuit. The plant will be located adjacent to the Clear Water Dam, as shown in **Figure 2-1**. This plant will treat the water at the Clear Water Dam, removing lithium. The pump location will be based on managing the water quality within the circuit with treated water likely to go to Austins Dam.

The treatment plant has been designed according to the following key requirements:

- Remove 5 – 10 tpa of lithium from the mine water circuit;
- Treat up to 125 kilolitres per hour (kL/h) (average) and 150 kL/hr (max), equating to 1,000,000 litres per annum of water fed to the treatment plant; and
- The plant must be able to treat CWD water quality to specific the criteria specified in **Table 4-17**.

Further design details for the plant can be sourced from the *Talison Lithium – Water Treatment Plant Summary* (Veolia, 2017).

Table 4-17 Water treatment plant design criteria

		Historical CWP quality data (Monthly data from Jan 2012 to Mar 2017)				WTP design value	Comment
Parameters	units	Maximum	90%ile	Average	Minimum		
pH	pH	8.66	8.27	7.96	7.02	7.96	Average
Conductivity	uS/cm	1991	1914	1682.3	1302	1991	Maximum
TDS	mg/l	1260	1140	1004.3	764	1260	Maximum
Fe	mg/l	9.4	0.207	0.3	0.031	0.207	90%ile
Na	mg/l	304	289	250.7	190	304	Maximum
K	mg/l	14.8	13.6	11.3	7.8	14.8	Maximum
Ca	mg/l	54	46.5	37.5	25.9	54	Maximum
Mg	mg/l	37.7	32.6	24.2	17.7	24.2	Average
Cl	mg/l	351	325	271.5	199	351	Maximum
CO_3	mg/l	15.4	0	0.3	0	15.4	Maximum
HCO_3	mg/l	276	230	183.7	115	276	Maximum
SO_4	mg/l	331	311	261.1	194	331	Maximum
NO_3	mg/l	21	1.81	0.8	0	1.81	90%ile
As	mg/l	0.515	0.413	0.3	0.023	0.515	Maximum
Cd	mg/l	0.00	0.00	0.00	0.00	0.00	Maximum
Co	mg/l	0.01	0	0.0	0	0.01	Maximum
Cu	mg/l	0.01	0	0.0	0	0.01	Maximum
Mn	mg/l	1.3	1.1	0.6	0.068	1.3	Maximum
Ni	mg/l	0.01	0.01	0.0	0	0.01	Maximum
PO_4	mg/l	0.95	0.68	0.3	0	0.95	Maximum
Th	mg/l	0	0	0.0	0	0	Maximum
Li	mg/l	16.9	15.5	13.1	8.8	25	Worst case value set by Talison
U	mg/l	0	0	0.0	0	0	Maximum
Zn	mg/l	0.08	0.02	0.0	0	0.08	Maximum
Pb	mg/l	0.06	0	0.0	0	0.06	Maximum
SiO_2	mg/l	NA	NA	NA	NA	12	Worst case value set by Talison
Al	mg/l	NA	NA	NA	NA	0.27	Maximum see from Pilot II test
TOC	mg/l	NA	NA	NA	NA	7.5[Note 1]	Maximum seen from Pilot II test
TSS	mg/l	NA	NA	NA	NA	17.5	Worst case value set by Talison
Temp. (Min)	°C	NA	NA	NA	NA	10	Assumption
Temp. (Max)	°C	NA	NA	NA	NA	35	Assumption

This water treatment plant should result in a significant reduction in lithium concentrations in the mine water circuit. As discussed in **Section 4.2**, GHD has developed a numerical water balance model of the overall mine water circuit (GHD, 2017a, 2018a, 2018b). This model also simulates changes in water quality including lithium.

The model predicted that lithium concentrations will reduce within Austins Dam primarily as a result of the treatment plant, despite increasing production rates from CGP2, CGP3 and CGP4. Lithium concentrations are also predicted to reduce within Southampton Dam, Cowan Brook Dam and ultimately, Norilup Dam.

Figure 4-28 and **Figure 4-29** illustrate the latest model predictions for lithium concentrations in Austins Dam and Norilup Dam, respectively. Specifically these figures show a scenario which includes key aspects of the mine expansion. This model iteration was primarily aimed at maximising water reuse within the mine water circuit, and as such predicts no overflows from Cowan Brook Dam into Norilup Dam from 2024 (to alleviate security of supply risks). The lithium concentrations within Norilup Dam are therefore predicted to decrease and remain low from 2024. Furthermore, Austins Dam lithium concentrations are predicted to decrease over time and stabilise as a direct result of the water treatment plant. Fluctuations in the concentrations from 2024 are a result of model runs that resulted in low water volumes (security of supply issues) in a number of storages and consequently higher concentrations of lithium.

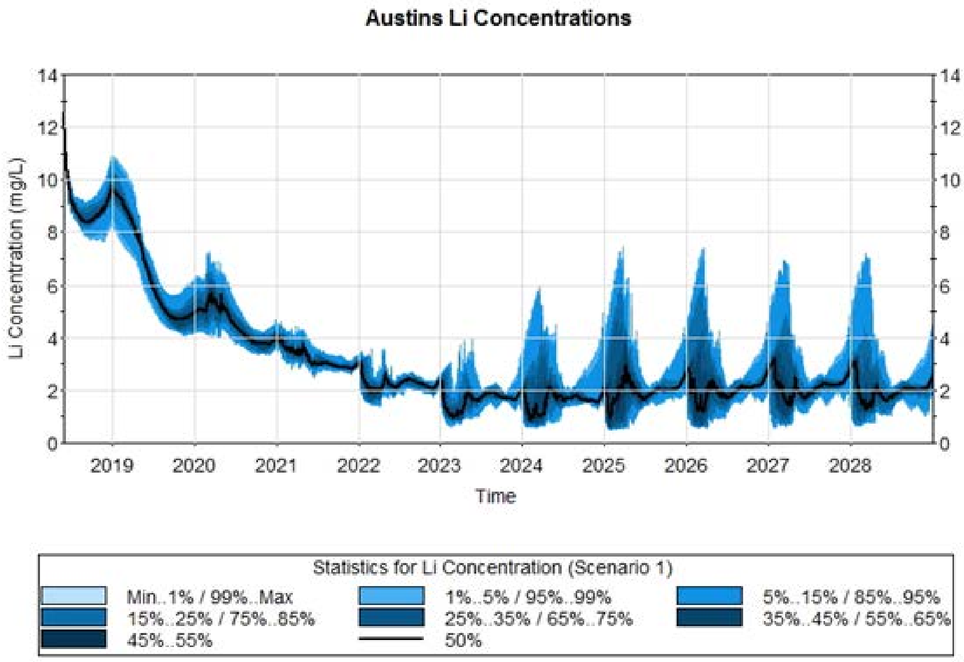


Figure 4-28 Predicted Austins Dam lithium concentrations to 2028 (Scenario 2)

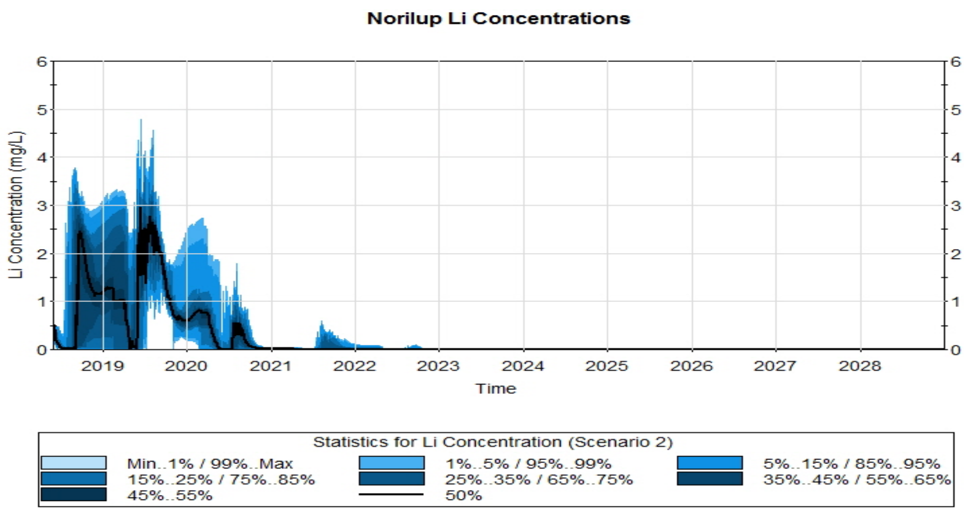


Figure 4-29 Predicted Norilup Dam lithium concentrations to 2028 (Scenario 2)

4.5.4 Analysis summary

The following conclusions from the water quality monitoring and analysis undertaken for the site are noted:

- Key contaminants of concern are sufficiently monitored at site discharge locations, as well as at upstream and downstream locations.
- Surface water within the western site water circuit generally reports declining water quality, however site water management measures have sufficiently controlled discharges of poor quality water from the site. This aligns with the continued compliance with Licence conditions with respect to site water quality limits.
- Lithium in particular is a key contaminant of concern that has continued to increase in concentration within the site water circuit. However, site water management is successfully limiting discharge of lithium from the site, and it is expected that lithium concentrations within the mine water circuit will be sufficiently controlled and potentially reduced in key dams as a result of the water treatment plant being commissioned.
- Arsenic is another key contaminant of concern within the western catchment which showed an increasing trend in Austins, Southampton and Cowan Brook Dams up to 2014. Arsenic concentrations have been compliant with Licence conditions, however it is noted that prior concentrations would have exceeded the current site Licence conditions (0.01 mg/L) up to as recent as 2014. Since the introduction of arsenic remediation units, arsenic concentrations have stabilised or decreased within the western water circuit from 2014 onwards, thereby meeting Licence conditions.
- Discharges from the existing WRL catchment area (Floyds North) report higher concentrations of some key parameters (lithium, sulfate, and nickel) compared to the other discharge points from the eastern catchment, which are less or completely uninfluenced by drainage from the WRL. However, the concentrations of these parameters are still below the applicable ANZECC livestock guidelines and have generally been reporting stable or decreasing concentrations since 2002. Water quality from the WRL drainage may nonetheless deteriorate with expansion of the WRL.

4.5.5 Recommendations

Monitoring

The water quality monitoring program under the existing site Licence is sufficient to monitor surface water impacts from the proposed expansion, with the exception of water storage and drainage infrastructure associated with TSF4. Separate to the expansion, water quality monitoring within the Clear Water Dam (CWD) currently being commissioned should be undertaken.

It is therefore recommended that additional water quality monitoring is undertaken within:

- CWD;
- TSF4;
- Associated seepage drain downstream of TSF4; and
- Walgorup Creek, immediately downstream of TSF4.

The parameters and frequency of point source emission monitoring as specified in the Licence (Table 3.2.1) should be adopted for the above locations for the first year of operations. This program should be reviewed and updated accordingly beyond the first year.

A number of sample locations may not be required for continued monitoring given the extent and density of the existing program. Surface water quality sampling locations that may be considered for removal from the existing program include:

- D11, CWP, and DrainCWP – These sampling points will be redundant upon amalgamation of CWP with TSF2.
- D8-4 and FloydSSP – These sites have historically demonstrated very consistent observations compared to D8. As such D8 is considered suitably representative of water quality from the Floyds North catchment.
- TSFSEDRN – upon completion of TSF4 this sampling location will be inaccessible.
- VULTAN – after waste rock infill of Vultan Pit.

It is considered that sufficient water quality monitoring exists for point source emissions from the eastern catchment, and additional sampling locations will not be required.

Mitigation

Should water quality from the immediate eastern catchment (i.e. monitoring sites Carters, D8-4, FLOYDSTH, and SWG) begin to deteriorate, consideration should be given to establishing water collection infrastructure to intersect and store runoff from the eastern catchment (and ultimately from the WRL) for return into the western catchment. It is noted that Talison have begun investigating options to capture and return drainage from the eastern catchment primarily to supplement the mine’s water supply.

The proposed CGP3/4 processing area, ROM, explosives storage, and MSA, should be appropriately bunded, and any runoff directed into sumps for recirculation into the western mine water circuit. Contaminant spills outside engineered containment systems should be immediately recovered or disposed appropriately in accordance with the site Licence.

4.6 Surface water – groundwater interactions

The following sections provide comment on the surface water and groundwater interaction. These comments are based on the alluvium/dredge material and the underlying basement material determined as part of the site-wide hydrogeological assessment (GHD, 2018c).

4.6.1 Alluvium/dredge material

The areas in and around the mine development envelope which exhibit strong surface water and groundwater connectivity are associated with the current drainage and palaeo-drainage lines (See **Figure 4-30**).

In these areas, the alluvium/dredge material is generally coincident with the surface water drainage system and occupies the topographical lows and is also likely to underlie parts of the tailings facilities (TSF1 and TSF2).

The common occurrence of water bodies and observed baseflow into creeks (within the alluvium/dredge material), indicates that groundwater levels are shallow and there is likely a high degree of hydraulic connectivity between the surface water features, including the seepage interception drains around the tailings facilities.

The presence of a low permeability basement material beneath the alluvium/dredge material (clays), is inferred to limit the downwards migration of shallow derived waters into the deeper groundwater system.

As a result, any surface water expressions of groundwater within the western water circuit are likely to be captured and recycled within the water circuit. Conversely, surface water expressions from the eastern circuit discharge into the receiving environment (Salt Water Gully and Hester Brook).

4.6.2 Basement material

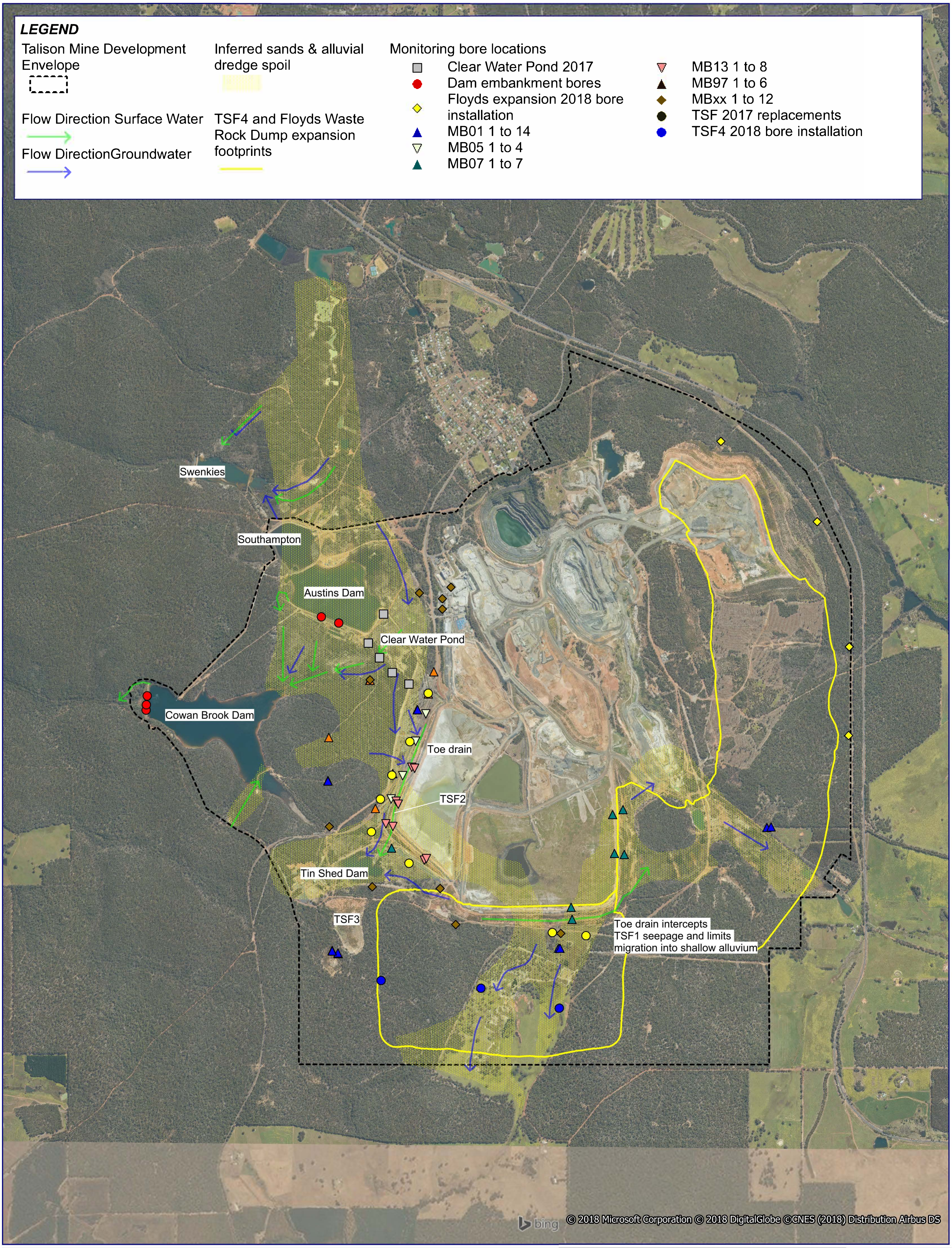
The current understanding of groundwater seepage into creeks derived from the basement material (weathered basement) is presented in **Figure 4-31**. The seepage, as baseflow, is inferred through observations during Site mapping, site walkovers, aerial photos (indicating wetlands/water bodies/creeks) and the groundwater steady state groundwater flow model (GHD 2018a).

Figure 4-31 shows that where seepage occurs outside the mining development envelope, these areas are deemed as the receiving environment, which may be affected should impacted groundwater discharge. This could negatively affect the ecological environment of the creeks.

4.6.3 Seepage discharge from existing facilities to off-site surface water areas

In general, where seepage occurs within the mine site area (eg: TSFs) the seepage is captured and managed within the water circuit. However, where dams and/or facilities are located on the margins of the mine development boundary, seepage will discharge into areas located outside the development boundary. These observed seepage sources into areas outside the development boundary include the following, **Figure 4-31:**

- Seepage at foot of Southampton Dam discharging into Spring Gully.
- Seepage at foot of Cowan Brook Dam discharging into Cowan Brook.
- Seepage at the foot of Cemetery Dam into the associated creek.
- Seepage derived from the WRL migrating into Saltwater Gully.



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Kilometers

Paper Size A3

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 50

N

Talison Lithium

Site-wide hydrogeological assessment 2018

Inferred distribution of sand & alluvial dredge, and water flow direction

Project No. 61-36958
Revision No. -
Date 08/08/2018

FIGURE 4-30

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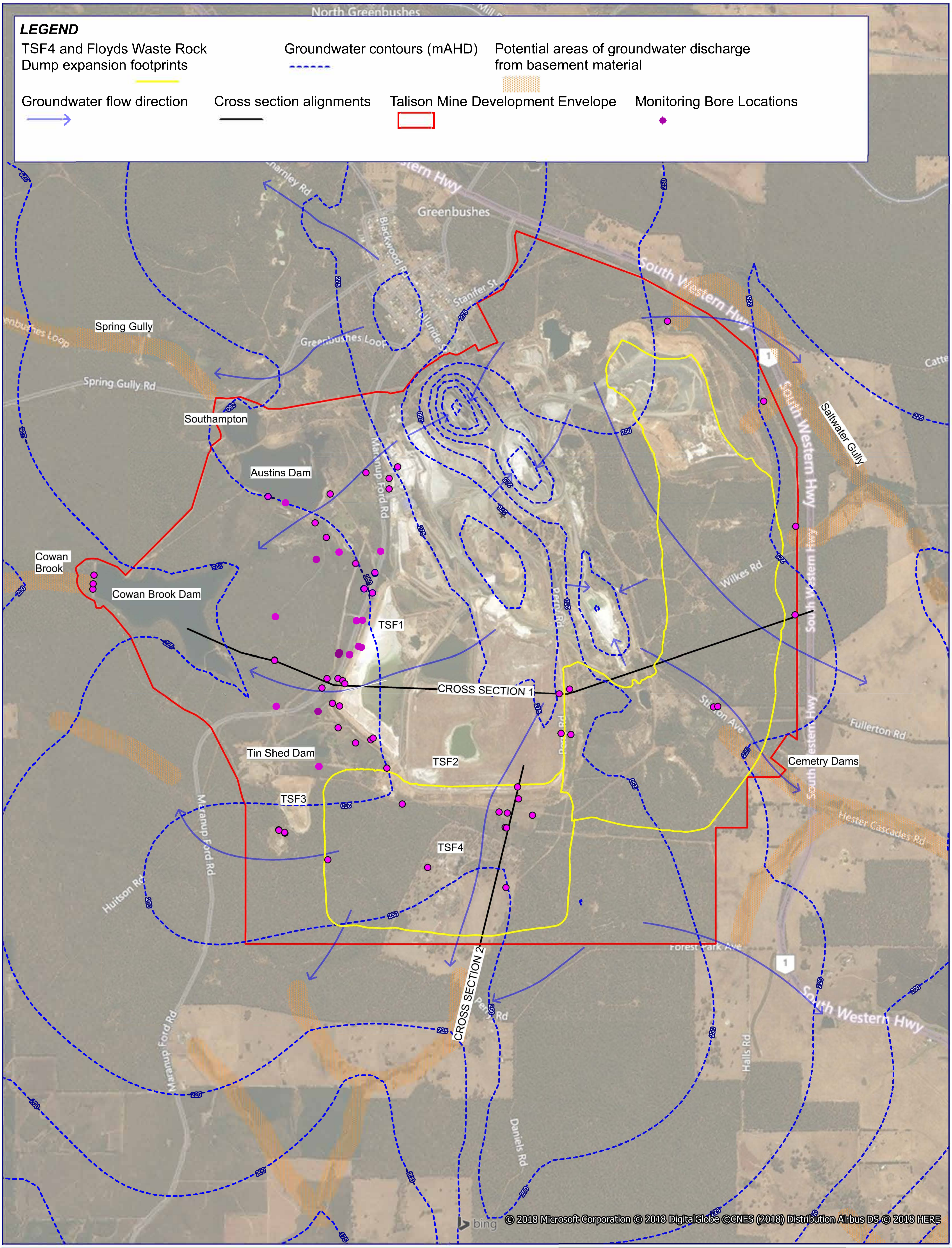
Data source: GHD, Talison, August 2018



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Kilometers

Paper Size A3

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 50

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GHD

Talison Lithium

Site-wide hydrogeological assessment 2018

Groundwater discharge

Project No. 61-36958
Revision No. -
Date 08/08/2018

FIGURE 4-31

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Data source: GHD, Talison, August 2018

5. Erosion and sedimentation

5.1 Overview

Erosion and sedimentation control (ESC) systems are in place for key aspects of the mine site within the following management plans:

- ENV3003 – Hydrocarbon Management – Maintenance and Clean-up
- ENV8000 – Weed Control Management Plan
- ENV8001 – Dieback Management Plan
- MIN2024 – Environmentally Hazardous Waste Rock management
- MIN10001 – Tailings Storage Facility management Plan
- MIN11000 - Waste Rock Management Plan

No specific ESC plan currently exists for the site. An ESC plan outlines ways to manage the risk of erosion and release of sediment to receiving waters. To this end, this section identifies existing and future ESC issues, and outlines a number of treatment measures (**Section 5.3**), maintenance processes (**Section 5.4**), and other specific considerations (**Section 5.5**) that may later be incorporated into a stand-alone ESC plan. This has been undertaken by way of the following staged approach:

- Identification of land uses and landforms at risk of releasing sediments and erosion to receiving waters;
- Undertaking a preliminary risk assessment to assess the impact on downstream water quality and requirement for management controls; and
- Determining the type and location of control measures based on land use using the ICEA (2008) ESC fact sheet and ESC matrix.

5.2 Sources

Key landforms with the potential to exhibit erosion and sedimentation issues are the WRL, mine pit, stockpiles, sediment ponds, and cleared areas. The following activities would contribute to erosion and sedimentation of these areas:

- Pre-strip clearing
- Pre-strip excavation
- Vegetation clearing
- Topsoil stripping
- Construction and maintenance of haul roads
- Overburden excavation
- Drill and blasting
- Crushing
- Loading and transportation of ore
- Stacking and reclaiming stockpiles
- Stockpiling and handling of ore

- Stockpiling of topsoil
- Placement of soils
- Stacking and reclaiming stockpiles
- Construction of linear infrastructure
- Placement of spoil and formation of WRL
- Excavator/earthmoving equipment
- Discharge of sediments and water

5.3 Treatment measures

5.3.1 Treatment selection criteria

Selection of the appropriate treatment measures are based upon the following principles:

- Control the location and velocity of surficial flows;
- Minimise the extent and duration of soil disturbances;
- Minimise soil erosion initiated by rain, concentrated flow or wind;
- Minimise sediment flow from and around site;
- Revegetate and stabilise all exposed and/or unstable soil surfaces as soon as practicable; and
- Install, operate, maintain and reassess appropriate erosion and sedimentation control measures.

5.3.2 General design and construction approach

All works on site should be undertaken with due consideration to the potential drainage, erosion and sediment risks. Areas showing existing erosion and sedimentation should be avoided where possible.

Sites that have been cleared should not be left without treatment for an extended period of time. Bunding and drainage should be constructed to ensure that runoff from disturbed areas is discharged without appropriate ESC treatment.

5.3.3 Erosion controls

Erosion control measures are required to minimise movement and loss of sediments at the source, and typical measures include:

- Minimising the area and duration of disturbance;
- Minimising soil and stockpile erosion caused by wind and rain; and
- Minimise turbidity in stormwater runoff by minimising exposure of soil to rain and surface flows.

Areas used for stockpiling, waste rock dumping, laydown areas, haul roads, ROM pads and other large cleared areas are susceptible to erosion. These areas should be bunded (or windrows for haul roads) and distanced from floodplains and waterways. Periodic wetting should be undertaken to minimise wind erosion during dry wind days. Stockpiles of growth media or cleared topsoils should be stored as close as practicable to their origin for use in closure works.

Stabilisation methods such as revegetation and gravel application should be undertaken on disturbed areas as soon as practically possible. These methods act to protect surficial sediments against raindrop impact and stormwater flows via:

- Increased surface roughness which reduce erosive flow velocities;
- Physical barrier between earth and raindrop impact/flow; and
- Increased water storing capacity of soil, reducing runoff volumes.

Revegetation is an effective long term strategy, and is a requirement of the mine closure plan. Revegetation should be carried out on exposed soil profiles and surfaces that have the potential to cause sediment movement and erosion, including the WRL in particular. Native plants are preferable as they have strong soil binding capability and generally compete well with weed species.

5.3.4 Sediment controls

Sediment control strategies aim to limit the movement of sediments by removing them from stormwater flow. Where practical, sediment controls should trap sediment close to its source to minimise soil particle breakdown and release of dispersive clays. An additional control is typically required immediately prior to discharging water from site.

Sheet flow is anticipated on a small scale via the access roads throughout the site. Sediment and debris washed from the roads may impact sheet flow. Control options such as road bunds and buffer zones along road verges are currently in place amongst the majority of existing roads, and are recommended for the proposed haul roads. Buffer zones are flat or gently sloped areas with a rough surface, for example a grassy area or gravelled area.

Settling ponds or basins and other treatment options are currently utilised within the processing areas on site. These should also be applied to capture sediments from the WRD. Sediment basins can retain particles down to 0.045 mm, and are typically designed to be cleaned out on a regular basis. To this end, sediment controls generally require the greatest maintenance of other ESC measures as sediment-removal after a storm event is important to ensuring sediment control structures function as intended.

Other more specific sediment control options are described in **Section 5.5**.

5.4 Maintenance

Ongoing maintenance of erosion and sedimentation controls is required, and appropriate access should be provided if maintenance is required on any structure. Mitigation measures requiring minimal regular maintenance or simple maintenance procedures are generally preferred.

The Environmental Management Strategy (EMS) documents listed in **Section 5.1** identify monitoring and maintenance requirements related to erosion and sedimentation control for particular aspects of the mine, including a Water Rock Management Plan for the WRL.

Some typical maintenance requirements for specific items located throughout the mine are summarised in **Table 5-1**. A monitoring checklist should be kept of ESC measures, with entries made following inspection and maintenance activities.

Table 5-1 Typical ESC maintenance requirements

Item	Inspection frequency	Required maintenance	Maintenance activities
Culvert	Prior to wet season After a major rainfall event	When sediment accumulates to the extent that it disrupts flow volumes	Remove accumulated sediment, plant matter and debris Dispose of removal materials to an appropriate facility of licenced storage location Repair all damages made by sediment to maintain erosion protection measure.
Revegetation	Monthly After a major rainfall event	When areas have been eroded of topsoil or growth medium. Where vegetation is not yet fully established.	Re-application of topsoil or growth media where required Assess if vegetation has been damaged, or if any channelling, erosion or weed problems have occurred. Watering, reseeding and weeding to maintain revegetation level. Maintenance of any upslope diversion channels or protective fencing
Landform slopes	Prior to wet season After a major rainfall event	When erosion patterns change landform aesthetics and structural stability	Re-application of topsoil or growth media where required Assess if slopes and vegetation on slopes have been damaged, or if any channelling, erosion or weed problems have occurred. Watering, reseeding and weeding to maintain revegetation level. Maintenance of any upslope diversion channels or protective fencing
Sediment trap	Prior to wet season After major rainfall event	When debris has accumulated or sediment has filled 10% of basin volume (marked by post)	Remove debris and sediment Dispose removed material appropriately Repair any scour damage to inlet/outlet, and embankment vegetation Pump-out retained water to maintain capacity for subsequent storm events

Item	Inspection frequency	Required maintenance	Maintenance activities
Revegetation	Weekly After a major rainfall event	When areas of mulch have been eroded or if vegetation does not establish within the required time	Re-application of mulch Assess if vegetation has established and identify any erosion, channelling or weed problems Watering, reseeding and weeding to maintain dense growth of vegetation. Fertiliser should be kept to a minimum. Regular watering during establishment period with possible soil conditioning. Application of additional mulch as required. Maintenance of any upslope diversion channels or protective fences.

5.5 Specific ESC considerations

The following specific ESC considerations apply to proposed mine expansion changes.

5.5.1 Mine pits

Design, construction and operation

Pits C1, C2 and C3 are active mining pits and Cornwall Pit and Cornwall Pit North are in care and maintenance. The expansion of the mine includes the amalgamation of the three active pits into one large “super pit” 2.6 km long 1.0 wide and 450 m deep. The overall footprint of the pit will increase from a current combined area of 60 Ha, to 120 Ha, and will increase from a current maximum depth of 130 mAHD to -130 mAHD.

The current erosion protection at the surface of the pits will need to continue to be incorporated in the design of the pit as it expands to prevent ingress of surface water runoff. In particular, the sumps located directly north and south of the C1/C2 pit should be maintained for as long as reasonably practicable. Suitable replacement sumps should be established to prevent ingress of surface water runoff into the pits when these existing sumps can no longer be maintained.

A dewatering assessment indicates groundwater inflow would increase from a current modelled rate of around 4 L/s to a maximum rate of 23 L/s (average of 15 L/s during the expansion phase) (GHD, 2018e).

Bunds along access roads to the pits should continue to direct water to these sumps as the pits expand. It is expected that the existing bunds on the western, northern and eastern walls of Cornwall Pit will continue to prevent surface runoff from entering the pit.

The pit expansion should be designed with slopes that will maintain stability and prevent erosion both during operation and after closure. Continuation of the benched approach will maintain the reduced velocity of the water down the sides of the pit, and provide a suitable runoff pathway for collection in the sump within the pit(s).

Runoff collected in the C3 sumps should continue to be transferred to Cornwall Pit, where it is pumped to the new CWD. Runoff collected in the C1/C2 sumps should continue to be transferred to Vultan Pit until such time that dewatering commences in Vultan Pit in preparation for infill by the WRL (expected to be 2024). At this point, pit water should be transferred to the new CWD for continued reuse.

Given that the pits are located on the ridgeline intersecting the mine, a flood risk assessment is not considered necessary for the pit expansion. Visual inspections of the pit walls, roads and sumps should be carried out after storm events for signs of erosion and sedimentation, and any damage made good.

Closure

The Cornwall Pit and combined super pit will remain after closure of the site. The walls of the pits should be stabilised for the closure required, which may include re-grading the slope and application of stabilisation techniques such as coarse material, geofabrics and revegetation. Access to the pit should also be restricted via fencing, landforms and/or abandonment bunds.

5.5.2 Floyds Waste Rock Landform

Design, construction and operation

The existing and proposed Floyds WRL comprises the deposition of overburden and barren rock which are excavated to access the pegmatite ore body. The existing and proposed waste rock is trucked and dumped onto the pre-existing unlined ground surface. The footprint of the existing and proposed Floyds WRL is presented in **Figure 2-1**. The conceptual design for the WRL extension is for an ultimate height of RL 330 m AHD, and a footprint of 362 ha with capacity to store up to 300 Mbcm of waste.

The profile of the WRL (e.g. height and slope angles) will be designed to ensure that the final structure is safe, stable and not prone to significant erosion, as per the Waste Rock Management Plan (Talison, 2017). Specifically, the design incorporates the following influencing factors:

- Height and operating life of the storage;
- Potential for changes in expected rock mass stored, and available material to provide long-term slope support;
- Production rate;
- Size, shape, and orientation of the storage;
- Location of infrastructure (haul roads, and access routes);
- Potential for surface water and groundwater problems;
- Equipment to be used for deposition of rock and forming and rehabilitating slopes
- Failure methods and potential risks;
- Presence of nearby surface features (i.e. town site, public roads);
- Potential for the general public to inadvertently gain access to the storage during and after construction;
- Time-dependent characteristics of the rock mass.

The construction of the WRL will continue to allow for progressive rehabilitation. The completed outside faces should be rehabilitated early in the operation when the viability of the topsoil is highest. Topsoil should be cleared and stockpiled progressively to provide the greatest opportunity for soil to remain viable for rehabilitation. Areas cleared should be sufficient for construction only and further clearing to accommodate expansion of the landform for the shallower slopes at closure should only occur prior to rehabilitation.

The surface of Floyds WRL is highly permeable and rainfall will infiltrate readily into the waste rock profile (until closure capping is completed). The WRL is located on the top of a hillside and as such its catchment area is limited to its own surface area. A small bund will continue to be constructed along the outer edge of the dump to reduce overflows down the WRL wall, and flows will also continue to be controlled via a series of 1:30 drainage ramps. Ongoing inspection of the drainage/ banks/bunds will be required through operation.

Closure

The WRL will preferably be designed to discharge storm water back into the open pits upon closure. Drainage and ESC treatment infrastructure for operation of the WRL can be removed and rehabilitated during closure. Surfaces should be deep ripped on contour at appropriate spacing. Rip lines on outer slopes are to be survey controlled to ensure horizontality and prevent erosion propagation. Seeding should occur within the optimal period that maximises benefits from annual rainfall and temperature.

The WRL should be finished with no short, steep topographical disruptions. Specifically, the WRL design should satisfy a rehabilitation strategy to prevent erosion, and it is noted that a rehabilitation strategy with further detail is being developed separate to this document. The WRL should be re-contoured to ensure:

- Slopes are no greater than 20˚ for more than 20 m unless it is on a contour of the surrounding forest floor;
- Slopes are always less than 25˚;
- Bench intervals are up to 200 m;
- Bench widths are approximately 10 m;
- Bench slopes are 0.5˚ along the contour;
- Bench back-slope angles are 5˚; and
- Cuttings or drains are at least three metres wide.

TalisonAfter re-contouring, collected stormwater should be conveyed to vertical drains. The number of vertical drains should be appropriate for the final slope angles and individual catchment area areas should not exceed 1 ha on 20 degree slopes. Water from these vertical drains should be dissipated and discharged in a manner that will not cause any erosion at the base of the slope.

Drainage structures should be maintenance free to ensure no failures occur before vegetation is well established. Waterways should be lined with rock. Vertical drains should be excavated so that they are lower in profile than the dump slope after placement of rock material. Wing banks should be constructed to direct runoff to the drain.

5.5.3 Tailings storage facilities

Design, construction and operation

There are three TSFs onsite, TSF1, TSF2 and TSF3. There is a proposed additional TSF, TSF4, which will be located south of the existing TSF2. TSF1 and TSF2 will combine into a single TSF through a progression of lifts and raises. TSF3 is a legacy TSF that has been progressively rehabilitated. TSF design is in accordance with ANCOLD 2012, and comprise unlined cells, constructed on the pre-existing surface level bound by retaining embankment walls.

Drain structures are constructed around their embankments to intercept seepage water which is directed to low points and pumped to the holding dams, such as Clear Water Dam.

Figure 2-1 shows that TSF4 is to be constructed immediately to the south of TSF1, with the southern TSF1 embankment forming the northern embankment of TSF4. This common embankment is to be raised to allow further filling of TSF2. The proposed southern toe of the embankment of TSF4 is to be keyed-in to the underlying clay through excavation of the shallow sands to expose the underlying weathered clay basement.

Tailings deposition in TSF4 will be consistent with that of TSF1 and TSF2, in that it will be placed around the perimeter with a central decant. TSF4 will be developed in stages, with the perimeter embankment being constructed at the outset.

To control surface runoff and avoid erosion of the perimeter embankment, surface runoff collector drains will be constructed along the downstream toe of the TSF4 perimeter embankment. Collected water will be directed/pumped to holding dams (e.g. Clear Water Dam).

Runoff and decant from TSF4 will be collected in a seepage sump and transferred to the process water dam for reuse. This will minimise water affected by the tailings discharged.

Topsoil should be cleared and stockpiled in a manner that ensures it remains viable for rehabilitation. Should TSF4 be constructed in the wet season, a temporary bank/bund should be constructed along the upstream (northern/western and eastern extents) to divert any runoff from the disturbed area.

Routine inspections of collector and toe drains should be undertaken, as consistent with the existing TSFs. These drains should be kept in working order throughout the life of the mine.

Closure

The TSFs will be capped and stabilised at closure. Seepage sumps will be deconstructed and perimeter embankment will be lowered or removed to ensure the final landform blends with the natural landscape. Slopes will be contoured to a gradient of 1:3. This slope may be problematic regarding erosion following rehabilitation. Accordingly, surface treatment for revegetation must break ground compaction in the plant root zone, enhance infiltration and water from rainfall and runoff. Contour ripping may be necessary and this operation should graft the topsoil layer into the underlying cap material.

5.5.4 Clearing

Where possible, topsoil from excavated areas should be stored for future use in rehabilitation. Topsoil stockpiles should be protected with appropriate ESC structures and stabilised to prevent excessive wind erosion. Construction of cleared areas should occur shortly after vegetation clearing and topsoil removal to limit the risk of erosion.

A number of dust mitigation measures incorporated as part of the site’s Environmental Dust Management Plan (ENV1004), including cropping, application of dust suppressants, wetting, and stockpile covers, also act as erosion mitigation and should continue to apply for future stockpiles.

5.5.5 Stockpiles

Design, construction and operation

Areas of stockpiled material can be particularly problematic with relation to ESC issues, and include:

- Ore stockpiles;
- Topsoil stockpiles;
- ROM pads; and
- Loadout facilities.

Stockpiles are recommended to be stored on sealed surfaces and preferably on areas graded to be relatively flat. Runoff from working areas should be conveyed to appropriately sized sedimentation basins, as is currently the case for the existing processing areas. Ongoing inspection of sedimentation basins and drainage banks/bunds is required through operation. Sediment collected from basins should be disposed of on the WRL.

Stockpiles of topsoil, where possible are advised to be stored near their origin to minimise the cross contamination of surficial soils across the site. Stockpiles of orange softrock are to be stored in close proximity to topsoil stockpiles to minimise external cross contamination of the growth medium and topsoils of different domains throughout the site.

Closure

The ROM pads will be demolished and related infrastructure removed. These should be landscaped to fit with the surrounding areas and revegetation and mulching should be completed as soon as practical. Where possible, topsoil from the site itself should be used in the revegetation. Gravel and other stabilising materials may be required to stabilise the pad while revegetation is occurring.

5.5.6 Access roads

Design, construction and operation

The details of a new access road, including its location, design, and construction have not yet been developed. The location is likely to be located west of the site, south of the town-site, through areas previously disturbed by mining activities. Key aspects in the construction of any new access roads with respect to ESC are:

- Borrow pits;
- Clear and stockpile material for remediation works;
- Road drainage; and
- Rehabilitation of road batters including cutting of drainage swales.

Any new road should be designed according to the appropriate Australian Standard. Roads with good drainage will degrade very quickly. Where possible, table or V drains should be constructed to remove the run-off water from the edge of the road for treatment. Catch drains should be constructed along slopes parallel to the road to divert runoff from up-gradient areas across the road alignment via culverts.

Adequate drainage should be provided to carry away the maximum expected rainfall, with minimum puddling, pot-holing or water entry into road sub-base. Appropriate diversion in the form of constant cross falls and drains should be provided. Safety berms are also required in the case of in-pit haul roads and roads in proximity to other operations. Due consideration to the maintenance of safety berms and drainage should be applied in design.

General design principles for ESC on mine sites:

- All roads need to be properly drained;
- Open drains steeper than 8% should be rock protected to prevent erosion; and

- Road drains should channel water to diversions and on to appropriately sized sedimentation basins.

Furthermore, the following general maintenance principles apply with respect to ESC:

- All road drains need to be inspected and maintained;
- Sedimentation basins should be inspected and any excess sediment removed and disposed of appropriately;
- Drains and culverts should be kept clear of obstructions to minimise potential erosion factors; and
- Continued upkeep is required to maintain cross slopes, remove spills and to fill and smooth surface depressions.

Dust suppression should continue as required, during dry windy conditions, and during summer months to minimise wind erosion.

Closure

Access and haul roads will be maintained until closure is complete.

6. Preliminary risk assessment

6.1 Overview

This preliminary risk assessment considers only the risks associated with the proposed mine expansion. This assessment does not classify the risks, but rather aims to identify the key risks as well as the associated mitigation measures proposed.

6.2 Source receptor pathways

This section identifies the sources, pathways, and receiving environment for contaminants from the Site. Other risks (such as reduced discharges into downstream waterways) are explored in **Section 6.3**.

6.2.1 Sources

Potential contaminant sources resulting from the proposed mine expansion include:

- Disturbed surfaces such as pre-strip;
- Beneficiation associated with crushing, grinding and concentration;
- WRL;
- TSFs;
- Active mining areas;
- ROM pads;
- New haul roads and lay down areas;
- Mine services area;
- Magazine; and
- Water storages, particularly Cowan Brook Dam, Southampton Dam, and Austins Dam.

Potential release mechanisms for contamination include:

- Erosion of disturbed surfaces;
- Inadequate stormwater/runoff separation;
- Leaching from the WRL and long term stockpiles;
- Seepage from the TSF and water storages; and
- Accidental spills.

Specific source and release mechanisms are explored further below for each operational domain of the expansion.

TSF4

A general description of TSF4 is provided in **Section 5.5.3**. The water quality in the tailings water is a reflection of the tailings/slurry deposition, constituents derived during weathering of the tailings in-situ, as well as elements derived from other mining areas, including processing, dust suppression, and herbicides. The active TSF2 demonstrates this with concentrations of heavy metals and reagents in tailings water that have increased over 17 years of monitoring.

Water from the TSF will be recirculated to the CWD as far as reasonably practical.

The TSF4 will be unlined, however the underlying low permeability clay is expected to restrict downwards migration of water. Seepage collection at the TSF toe will be constructed to manage any lateral seepage through the embankment toe and walls. This water will be re-circulated into the western water circuit.

WRL

A general description of the WRL is provided in **Section 5.5.2**. The expansion of the WRL may result in the generation of degraded water quality and subsequent seepage or runoff of this water downstream. Degradation of water quality has been observed from the existing WRL, particularly with respect to Lithium, Sulfate, Arsenic and Nickel. The prevalence of low permeability clays which underlie the WRD should hydraulically isolate connectivity with the underlying groundwater system. As such, the majority of water captured within the WRL catchments will discharge into Salt Water Gully.

CGP3/4 Processing Area and ROM

The processing techniques for production for chemical grade lithium includes, crushing, milling, screening, flotation, attritioning, heavy media separation and dewatering. The reagents used for both lithium grades are oleic acid, soda ash and frother and filter aids. Ferrosilicon is used in the chemical grade processing pathway.

The potential sources of impact comprise chemicals, acids, alkalines, lubricants and fuels used for processing ore and maintenance and servicing of equipment.

Stored ore/processed ore has potential to runoff or leach contaminants during weathering/infiltration of rainfall located on ROM pads.

Expanded Pits

A general description of the pits is provided in **Section 5.5.1**.

Preliminary AMD assessments indicate that the ore and water are relatively geochemically inert (GHD 2018d), however the exposure of the mining face may result in the oxidation and weathering of minerals which has the potential to generate and degrade water quality..

Blast reagents containing residual nitrates may also be generated within the pit domain.

Any degraded water quality will gather within the pit sumps, and dewatering from these sumps will re-distribute this water within the western water circuit.

Water Storages

Section 3.3.3 provides a description of the mine water storages. The generalised water quality within the existing storage dams has been characterised in **Section 4.5.2**.

Discharge of surface waters is limited to:

- Dam water seepage from Cowan Brook and Southampton Dams.
- Discharge of surface water from the eastern catchments.

All other water storages are internally draining.

Mine Services Area and Magazine

Existing workshops include areas for maintenance of light and heavy vehicles and plant and storage of dangerous goods including a batching facility, magazine and explosive workshop. These will be relocated to the Mine Services Domain during the initial stages of the expansion. All workshops are located on impervious surfaces. The potential sources of impact comprise chemicals, acids, alkalines, lubricants and fuels used for processing ore and maintenance and servicing of equipment.

6.2.2 Contaminants of potential concern

The following have been identified as CoPC as discussed in **Section 4.5**, with respect to point source emissions of surface water from the site:

- pH;
- Salinity;
- Lithium;
- Arsenic;
- Cadmium;
- Chromium;
- Copper;
- Manganese;
- Nickel; and
- Uranium.

6.2.3 Exposure pathways

Key exposure pathways include:

- Runoff from contaminated surfaces;
- Overflow and seepage of mine affected water from water storages;
- Leaching of contaminants from spoil stockpiles, WRL, TSFs and water storages;
- Airborne transfers from stockpiles, WRL, processing plant and vehicle movements;
- Fauna interaction with contaminated waters and sediments; and
- Human interaction with contaminated waters and sediments.

6.2.4 Receiving environment

The receiving environment that may be impacted by changes to surface water conditions from the proposed expansion include:

- Downstream aquatic systems (water ways, groundwater dependent ecosystems (GDE));
- Humans (recreation and consumption); and
- Fauna and livestock (consumption).

The downstream watercourses referred include Norilup Brook, Salt Water Gully, Hester Brook, Woljenup Creek and Blackwood River. **Figure 6-1** depicts these environmental receptors, which are described in further detail below. No Public Drinking Water Source Areas exist immediately downstream of the site, however it is noted that one exists upstream of the Site in the headwaters of the Norilup sub-catchment.

Land and water use

The majority of the Norilup sub-catchment downstream of the Site is State Forest and Crown Reserve. Approximately one third of the sub-catchment is made up of private rural holdings that have been cleared for agricultural use. A survey of landholders who have direct access to the

Norilup Brook was conducted to understand their water uses (Talison, 2015). Of the five landholders identified, four were private owners and with the other being the State of Western Australia. No landholders were using the brook for human consumption, three landholders used the water for livestock, and one had built a dam on Norilup Brook for garden irrigation purposes. None of the landholders questioned intended to increase or change their water use from Norilup Brook.

The Hester Brook, Woljenup Creek, Salt Water Gully, and Blackwood River catchments downstream of the Site are similarly made up of State Forest, Crown Reserve and Freehold land. Land-use generally comprises agricultural use including grazing andperennial horticulture as well as rural residential. A landholder survey identifying water use has yet to be undertaken for these waterways. These waterways are unlikely to be used for human consumption given their elevated salinity levels, which have been recorded prior to Talison operations. These waters may be in use for livestock and irrigation.

A review of the Water Information Reporting (WIR) database indicates that there are around seven predominately shallow bores located within 5 km of the mine site. Where information is provided on the bore's groundwater usage, they tend to be for supplementing garden irrigation.

Applicable water quality trigger values with relation to irrigation, livestock use, health and recreation are discussed in **Section 4.5.1**.

Environmentally sensitive areas

The BoM Groundwater Dependent Ecosystems Atlas identifies ecosystems with moderate reliance on sub-surface expressions of groundwater throughout the mine area, and areas with high potential for reliance situated downstream of Cowan Brook Dam and Swenkes Dam (BoM, 2012). No ecosystems reliant on surface water expressions of groundwater have been identified within the vicinity of the mine Site based on the Atlas.

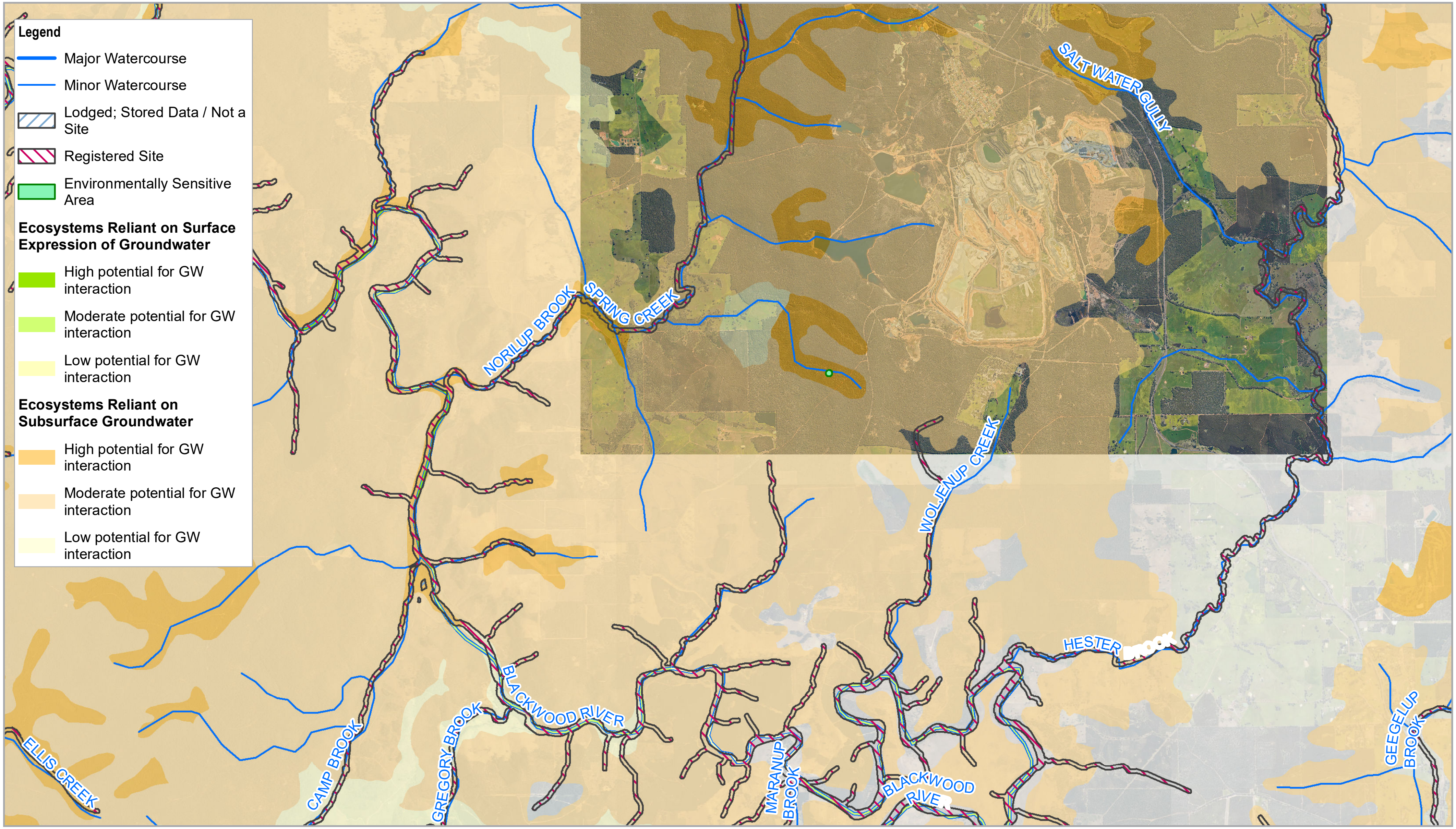
A number of biological surveys have identified conservation significant flora and fauna throughout the forest areas within and downstream of the Site (Biologic, 2018).

An Environmentally Sensitive Area exists approximately 1 km southwest of the site which is protected from clearing as declared in Environmental Protection Notice 2005, Government Gazette no. 55. An EPA Redbook Conservation Reserve named as part of 'The Darling System' exists approximately 1.2 km south of the Site. These areas are unlikely to be impacted by surface waters, and any impacts would be a result of indirect impacts to fauna and flora in these areas (i.e. impacts to GDE's).

Applicable water quality trigger values with relation to ecosystem protection are discussed in **Section 4.5.1**.

Heritage

The mine site and downstream flows are within the Indigenous Land Use Agreement held by the Wagyl Kaip Southern Noogar People and South West Boojarah # 2 People. An Aboriginal heritage survey undertaken for the Talison Mining Tenements identified the Blackwood River (including tributaries) as the only registered Aboriginal Heritage Site in proximity to the Mine (Brad Goode and Associates, 2016, 2018), (refer **Figure 6-1**). No water quality guidelines currently exist to specifically preserve the cultural integrity of surface water flows, however there are provisions under the Aboriginal Heritage Act 1972 to protect identified areas from being significantly modified or altered.



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

Talison Lithium Pty Ltd
Talison Mining Proposal
Surface Water Assessment

Project No.
Revision No. 0
Date 21/01/2019

Key Environmental Receptors

FIGURE 6-1

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Print date: 21 Jan 2019 - 13:38

Data source: DWER: ESA - 20170213; DAA - Aboriginal Heritage Place - 20160128; BoM - Subsurface-reliant GDE - 20121115, Surface-reliant GDE - 20121115; Talison: Imagery - 20171002; GA: Watercourse - 20060613 . Created by: cahardie

6.3 Assessment and risk management

A preliminary assessment of the potential risks and proposed control measures of the expansion is provided in **Table 6-1**.

Table 6-1 Risk management

Identified risk	Proposed control measure
Erosion of disturbed surfaces and WRL	• Continued application of ESC procedures incorporated in the following site specific procedures: – ENV3003 – Hydrocarbon Management – Maintenance and Clean-up – ENV8000 – Weed Control Management Plan – ENV8001 – Dieback Management Plan – MIN2024 – Environmentally Hazardous Waste Rock management – MIN10001 – Tailings Storage Facility management Plan – MIN11000 - Waste Rock Management Plan • Preparation of an ESC Plan in accordance with Guidelines for Best Practice Erosion and Sediment Control (IESC 2008). • The ESC Plan should provide a framework for managing the risk of erosion and release of sediments to receiving environment or the contamination of stormwater. • The ESC plan will specify erosion control strategies and measures for the various phases of the expansion including construction, operation and closure, as preliminarily outlined in this report.
Runoff of contaminated stormwater	• Mine affected water to be retained within western water circuit. • Lithium treatment plant (due late 2018) will reduce lithium concentrations within the water circuit. • Ongoing use of arsenic treatment units will reduce arsenic concentrations within the water circuit. • Ongoing monitoring of water quality as per existing monitoring program specified in Licence and SWMP, with the addition of monitoring locations in CWD, TSF4, TSF4 toe drain, and Walgorup Creek as per **Section 4.5.5**. • Runoff from the proposed CGP3/4 processing area, ROM pads, MSA, and magazine to be directed to contaminated sediment basins specific to each area. • SWMP should be updated to reflect the above, and to accommodate proposed infrastructure and associated operating rules, monitoring and maintenance requirements.
Discharge of contaminated sediments and water from	• Appropriate design (sizing) criteria developed and applied. • Routine inspections and de-silting. • Spills directed to mine water storage, where applicable.

Identified risk	Proposed control measure
holding/sediment basins	
Hydrocarbon and chemical spills from plant and equipment, and from holding storages	• All hydrocarbons will continue to be stored and handled in accordance with the various site Hydrocarbon Management procedures (ENV3001 to ENV3006, and ENV3011), and in accordance with AS 1940:2004: *The storage and handling of combustible and flammable liquids.*
Reduced discharge quantities from the western and eastern catchments	• Continued monitoring of discharge rates from the eastern catchment, and of any overflows from the western catchment. • Continued annual ecology surveys to monitor any impact of reduced discharge on downstream receptors.

7. Summary and recommendations

Surface water risks associated with the proposed mine expansion are summarised below, and key recommendations are highlighted in bold font. The conceptual nature of the expansion plan should be noted and further assessment will be required to validate the below findings.

7.1 Water supply

Due to the mine's reliance on surface water and the expected increase in water demand and associated water loss (~10% of water drawn for processing is lost to evaporation/infiltration), the likelihood of discharges from the site is expected to reduce (GHD, 2017). Additional water collection infrastructure may be required to supplement the existing supply. **The SWMP should be updated to accommodate proposed infrastructure and associated operating rules to optimise water reuse**. Talison should continue to investigate potential water storages to supplement mine water supply.

7.2 Streamflow

Discharges from the site may reduce as a result of the increased water demand and water reuse from the expansion. The following actions are recommended to better understand changes that may occur downstream of the site and allow for appropriate action to be taken should significant disruption to existing downstream environments occur:

- **Monitor flows from Carters catchment, as planned.**
- **Monitor discharges from Norilup Brook Dam prior to and throughout expansion.**
- **The SWMP should be updated to accommodate the above monitoring requirements.**

Investigation of previous mine workings in the Floyds South catchment may provide a better understanding of the low streamflows observed from the Floyds South catchment.

7.3 Flood risk

The only area that may present a risk to downstream environments is the eastern catchment as a result of the WRL expansion. The high-level flood risk assessment determined that the overall contribution to Hester Brook from the WRL expansion will be negligible as a result of:

- The total area of the eastern catchment remaining unchanged;
- The inherent porous nature of the WRL which will allow for greater water storage capacity and hence provide some mitigation to peak flow events.

It is noted that the flood risk assessment undertaken assumes that dam break and existing and proposed drainage systems and water storages on site are designed to accommodate their appropriate design storm event.

7.4 Water quality impacts

The following key water quality trends are observed:

- Water quality in the mine water circuit has been declining, however management measures have sufficiently controlled discharges of poor quality water from the site, in line with Licence water quality limits.

- Surface water from the existing WRL reports higher concentrations of lithium, sulfate and nickel, compared to other undisturbed areas of the eastern catchment. As such, expansion of the WRL presents a risk of increased downstream impacts.

Potential impacts of poor water quality to receiving environments are limited to the following sources:

- Dam water seepage from Cowan Brook and Southampton Dams.
- Seepage from Cemetery Dam.
- Discharge of surface water from the eastern catchments.

Arsenic and lithium concentrations are expected to reduce within the mine water circuit as a result of the water treatment plant being commissioned (due 2019), and continued use of arsenic remediation units.

This study recommends that:

- **Additional surface water sampling locations are established at CWD, TSF4, TSF4 toe drain, and Walgorup Creek.**
- **Continued annual ecology surveys are undertaken to monitor water quality impacts on downstream receptors.**
- **Undertake survey of landholders adjacent to Salt Water Gully and Hester Brook to understand existing and potential future water uses.**
- **The SWMP should be updated to accommodate proposed infrastructure and associated operating rules, monitoring and maintenance requirements.**

7.5 Erosion and sedimentation

Clearing and construction of the TSF4, WRL and MSA result in disturbed surfaces that pose a risk of erosion. ESC procedures are incorporated as secondary aspects to a number of site specific procedures, however no specific ESC plan exists for the site. As such it is recommended that **an Erosion and Sediment Control Plan should be developed for the site**.

8. References

Biologic 2018, *Greenbushes Vertebrate, SRE and Subterranean Fauna Desktop Assessment*. Report for Talison Lithium Australia Pty Ltd, Greenbushes, April 2018.

Brad Goode and Associates, 2016. *Report of an Aboriginal Heritage Survey of Areas within Talison Lithium Greenbushes Operations at Greenbushes, Western Australia.* Report prepared for Talison Lithium Australia Pty Ltd, February 2016.

DMP 2016, *Guideline for Mining Proposals in Western Australia*, Department of Mines and Petroleum, April 2016.

GHD 2016, *Characterisation of Acid Metaliferous Drainage Potential from Tailings Storage Facility 2 (TSF2)*, GHD report for Talison Lithium Australia Pty Ltd, Talison Lithium Mine, Greenbushes, September 2016.

GHD 2017, *Water Balance Model and Lithium projections Study*, GHD report for Talison Lithium Australia Pty Ltd, Talison Lithium Mine Greenbushes, September 2017.

GHD 2018a, *Greenbushes Water Balance Model – Preliminary Assessment of Future Security of Supply*, GHD technical memorandum for Talison Lithium Australia Pty Ltd, Talison Lithium Mine, Greenbushes, February 2018.

GHD, 2018b. *Mine Expansion Water Balance Model*. Report for Talison Lithium Australia Pty Ltd, August 2018.

GHD, 2018c. *Site-wide hydrogeological assessment 2018*. Report for Talison Lithium Australia Pty Ltd, August 2018.

GHD, 2018d. *Assessment of acid and metalliferous drainage – 2018 Mining Proposal.* Report for Talison Lithium Australia Pty Ltd, July 2018.

GHD, 2018e, *Hydrogeological Investigation Open Pit Dewatering Assessment*, Report prepared for Talison Lithium Australia Pty Ltd, August 2018.

Neave, H., Sparrow, B, and Clifford, B. (2005) *Preliminary report: Towards a resource assessment of the Burt Plain Bioregion for conservation planning*, Conservation and Natural Resources, Department of Infrastructure, Planning and Environment, January 2005.

Talison 2014, 2013 Mining Proposal. Talison Lithium Australia Pty Ltd, Greenbushes Operations.

Talison 2015, ENV1001- Surface Water Management Plan, Version 5, Talison Lithium Australia Pty Ltd, September 2015.

Talison 2016, Mine Closure Plan 2016 – Greenbushes Mineral Field 01. Talison Lithium Australia Pty Ltd, September 2019.

Talison 2017, MIN11000 – Waste Rock Management Plan, Version 5, Talison Lithium Australia Pty Ltd, October 2017.

Waters and Rivers Commission (2000) *Water Facts: Sheet 13*, the Government of Western Australia, July 2000.

GHD

GHD, 999 Hay Street, Perth, WA 6000
P.O. Box 3106, Perth WA 6832
T: 61 8 6222 8222   F: 61 8 6222 8555   E: permail@ghd.com.au

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