CHAPTER 18
SURFACE WATER

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18 Surface Water

This chapter provides an overview of the existing environmental values relevant to surface water at the area covered by the proposed mining lease (the mine site). It includes a review of existing surface water characteristics and water quality. Earthworks and the establishment of hardstand areas have the potential to alter the quality and quantity of surface water available to support existing environmental values and changes to the landscape as a result of the integrated waste landform and open pit will alter surface water flow regimes at the site. The scale of effects on existing environmental values is discussed and, where relevant, management and/or mitigation measures that would minimise impacts and risks are identified.

18.1 Applicable Legislation and Standards

The relevant legislation relating to surface water at the mine site is the *Environment Protection Act 1993* (EP Act) and the *Natural Resources Management Act 2004* (NRM Act). The *Mining Act 1971* (Mining Act) also provides a legislative framework which seeks to ensure that mining operations manage environmental impacts and risks as far as reasonably practicable through the establishment of a Program for Environment Protection and Rehabilitation (PEPR). The PEPR sets out environmental outcomes which are expected to occur as a result of the mining operations and specific criteria to measure the environmental outcomes.

The EP Act requires that 'all reasonable and practicable measures are taken to protect, restore and enhance the quality of the environment and to prevent, reduce, minimise or where possible, eliminate harm to the environment'.

The EP Act establishes specific Environment Protection Policies which outline enforceable requirements or standards. The Environment Protection (Water Quality) Policy (Water Quality EPP) together with the EP Act forms the legislative framework which regulates activities likely to affect surface water.

Specifically, the Water Quality EPP specifies the following environmental values to be protected:

- Fresh water aquatic ecosystems
- Human water use, including:
  - Recreational use
  - Aesthetic value
  - Drinking water
  - Agricultural water use (including irrigation and livestock)
  - Industrial water use

The NRM Act promotes sustainable and integrated management of the State's natural resources and provides for their protection. The NRM Act includes provisions relating to the sustainable extraction of water resources and provides for prescription of water resources to protect against over use and to minimise adverse effects from development.

Water Affecting Activities (WAA) are administered under Section 127 of the NRM Act. To undertake most types of WAA, a permit is required from the relevant authority which, in most cases, is the Minister for Sustainability, Environment and Conservation through the South Australian Government Department of Environment, Water and Natural Resources (DEWNR) or the relevant Regional Natural Resources Management Board (NRM Board). To obtain a permit, the applicant must demonstrate that the WAA will be appropriately managed to protect environmental values. The area of the proposed mine site is located within the Eyre Peninsula NRM Board region.

18.2 Assessment Method

Existing surface water characteristics within the area of the proposed mine site were assessed by a desktop review of publically available information. The desktop investigation included a review of the following documents and information sources:

- CEIP Mine Site Hydrology Study (RPS 2015). The hydrology study provided a detailed analysis of climate data and baseline surface water run-off studies at the mine site and northern end of the infrastructure corridor. The study methodology included site inspections, limited soil permeability testing and landowner surveys and interviews to establish historic run-off patterns during heavy rainfall event. This report is at Appendix H.
- Natural Resources Management Plan for the Eyre Peninsula Natural Resources Management Region (Eyre Peninsula Natural Resources Management Board 2009).
- Eyre Peninsula Water Supply Interim Report “Under the lens” (Natural Resources Committee 2012).
- Surface water stream flow measurement data for the Tod River (Australian Natural Resources Atlas 2002).
- Long-Term Plan For Eyre Region: Summary (SA Water 2008).
- River Health on Eyre Peninsula (Ausrivas 1999).
- Eyre Peninsula Demand and Supply Statement (Department for Water 2011).
- Climate records for the Warramboo weather station 018090 (BoM 2014).
- WaterConnect data portal (DEWNR 2013).
- Stream flow paths as shown in the Australian Hydrological Geospatial Fabric (Geofabric) hosted by the Bureau of Meteorology.
- Australian Rainfall and Runoff: A guide to flood estimation (Engineers Australia 2003).

Field investigations were not undertaken as the occurrence of sufficient rainfall to generate sustained flows in the ephemeral drainage lines present in the region surrounding the proposed mine is uncommon and between rain events the landscape is typically dry. As such, the information that is able to be obtained from field investigations was not considered critical for a comprehensive assessment.

18.3 Existing Environment

This section provides an overview of the existing environment in the region surrounding the proposed mine in relation to surface water. Existing drainage patterns and watercourses are identified, as well as any known users of surface water runoff.

18.3.1 Rainfall

Climatic conditions at the proposed mine site and regionally are described in detail in Chapter 3. Mean annual rainfall on the Eyre Peninsula ranges from 263 mm at inland areas such as Wudinna, to 381 mm at coastal locations such as Port Lincoln (BoM 2013). There are three BoM stations within 15 km of the mine site, located at Warramboo, Kyancutta (Kyanbrae) and Koongawa (Retawon). Mean annual rainfall at the three closest BoM stations varies between 307.7 mm at Kyancutta and 343.4 mm at Koongawa. Based on recorded rainfall at each of the three closest stations, the representative mean annual rainfall at the proposed mine was calculated to be 325.4 mm.

Rainfall predominately occurs in the winter months of May to September, however major rainfall events can also occur in December, January and February during summer storms and in rare circumstances intense daily rainfalls can occur. The largest single rainfall event was recorded in February 1938 when 88.9 mm of rain fell in 24 hours and 114 mm fell in a 72 hour period (RPS 2015).

Recorded annual rainfall is variable, with wet and dry cycles ranging from 5 to 15 years in duration. The highest recorded annual rainfall in the region was more than three times the lowest recorded annual rainfall, with no discernible trend or overall tendency shown in the last century (RPS 2015).

18.3.2 Evaporation

Evaporation figures for the Wudinna Aero meteorological station reveal that the mean annual evaporation is approximately 1,912 mm over the last 4 years. The highest evaporation typically occurs in the summer months of November to February. It is also notable that average evaporation exceeds average rainfall for all months of the year.

Figure 18-1 portrays the recorded rainfall and evaporation figures for Wudinna Aero which is representative for the study area. Evaporation rates for other meteorological stations in the region are shown in Appendix H.

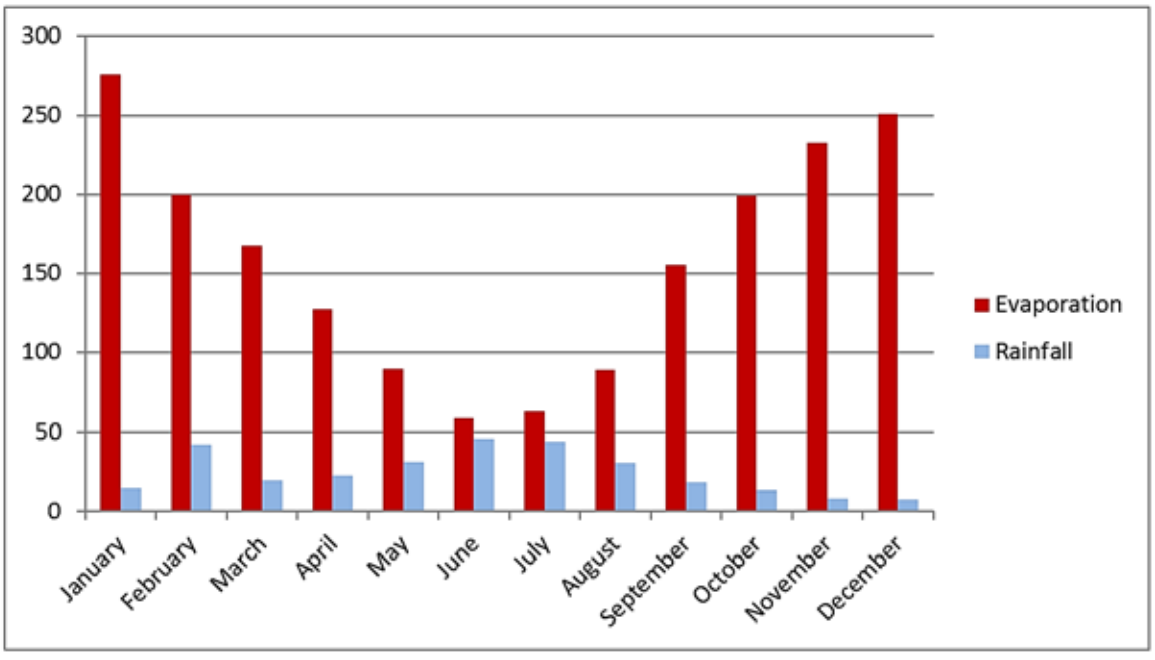

Figure 18-1 Rainfall and Evaporation

18.3.3 Soil Permeability

Inferred soil permeability varies across the mine site based on the soil type. The majority of the area of the mine site (approximately 70%) contains soils of medium inferred permeability; clean sand, sand and gravel mixtures with typically less than 12% of fine content (RPS 2015).

Soils of low permeability and very low permeability cover approximately 25% and 5% of the area of the mine site respectively. Low permeability soils comprise sand or clayey sand with typically more than 12% of fine content. Very low permeability soils comprise silts and clays with typically more than 50% of fine content (RPS 2015).

The inferred soil permeability across the mine site is depicted in Figure 18-2.

18.3.4 Existing Drainage and Watercourses

The landscape incorporating the area of the proposed mine is characterised by sand dunes with no stream lines or creek lines. Most rainfall infiltrates directly to the soil. Prolonged heavy rainfall events may generate run-off which collects in natural swales, as indicated in Figure 18-3, forming ephemeral saline lakes in some low lying areas. The ecological value of the ephemeral saline lakes is discussed in Chapters 12. This captured rain water is either stored in top-soils or sub-soils until it is used by plants or evaporates, or it infiltrates to the groundwater table. The occurrence of sufficient rainfall to generate sustained flows or pooling in the ephemeral drainage lines and salinas present in the study area is uncommon as the sandy soils present within the mine site generally have medium permeability (RPS 2015). Where ponding does occur, it may last up to several weeks. Minimal ponding occurs in summer due to high evaporation rates. The maximum water surface areas and storage volumes that could be expected in swales is shown in Table 10 in Appendix H.

Several landowners were surveyed as part of the CEIP Hydrology Study (RPS 2015) and identified minor local flooding to a depth of less than 0.5 m in 1956, 1968 and 1992. In typical years, summer rains infiltrate or evaporate, while winter rains fill swales and salinas between the dunes to a depth of less than 0.3 m. Landowners report that overtopping of swales and subsequent overland flow has not occurred in living memory. Calculation of swale storage volumes demonstrates that overtopping of swales and subsequent overland flow would not have occurred during a number of historical high rainfall events, including the maximum annual rainfall year of 1968, due to the large storage volumes within each swale.

Wudinna DC report that no damage to infrastructure (roads) has occurred due to overland flow from the natural landscape in the area of the mine site. Stormwater runoff from roads and impervious areas is currently managed by Wudinna DC through the use of shallow excavated drainage channels that direct flows towards low lying areas within road reserves for infiltration.

18.3.5 Water Protection Areas

The area of the mine site does not include or extend into any defined Water Protection Areas. There are 10 Water Protection Areas on the Eyre Peninsula, all of which are located on the south-west coast. The nearest Water Protection Area is the Polda Water Protection Area, approximately 35 km southwest of the mine site as depicted in Figure 18-4.

18.3.6 Water Users

The majority of the landscape within and surrounding the area of the mine site has been cleared for agricultural purposes. Dams are not a common feature within the region due to the limited rainfall, with piped water being the primary water source for livestock (SA Water 2008). Crops in the region are rain-fed and as such, low water requirement varieties (such as non-irrigated wheat) are typically utilised. Surface water that pools in swales is not used as it becomes saline.

The Lake Warramboo complex is located approximately 1.2 km northwest of the mine site and comprises a series of small salt 'lakes' or saline depressions. A number of other small salt lakes and saline depressions are located across the region, including on the northern part of the proposed Mining Lease, (Plate 18-1) and are likely to be dependent on surface water to provide short periods of inundation. The ephemeral saline ponds on the proposed Mining Lease show evidence of vegetation dieback due to the raised groundwater table and have minimal ecological values (see Chapters 19 and 12).

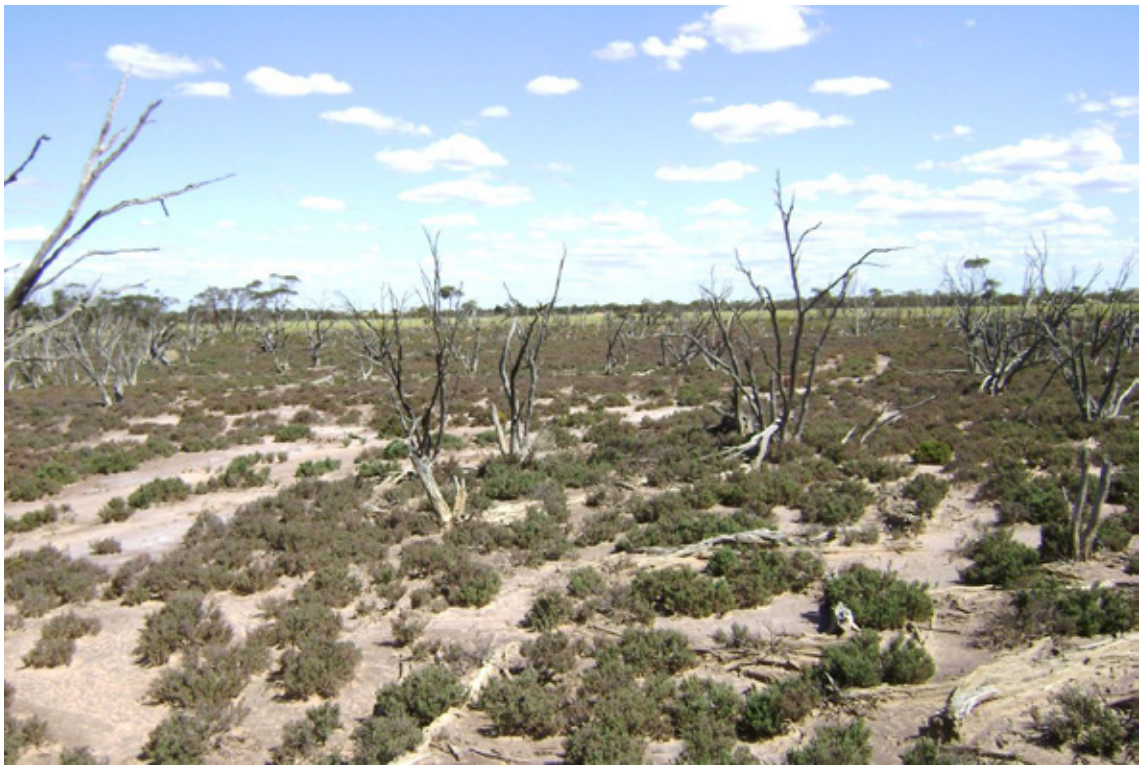

Plate 18-1 Low Lying Saline Depression

18.3.7 Water Quality

There is no publicly available water quality data for surface water within or adjoining the area of the mine site. Rainfall runoff entering salinas and salt lakes is expected to become saline prior to evaporation or infiltration. Ponded water is not currently used for irrigation or stockwater and is not expected to be suitable for any use.

18.3.8 Summary of Key Environment Values

The desktop review and CEIP Hydrology study indicated that there is no current capture or retention of surface water for potable, agriculture, or industrial purposes within catchments located within the mine site. Crops in the region are rain-fed, utilising rain falling directly onto the land, whilst stock water is supplied by reticulated mains water. Lake Warramboo and a number of other small salt lakes in the region are likely to be dependent on surface water to provide short periods of inundation; however none are within the same surface water catchment area as the mine site.

There are no permanent watercourses, or publically available water quality data within or adjoining the proposed mining area. Rainfall runoff entering salinas and salt lakes is expected to interact with elevated saline soils and groundwater and become saline prior to evaporation or infiltration. Ephemeral saline ponds may persist on the proposed Mining Lease for several weeks after heavy winter rainfall events, but have no significant environmental values.

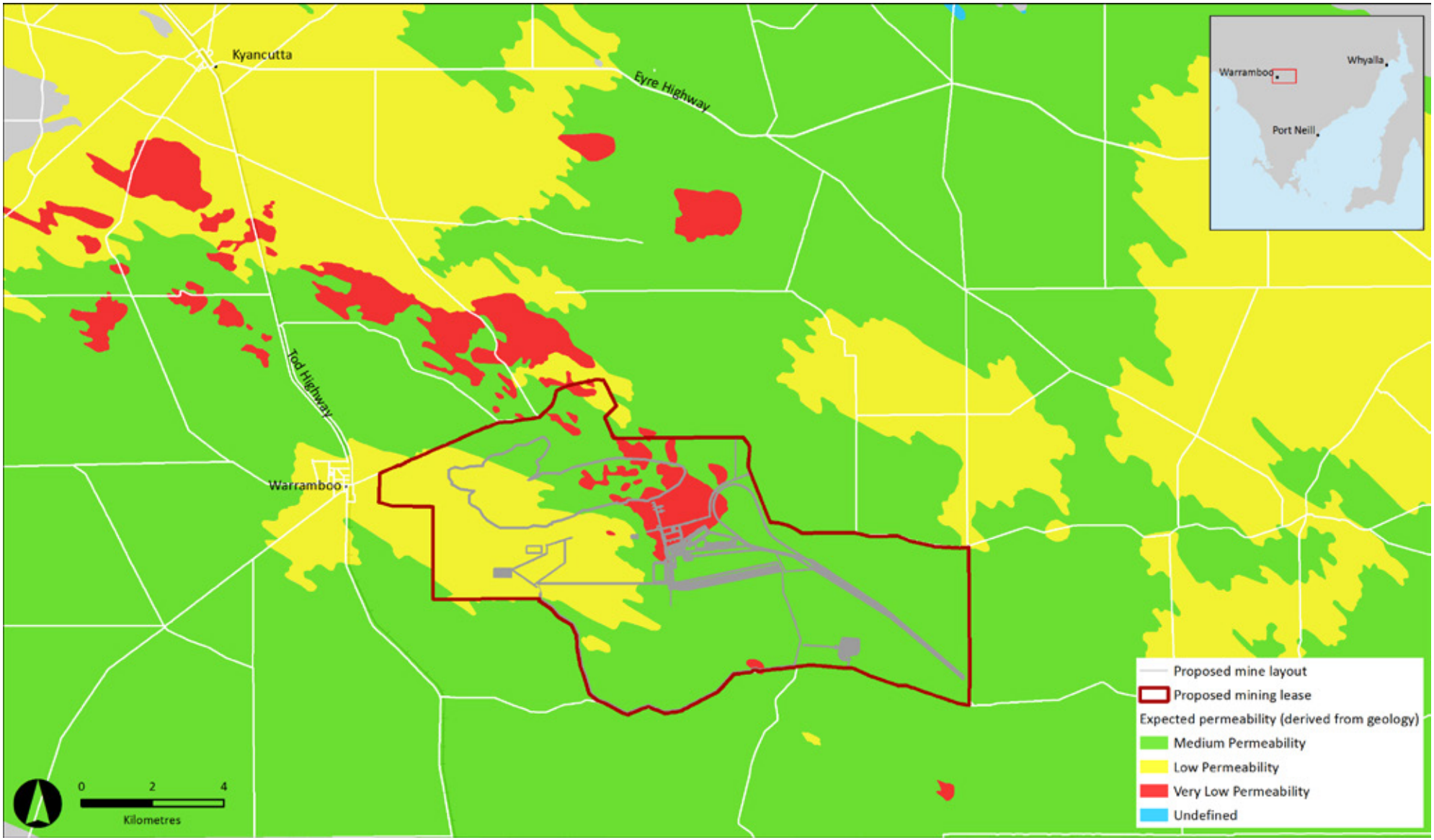

Figure 18-2 Anticipated Soil Permeability (RPS 2015)

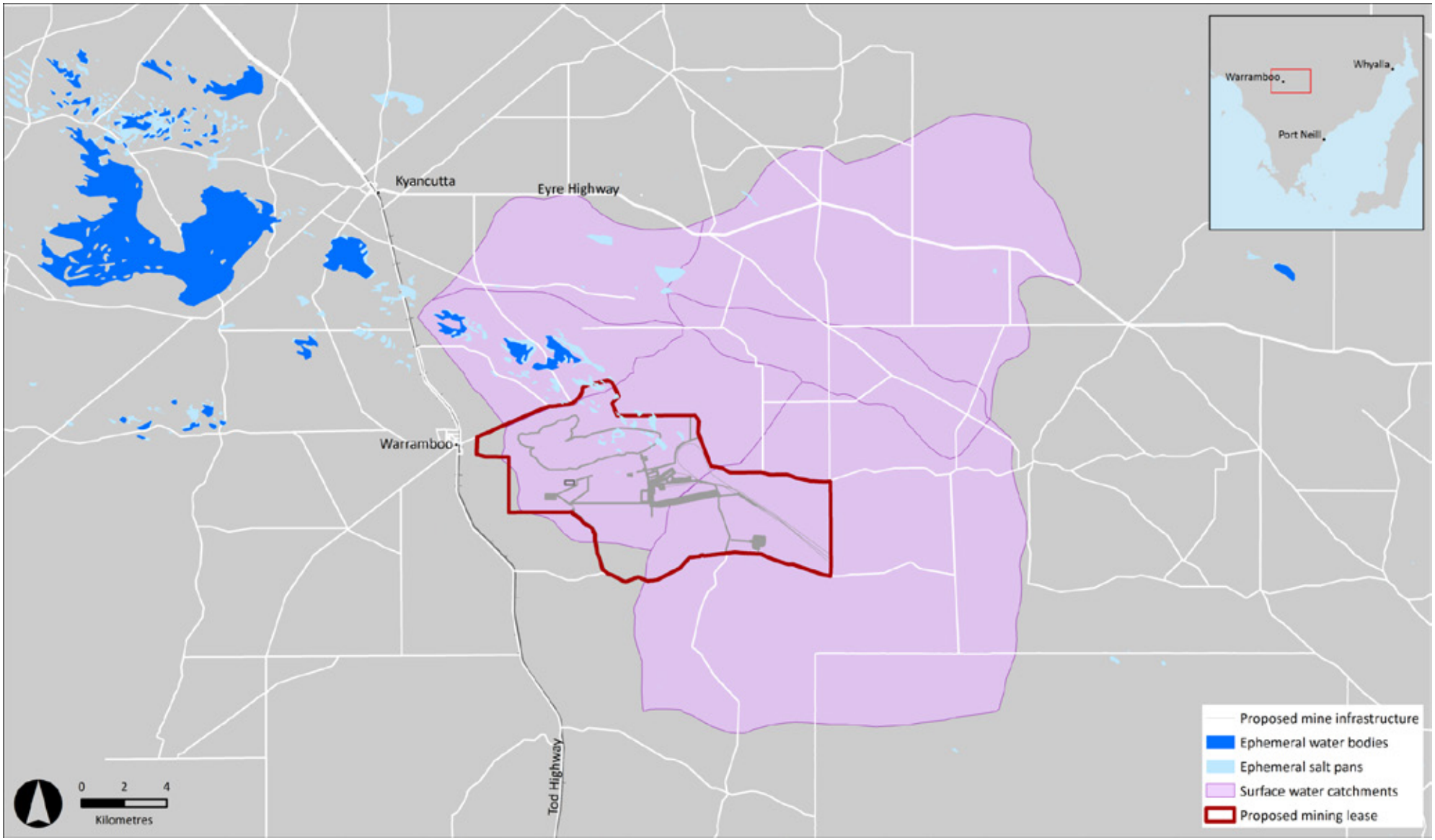

Figure 18-3 Surface Water Drainage

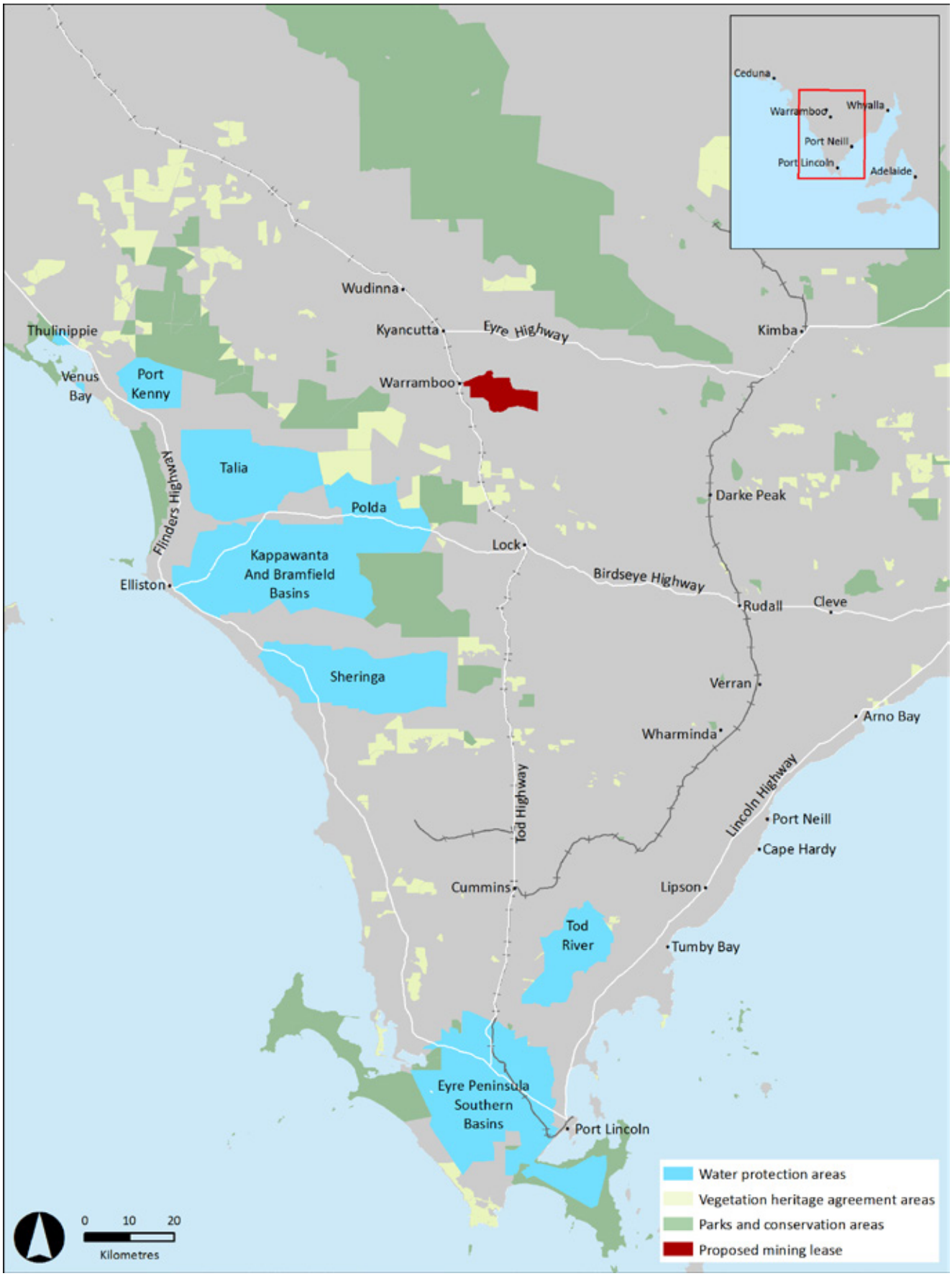

Figure 18-4 Proximity of Water Protection Areas

18.4 Context and Views of Affected Parties

Stakeholders relevant to surface water include the local landowners surrounding the area of the mine site, Wudinna DC, EPA, DEWNR and the Eyre Peninsula NRM Board. Stakeholders are seeking the following outcomes in relation to surface water:

- No impact as a result of changed flow regimes during construction, operation and closure of the mine.
- No saline surface water runoff on adjoining properties.
- No uncontrolled surface water runoff from the integrated waste landform (IWL) resulting in erosion, sedimentation and loss of topsoils.
- Mine infrastructure designed to accommodate high rainfall events.

Impacts and risks relevant to each of the existing environmental values and issues identified by stakeholders are discussed in Section 18.7 below.

All issue raised by stakeholders across the entire project are presented in Chapter 5 and summarised in Table 5-8. Impacts and risks relevant to each of the existing environmental values associated with surface water and potential issues identified by stakeholders are discussed below and summarised in Table 18-2, with all impact events across the entire project presented in the Impact and Risk Register in Appendix C.

18.5 Potentially Impacting Events

Considering the views and contexts of affected parties and the issues identified during technical studies, an assessment of Source Pathway Receptor (SPR) has been undertaken, as per the methodology outlined in Chapter 6, to determine which potential impact events are considered applicable to this project. Potential impact events associated with the construction, operation and closure of the mine site that have a confirmed SPR linkage which effects surface water include:

- Contamination of surface water from acid forming materials or elevated elemental toxicities impacting adjacent agricultural properties (IM_18_01).
- Contamination of surface water from chemicals or hyrdocarbons proposed to be stored/used on the proposed mining impacting adjacent agricultural properties (IM_18_02).
- Altered surface water flow regimes as a result of increased run-off from constructed surfaces as compared to the natural landscape (e.g . internal roads, buildings) results in erosion of, or impacts on, productive land (IM_18_03).
- Reduced surface water quality through the mobilisation of saline material resulting from the application of saline groundwater as a dust suppressant (noting that surface water flows are localised to within swales and infrequent) (IM_18_04).

The impact and risk register presented in Appendix C provides confirmation of a source pathway and receptor for each of the potential impact events (PIMs) considered above and therefore follows each through as actual impact events (IMs) with a complete impact and risk assessment.

For surface water, a number of potential impact events (listed below) are not considered further as there is no confirmed linkage between source, pathway and receptor, as demonstrated in Appendix C. These include:

- Sedimentation of surface water via erosion of the integrated waste landform results in reduction in water quality (PIM_18_1). As soils adjoining the IWL, other than in the vicinity of the pit and processing plant, have medium permeability, there is minimal potential for significant surface water ponding. Consequently, surface water receptors are considered to be trivial and the risk to soil quality is more relevant. For this reason, sedimentation from the IWL is addressed in Chapter 13.

- Saline runoff from mine infrastructure impacts surface water quality as surface water only pools for brief periods after heavy rain events and does not represent an environmental value, other than providing a minimal ecological value (PIM_18_3). This is addressed in Chapter 12.
- Interaction of surface water with pit shell results in poor water quality in the pit lake (PIM_18_4). Surface water running down the pit wall will pass two discontinuous zones of potentially acid forming material (PAF) in the saprolite and cover layers. Run-off interacting with these zones has the potential to generate acid. However, the remaining rock that makes up the pit wall has a moderate acid consuming potential. As shown in Appendix H, the amount of acid that can potentially be generated by the small percentage of exposed PAF material near surface is far outweighed by the acid consuming potential of the 280m length of exposed fresh rock down to the pit lake level. Consequently, the pit lake is not expected to be acidified and it will not contain any contaminants that pose a risk to humans or fauna. The salinity is expected to stabilise at approximately 360 g/l after 400 years (Appendix O).
- Altered hydrological/hydrogeological regime impacting inundation periods at Lake Warramboo complex. Given the lack of natural drainage systems and overland flow to Lake Warramboo from the mine (refer Figure 18-3), there is no pathway for alterations to surface water movement at the proposed mining lease to impact Lake Warramboo (PIM_18_5).
- Alterations to surface flows as a result of the proposed mining lease results in reduced water supply for environmental and/or human usage. Surface water only pools in low lying areas for brief periods following heavy rain events. As noted above, surface water values are considered to be trivial (PIM_18_6). Other than the mine pit lake, surface water values post mine completion will continue to be restricted to ephemeral pooling of saline water (no surface water features are proposed). The pit lake will be hyper-saline and is not regarded as an environmental value.

18.6 Control Measures to Protect Environmental Values

This section identifies design measures and management or control strategies which will be implemented to mitigate the level of impact and risk associated with surface water such that it is considered as low as reasonably practicable.

18.6.1 Design Measures

The following design control measures have been incorporated to minimise impacts and risks to surface water drainage and water quality as a result of the construction, operation and closure of the proposed mine:

- The slopes of the integrated waste landform will incorporate a series of concave slopes, berms and back-benches to control runoff and encourage infiltration into the landform.
- The cover surface of the integrated waste landform will be shaped to prevent runoff down the face of the outer slopes. The water will be absorbed by the soils and waste rock matrix of the cover profile and up-taken by vegetation and lost to evaporation.
- A collection sump will be constructed along the outer perimeter of the integrated waste landform to ensure stormwater run-off remains on the mine site and is dissipated by evaporation and infiltration.
- Vegetation will be established on the top surface and slopes of the integrated waste landform to control surface water flows, encourage infiltration and facilitate nutrient and water cycling.
- Trench drains will be installed in swales that are cut off by the pit with flows directed away from infrastructure to a sump for pumping out.
- Hydrocarbon and chemical storage facilities will be designed in accordance with Australian Standards, relevant legislation and best practice guidelines.
- Fuel and lubricant storage and dispensing facilities designed and installed in accordance with:

- AS 1940-2004: The storage and handling of flammable and combustible liquids
- AS 1692-2006: Steel tanks for flammable and combustible liquids
- Relevant South Australian legislation
- Best practice guidelines

- Design and construction of the explosive magazines will be in accordance with the *Explosives Act 1936* (SA) and Australian Standard AS 2187.2-2006.
- Vehicle washdown areas will be bunded, with washwater recycled within the washdown area.
- Rail and road infrastructure within the mine site will be constructed with culverts at low points to allow natural movements of surface water runoff.
- Rock armour will be installed downstream of culverts to minimise soil erosion.
- Post closure hardstand areas will be deep ripped and returned to cropping or native vegetation where practical/appropriate.

The design of surface water management controls has been undertaken with the overarching aim of maintaining the natural flow regime and minimising sediment runoff from within the mine site.

18.6.2 Management Strategies and Commitments

In order to minimise and mitigate impacts to surface water during construction, operation and closure activities, control and management strategies would be incorporated into the PEPR and implemented for relevant project phases. Key control and management strategies are outlined below in Table 18-1.

Table 18-1 Control and Management Strategies: Surface Water

Control and Management Strategies	Project Phase
During operations, rainfall runoff from undeveloped portions of the site will be allowed to flow to the natural low points and swales where it has historically evaporated/infiltrated. Where these flow paths are crossed by infrastructure, armoured channels and culverts will be installed to support natural flows.	Operation
Dust from the internal unsealed roads will be suppressed using saline groundwater. Saline water used for dust suppression will be restricted for use on internal roads only. Roadside swales will be maintained to collect any surface water run-off, including saline material.	Operation
For appropriate storage and handling of hydrocarbons and chemicals, the following measures will be implemented: · Develop and implement chemical and fuel storage, handling and emergency response procedures in accordance with AS 1940-2004. · Develop and implement a regular inspection programme to audit and monitor fuel and chemical storage areas to ensure integrity, housekeeping and correct use. · Maintain appropriate spill kit/clean up material, as required by the developed procedures.	Construction, Operation
Construction activities will incorporate sediment and erosion management practices which align with standard industry practice to manage sediment from construction sites, such as hay baling, temporary sediment traps, dust generation management and bunding of stockpiles.	Construction
The integrated waste landform will be rehabilitated progressively during the project, reducing the area exposed to runoff.	Operation, Closure
Saline water used for dust suppression and runoff from areas subject to saline water application will be controlled and directed to sedimentation ponds, or the bunds surrounding the integrated landform to avoid discharge onto adjoining property. Salt collected in the ponds and bunds will be periodically removed. Inspections of ponds will be undertaken periodically to assess integrity.	Construction, Operation

18.7 Impact and Risk Assessment

This section identifies and assesses impact and risk associated with existing surface water values as a result of the construction, operation and closure of the proposed mine. Impact events (confirmed by presence of a source, pathway and receptor) are those which are predicted to occur as a result of the development, whilst risk events would not be expected as part of the normal operation of the project, but could occur as a result of uncertainty in the impact assessment process. Although the risks may or may not eventuate, the purpose of the risk assessment process is to identify management and mitigation measures required to reduce the identified risks to a level that is as low as reasonably practicable. This assessment has been undertaken in accordance with the methodology outlined in Chapter 6.

Impact and risk events were identified through technical studies and stakeholder consultation. Impact events can include multiple sources, pathways or receptors and where practical have been grouped together to minimise duplication of information. Risks are events that would not be expected as part of the normal operation of the project, but could occur as a result of either uncertainties with the impact assessment, or as a result of faults, failures and unplanned events. A summary of impact and risk events relating to surface water is presented in Table 18-2 at the end of this section (with Impact IDs) and a complete register of impact and risk events by source, pathway and receptor is provided in Appendix C.

Impacts and risks are assessed following the application of the design measures outlined in Section 18.6. Where required, management measures are proposed to reduce the impact to a level that is considered as low as reasonably practicable. Through the adoption of design modification or specific mitigation measures, all identified impacts and risks were categorised as low (or negligible) and considered ALARP. The key environmental risks would be monitored through the environmental management framework.

18.7.1 Contamination of Surface Water

There are no creeks or existing surface water drainage lines within the mine site. Surface water expressions within the area of the mine site are limited to temporary pooling in natural swales prior to infiltration and evaporation. Through bunding of the integrated waste landform, washdown areas and chemical storage facilities, no impacts to surface water quality are anticipated as contaminated water will be held on site for reuse or disposal and site drainage infrastructure will be armoured at locations likely to experience erosion. As such, the construction, operation and closure of the proposed mine are considered to have a **negligible impact** on surface water quality both within and outside the mine site.

Mobilisation of Chemicals or Hydrocarbons

Chemicals and hydrocarbons will be kept within designated storage areas bunded to prevent the accidental mobilisation of contaminants affecting soil and land quality. The bunding in hazardous materials storage area(s) is designed to retain surface water flows during a 1 in 100 year flood event. A storm event exceeding the capacity of the storage area could result in the contamination of surface water flows by contaminants, subsequently affecting soil and land quality. As hazardous materials will be stored centrally within the area of the mine site and sustained surface water flows within the mine site are uncommon (and do not support any ecological value or represent a resource for local farmers), contaminated surface water would be restricted within the boundary of the mine site. Therefore the consequences of contaminating surface water are considered to be **minor**, as effects will be limited to the area of the mine site and able to be rectified.

A flood event exceeding the capacity of the storage area is considered **possible** (i.e. during the 25 year project lifespan) during construction or operation of the proposed mine. As such, the overall risk of contamination of surface water is considered to be **low**.

Mobilisation of Acid Forming Material

The integrated waste landform will incorporate portions of the waste rock with elevated concentrations of sulphides that may result in acidic forming material contaminating surface water. As previously outlined, areas of elevated sulphur content (potentially acid forming material) are offset by neutralising calcrete in nearly all cases. Similarly, the integrated waste landform has been designed to be a water retaining structure and rainfall will infiltrate directly into the structure in all but extreme rainfall events. The series of slopes and back-benches will retain any rainfall which does run off upper slopes and a sump is proposed around the perimeter of the landform to prevent any flows leaving the site from lower slopes. As such, the consequences of surface water contaminated with acid forming material are considered to be **minor**, as effects will be limited to the area of the mine site and able to be rectified.

A flood event exceeding the capacity of the storage area is considered **possible** (i.e. during the 25 year project lifespan) during construction or operation of the proposed mine. As such, the overall risk of acid forming material contaminating surface water is considered to be **low**.

18.7.2 Disturbance to Existing Flow Regimes

There are no creeks or surface water drainage lines within the mine site as a result of the low rainfall and the permeability of soils which occur across the majority of the site. Surface water expressions are limited to temporary pooling in natural depressions prior to infiltration and/or evaporation. Runoff following extreme rainfall events from undeveloped portions of land within the mine site will be allowed to drain to natural low points and swales where it historically has evaporated or infiltrated. Where periodic flow paths are crossed by infrastructure (i.e. internal roads, rail line), channels and culverts will be installed to support natural flow regimes.

During operation, all rainfall on the surface area of the processing facilities will be redirected to an onsite water storage and treatment facility for re-use in dust suppression and processing. Rainfall within the footprint of the pit will be collected along with groundwater seepage during pit dewatering and also directed to the onsite water storage for re-use at the site. To avoid increasing seepage into the pit, swales that are cut off by the pit will be drained and any water present re-used on site. Any rainfall in these areas therefore will not contribute to an increase in surface water flows.

The integrated waste landform has been designed to be a water retaining structure and rainfall will infiltrate directly into the structure in all but extreme rainfall events. The series of slopes and back-benches will retain any rainfall which does run off upper slopes and a sump is proposed around the perimeter of the landform to prevent any flows leaving the site from lower slopes (MWH 2015).

At the completion of mining, the processing and handling facilities will be decommissioned and the site rehabilitated, with the integrated waste landform and mine pit remaining in place. Runoff will be directed into the mine pit and combine with saline groundwater in the pit. As this alteration in flow does not impact upon any receptors dependent on surface water, the impacts to surface water flows are considered to be **negligible**.

Material Deposition from Erosion

In heavy rain events, rainfall runoff may erode soil, especially where that soil is exposed and unprotected. Erosion is most likely to occur at locations of uncontrolled flow concentration such as drainage gullies, near culverts and on slopes (e.g. slopes of the integrated waste landform).

As previously outlined, the following measures would be implemented to minimise erosion:

- Drainage gullies and culvert outlets would be armoured to reduce the risk of soil erosion.
- The area exposed on the integrated waste landform would be minimised by progressive rehabilitation during the life of the project, with runoff captured within a series of back-benches breaking up the landform slopes.

- Revegetation of disturbed areas undertaken as soon as practicable.
- Sediment and erosion management practices would be adopted for construction activities to minimise and capture mobile sediment during rainfall runoff events through the construction phase of the project.

If erosion does occur, sediment laden runoff will be contained within bunds, sumps, ponds and the mine pits. The consequences of reduced water quality from erosion are considered to be **minimal** and will not affect any existing surface water features (as there are none present at the site) and will have an insignificant effect on existing land use in the area. Despite the implementation of the proposed design controls and management methods, localised erosion to disturbed areas such as the integrated waste landform, the mine pits and material stockpiles due to rainfall runoff events is considered to be **likely**. As such, the overall risk is considered to be **low**.

18.7.3 Salinisation of Surface Water

Saline groundwater will be used for processing and dust suppression on internal unsealed roads and the integrated waste landform. As such, runoff generated during rainfall events is likely to dissolve salts crusted in the surface of the integrated waste landform, increasing the salinity of runoff. As previously outlined, the integrated waste landform will be shaped with a series of concave slopes and back angled benches with earthen bunds to prevent runoff from the top surface down the outer slopes. Water will either infiltrate into the soil and rock matrix of the landform, be taken up by vegetation, or lost to evaporation. Bunds on the outer slopes will restrict runoff from exiting the mine site and facilitate infiltration. As such, the salinization of surface water flows and impacts to surrounding agricultural land is considered to represent a **negligible impact**.

Uncontrolled Release of Saline Material

Saline groundwater is proposed to be used in ore processing and other activities including dust suppression of unsealed internal roads. An uncontrolled discharge of saline water may occur via:

- Spill or leak from water distribution infrastructure, or water storage infrastructure
- Failure of surface water management measures to contain runoff
- Dust suppression spraying occurring during extreme weather events (e.g. high winds)
- Failure of bunds/sumps on integrated waste landform to contain runoff laden with saline material
- Overuse of water for dust suppression

Water used for dust suppression and runoff from areas subject to water application, are expected to occur in small volumes that will quickly infiltrate or evaporate. Spills from water distribution infrastructure could occur as a result of human error in operating valves, or due to damage to pipelines (e.g. as a result of vehicle impact). Should a spill occur, the consequences are considered to be **minimal**; limited to a short period of water flow and restricted to the mine site through containment within bunds, sumps, ponds and the mine pits. The likelihood of a spill occurring is considered to be **possible** and may occur at some point during the life of the mine.

Uncontrolled water releases would not affect water quality of existing surface water values (as there are negligible values present), however it may affect soil resources. The nearest surface water features that may have an environmental value are many kilometres from the mine site boundary. As such, the overall risk of an uncontrolled release of saline water to surface water is considered to be **low**.

18.7.4 Summary of Impacts and Risks

With the implementation of design and management measures, all residual impacts have been categorised as negligible. Similarly, all risks have been reduced to a level of low. The impacts and risks were considered to be as low as reasonably practicable and not warrant further specific control measures other than the environmental management controls and measures outlined here. A summary of each of the identified impacts and risks associated with surface water at the mine site are presented in Table 18-2.

Table 18-2 Impact and Risk Summary: Surface Water

Impact ID	Impact Event	Level of Impact[1]	Level of Risk[2]
IM_18_01 IM_18_02	Reduction in surface water quality as a result of contamination of surface water.	Negligible	Low
IM_18_03	Altered surface water flow regimes as a result of vegetation clearance, or construction of site infrastructure.	Negligible	Low
IM_18_04	Reduction in surface water quality as a result of mobilised saline material.	Negligible	Low

[1] Impact events are expected to occur are part of the project. Level of impact is assessed post control strategies, as per the impact assessment methodology provided in Chapter 6.

[2] Level of risk reflects the risk that the assessment of impact is incorrect due to uncertainties in the assessment method, the control strategies, or in assumptions uses. Risk is assessed post control strategies, as per the risk assessment methodology provided in Chapter 6.

18.7.5 Justification and Acceptance of Residual Impact and Risk

With the implementation of design and operational management measures, all impacts associated with surface water are considered to be **negligible**. Similarly, all risks have been reduced to a level of **low**. The impacts and risks are considered as low as reasonably practicable.

18.8 Proposed Outcomes

In accordance with the methodology presented in Chapter 6, outcomes have been developed for all impact events with a confirmed linkage between source, pathway and receptor. Each outcome is supported by measureable assessment criteria that will be used to assess compliance against the proposed outcomes during the relevant phases (construction, operation, closure) of the mine. Proposed outcomes and measurement criteria have been developed for each of the impact events identified with a confirmed linkage and these are presented in Table 18-3.

Table 18-3 Outcomes and Assessment Criteria: Surface Water

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria	Draft Leading Indicator Criteria
No impacts to agricultural productivity for third party land users on or off the lease during construction, operation and post mine completion, including: · reduction in crop yield · reduction in grain quality · adverse health impacts to livestock other than those agreed between the tenement holder and the affected user.	IM_18_01	Reduction in surface water quality as a result contamination of surface water.	Survey demonstrates no surface water runoff from the IWL is leaving the proposed mining lease boundary	None proposed
	IM_18_04	Reduction in surface water quality as a result of mobilised saline material.	Soil testing on adjoining land demonstrates there is no statistically significant increase in the level of salinity	None proposed
No adverse impacts on soil quality or quantity that could compromise the post mining land use within the proposed mining lease or existing land use outside the proposed mining lease.	IM_18_02	Flooding or release of contaminated surface water results in spread of contaminants and impacts on productive land or vegetation	Inspection of hazardous material storage areas following significant rain events	None proposed
	IM_18_03	Changes to surface water flows result in erosion and impacts on productive land or vegetation	Post construction audits of all landforms and structures that may affect water flow confirm they have been constructed in accordance with design parameters.	None proposed

18.9 Findings and Conclusion

No users of surface water were identified as reliant on surface water flows from the proposed mining operations. Surface water ecosystems are degraded and have minimal environmental value. They are not regarded as a sensitive environmental receptor. As such, no significant change to the surface water regime or water quality that would adversely affect ecosystems and/or water users dependent on surface water flows is anticipated as a result of the construction, operation or closure of the proposed mine, with all identified impacts considered to be nil or negligible.

There were no risks identified to the environmental value of surface water, since surface water values present at the site are not considered to be a sensitive environmental receptor. Surface water does however represent a pathway between sources and receptors which generates the potential for environmental impacts (risks) as a result of changes to surface water regimes at the site. All risks identified where surface water was a pathway were considered to be low. Risks will be alleviated wherever possible through the implementation of control and management strategies.