SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

Chapter 8
Surface Water Resources

BHP

Contents

Saraji East Mining Lease Project

8 Surface Water Resources

8.1 Introduction

This chapter provides a description of the existing surface water resources in and within the vicinity of the Project Site. It also identifies potential impacts to surface water from the Project and the required mitigation measures proposed to minimise any adverse impacts.

A range of technical studies were undertaken to address specific aspects of significance to surface water resources. These include:

- Appendix E-1 Surface Water Quality Technical Report
- Appendix E-2 Mine Water Balance Technical Report
- Appendix E-3 Hydrology, Hydraulics and Geomorphology Technical Report.

To obtain a complete understanding of the significance of surface water values and the possible impacts of the Project, the following chapters are also relevant:

- Chapter 7 Aquatic Ecology
- Chapter 9 Groundwater.

A Subsidence Management Plan has been developed for the Project and is found in **Appendix K-2 Subsidence Management Plan**.

8.2 Legislation and policy

8.2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the management and protection of flora and fauna of national environmental significance, referred to as Matters of National Environmental Significance (MNES). Large coal mining developments such as the proposed Project can potentially disrupt aquatic ecosystems and therefore have adverse impacts on aquatic species, water resources and Ramsar wetland sites. Any action with the potential for a significant impact on these MNES must be referred to the Australian Government Environment Minister and may require approval under the EPBC Act.

On 18 November 2016, the Project was determined as a controlled project, with one of the controlling provisions being *a water resource, in relation to coal seam gas development and large coal mining development.* Discussion of the impacts upon MNES is provided in **Chapter 21 Matters of National Environmental Significance.**

8.2.2 Water Act 2000

The use of water for activities such as irrigation, stock water, drinking water and industrial use is regulated under the *Water Act 2000* (Water Act). The Water Act provides the basis for the planning and allocation of Queensland's water resources. The watercourses potentially affected by the Project are subject to protection under the Water Act.

The Water Act defines a watercourse as a:

- river, creek or stream in which water flows permanently or intermittently in a natural channel, whether artificially improved or not, or
- an artificial channel that has changed the course of the watercourse.

The creeks within the Project Site are declared watercourses under the Water Act, including Boomerang, Hughes, One Mile, Spring, Plumtree and Phillips Creeks. Resources within a declared watercourse are managed by the State and may be subject to licensing provisions (DSDMIP, 2019).

The Water Act and its instruments are administered by the Department of Natural Resources, Mines and Energy (DNRME). Water Resource Plans (WRPs) and Resource Operations Plans (ROPs) are governed by the Water Act.

WRPs establish a framework for sharing water between human consumptive needs and environmental values. ROPs are developed in parallel with WRPs and provide a framework by which objectives from the WRPs are implemented, including water allocations and administrative directions. The WRP and ROP applicable to the Project are detailed below.

BMA is seeking authorisation to take water and otherwise interfere with the flow of water arising from Project-related subsidence of Boomerang, Plumtree and Hughes Creeks via the EIS process and the resulting EA that has been applied for. The mitigation of impacts will be delivered in accordance with the proposed subsidence management plan to be conditioned in the EA.

This is in accordance with the framework provided by the Water Act:

- Section 97 (1) (a) of the Water Act provides that a person may take overland flow water that is not more than the volume necessary to satisfy the requirements of an environmental authority
- Section 97 (2) provides that a person may interfere with the flow of water by impoundment if the interference is not more than is necessary to satisfy the requirements of an environmental authority
- Section 97 (3) provides that subsections (1) and (2) apply only if (a) the impacts of the take or interference were assessed as part of a grant of an environmental authority or development permit; and (b) the environmental authority or development permit was granted with a condition about the take or interference with water.

Appendix B-2 Subsidence Modelling sets out the estimated extent of interference and **Appendix K-2 Subsidence Management Plan** provides mitigations related to subsidence. BMA will consult with DNRME to ensure any residual information requirements are addressed.

Fitzroy Basin Water Resource Plan

The Project is located within the Fitzroy Basin. The Water Plan (Fitzroy Basin) 2011 was finalised in 1999, but was amended in 2005 to address overland flow water management and was again updated in 2011.

Fitzroy Basin Resource Operations Plan

The Fitzroy Basin ROP came into force in January 2004 and subsequently amended in 2011, 2014 and 2015. It details how the objectives of the Water Plan (Fitzroy Basin) 2011 will be met on an operational level, and defines strategies to support the WRP's overall goals for water entitlement security and ecological health.

In general, it provides the basis and rules for trading of water allocations, allows for unallocated water to be identified and allocated, and also details operating rules for the use of water management infrastructure such as weirs and dams. The Nogoa Mackenzie, Lower Fitzroy, and Fitzroy Barrage Supplemented Water Supply Schemes operate within the wider Fitzroy Basin catchment.

8.2.3 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The quality of Queensland waters is protected under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water)). The EPP (Water) achieves the objectives of the *Environmental Protection Act 1994* (EP Act) to protect Queensland's waters while supporting ecologically sustainable development. Queensland waters include water in rivers, streams, wetlands, lakes, groundwater aquifers, estuaries and coastal areas.

The EPP (Water) seeks to protect and enhance the suitability of Queensland's waters for various beneficial uses. The Queensland Department of Environment and Science (DES) (previously the Department of Environment and Heritage Protection (DEHP)) hold responsibility for administering the EPP (Water).

The policy identifies environmental values for waters in Queensland and guides the setting of water quality objectives to protect the environmental values of any water resource. Water quality guidelines or objectives are the minimum levels required to protect all of the beneficial uses of a waterway (DEHP, 2009). In accordance with the EPP (Water), environmental values, water quality guidelines and water quality objectives were established (DEHP, 2011).

The document that is of relevance to the Project Site's receiving environment is the *EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP, 2011).

8.2.4 Mineral Resources Act 1989

The *Mineral Resources Act 1989* (MR Act) provides for the assessment, development and utilisation of mineral resources to the maximum extent practicable, consistent with sound economic and land use management. It provides for the issuing of permits, licences and leases relating to prospecting, exploration, mining and mineral development, and the granting of mining claims. It also provides for landholders affected by these activities to be compensated.

Section 50 (4) of the MR Act states that: "where any Act provides that water may be diverted or appropriated only under authority granted under that Act, the holder of a mining claim shall not divert or appropriate water unless the holder holds that authority".

Open cut mining operations immediately west of the Project Site have modified the upstream catchment and landscape of the streams, and diversions are used to manage catchment runoff. As this is an underground mine, disturbance to the surface topography will be limited. There are no new diversions planned as part of the Project; overland flow will continue to be managed through a series of existing diversion drains that were designed to contemporary standards to comply with regulatory requirements (refer to **Appendix E-3 Hydrology, Hydraulics and Geomorphology Technical Report**).

8.2.5 Regulated structures

The *Water Supply (Safety and Reliability) Act 2008* (WSSR Act) sets out the requirements for referable dams. Generally, these relate to dams that exceed a certain height and volume criteria which defines the scope of failure impact assessment (FIA) required to determine the population at risk in the event of dam failure.

All structures which are dams or levees associated with the operation of an environmentally relevant activity (ERA) are generally required to have their consequence category assessed in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (DES, 2016) (the DES manual). Assessment is based on the potential environmental harm that would result from a number of failure event scenarios including seepage, overtopping and dam break. Each scenario is assessed against three assessment criteria - potential harm to humans, general environmental harm and general economic loss or property damage with the potential consequence category for each criterion being either low, significant or high. The consequence category of a structure is hence the highest consequence category determined under any of the assessment criteria for each failure scenario.

Regulated structures must be conditioned by DES in the EA for the Project, designed according to specific hydrologic and hydraulic performance criteria set out in the manual, and inspected annually by a suitably qualified professional.

8.2.6 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) provide recommended parameters for:

- water and sediment quality that will sustain the ecological health of aquatic ecosystems
- irrigation and general water use
- livestock drinking water
- aquaculture and human consumers of aquatic food
- waters for recreational activities, such as swimming and boating
- preservation of the aesthetic appeal of these waters.

8.2.7 Other guidelines

Information on water quality has also been obtained from the *Queensland Water Quality Guidelines* (QWQG) (DEHP 2009). This chapter has considered the DES *EIS Information Guideline – Water*.

8.3 Methodology

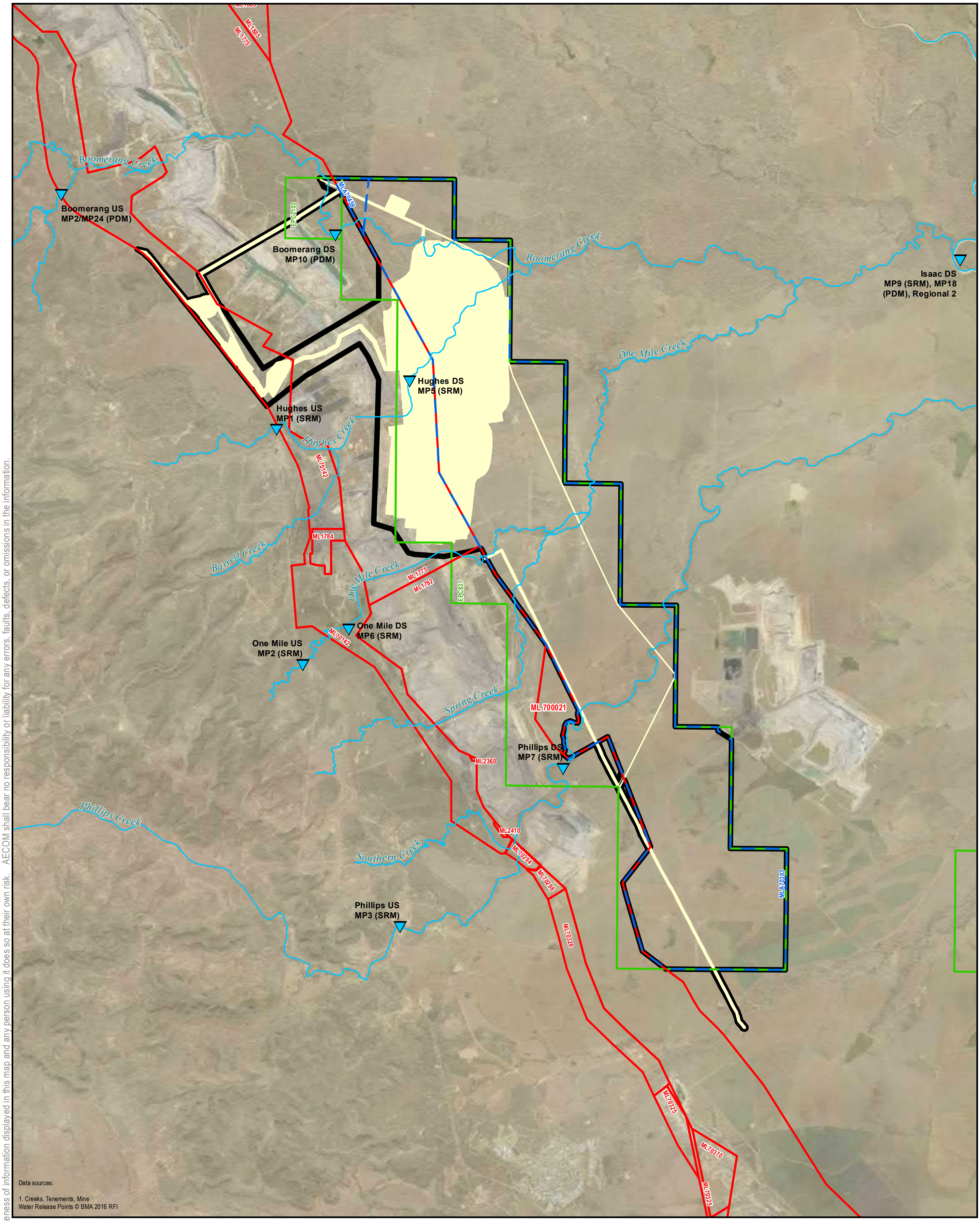
The assessment methodology identified potential impacts from the Project on the environmental values and preventative and mitigation measures to demonstrate that the Project will not result in degradation of water quality related values.

8.3.1 Surface water quality

The surface water quality assessment involved:

- identification of the environmental values of surface waters within the Project Site and immediately downstream that may be affected by the Project
- definition of relevant water quality objectives applicable to the environmental value
- characterisation of the quality of surface waters within the Project Site
- identification of the quantity, quality, location and timing of all potential and/or proposed release of contaminants (such as controlled water releases to surface water streams) from water and wastewater from the Project
- assessment of the likely impact of any releases on all relevant environmental values of the surface water receiving environment
- assessment of how the water quality objectives and performance outcomes will be achieved, monitored and audited, and how corrective actions will be managed.

The assessment was informed by monitoring data from locations monitored as part of Receiving Environment Monitoring Programs (REMP) for Saraji Mine (SRM) and Peak Downs Mine (PDM) between 2010 and 2020, dependent on location, as well as trend reports from 2012-2016 (CQU, 2016). Most of this data was collected downstream of the existing Saraji Mine (Figure 8-1) and therefore similar to the existing baseline conditions of the Project Site. These are discussed in greater detail in **Appendix E-1 Surface Water Quality Technical Report.**



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Monitoring Locations
- Watercourse

N

Figure 8-1
Existing monitoring points

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:150,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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8.3.2 Mine water assessment

To inform the mine water assessment, the key steps undertaken included:

- identification and description of the existing environment relevant to the conceptual Project mine water management strategy (WMS)
- identification of key objectives and considerations for the mine WMS
- development of the proposed mine WMS required to meet the key objectives and considerations
- validation of proposed mine WMS through water balance assessment
  - development of schematic for mine WMS
  - confirmation of mine plan and all model input data
  - development and confirmation water balance model
  - validation of proposed mine WMS to meet outlined key objectives and considerations.

Model development

A dynamic water balance model (WBM) was developed for the Project using GoldSim probabilistic modelling software. GoldSim is a Monte Carlo simulation software package that is commonly used in the mining industry for water balance modelling. The purpose of the water balance assessment was to validate the proposed mine WMS under a range of historical climatic conditions, with the aim of:

- estimation of the potential quantity and quality of mine affected water (MAW) that may be generated during the operation of the Project
- estimation of the storage capacity required for each of the WMS dams to meet the stated MAW containment objectives
- confirmation that the proposed operational rules are supportive of the proposed MAW containment and reuse objectives
- identification of the required transfer capacities to move MAW around the mine WMS so that containment, productivity and reuse objectives are met
- estimation of the potential volumes of raw water required to satisfy Project consumptive demands that either:
  - cannot be satisfied through the reuse of MAW, or
  - when stored volumes of MAW are unavailable following periods of prolonged drought
- development of an understanding of the potential risk of overflow to the receiving environment.

The WBM was developed to dynamically simulate the proposed 20 year production schedule. This allowed for key model inputs such as climate data, water demands and groundwater inflow to vary with each simulated mine year. In this manner, the WBM provided for a more representative simulation of the Project as it allowed for ready identification of critical WMS stress points such as maximum containment requirements and peak raw water demand.

A detailed discussion of the WBM development is provided in **Appendix E-2 Mine Water Balance Technical Report**.

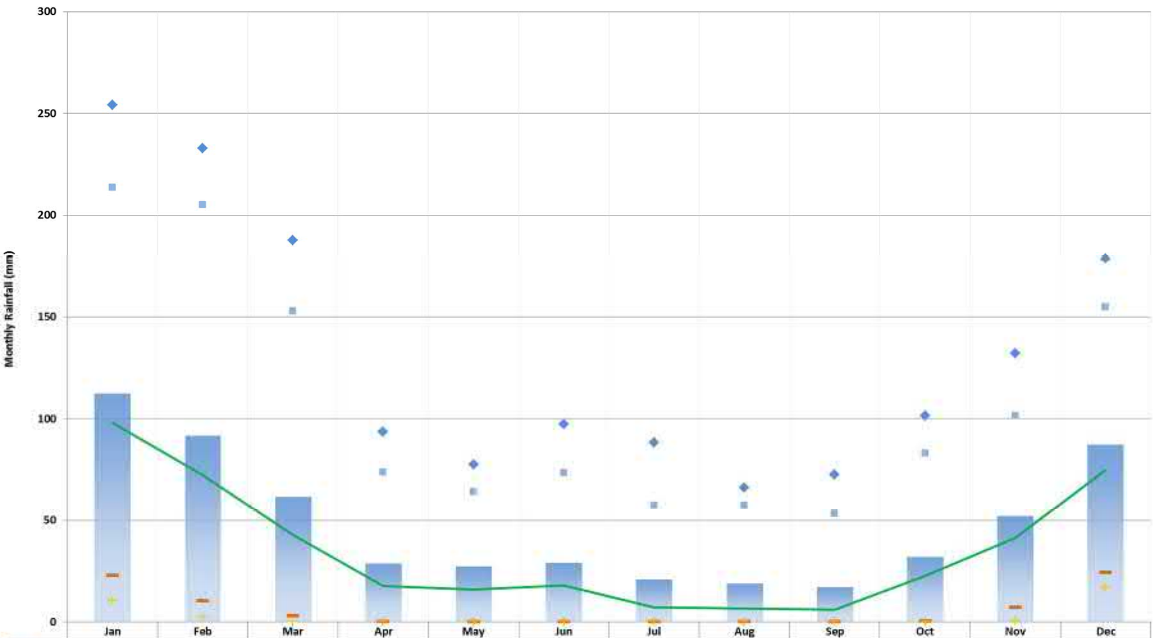
8.3.3 Flooding, hydrology and geomorphology

The assessment required the establishment of baseline environmental values (existing conditions) against which changes caused by subsidence (of the maximised underground layout) could be compared. Determining the magnitude and nature of impacts and changes involved the creation of hydraulic models for pre- and post-subsidence conditions. Modelling was undertaken for a range of flow events to identify the likely hydrologic, hydraulic and geomorphic responses. Predicted subsidence was assumed to have no impact on the flows entering the Project Site from upstream; therefore, the same flow estimates were used for both the pre- and post-subsidence modelling.

8.4 Description of environmental values

8.4.1 Climate

Climate at the Project Site is classified as subtropical with a moderately dry winter (as per the Köppen Climate Classification). Historic climate data was sourced from the Bureau of Meteorology SILO Data Drill using 128 years of records (1889 to 2017). The data is produced by accessing grids of data derived from interpolating the bureau's records from individual weather recording stations. Figure 8-2 shows mean monthly rainfall and Figure 8-3 shows mean monthly evaporation. It can be seen that annual rainfall at the Project Site is highly variable and subject to prolonged periods of above and below average rainfall. The mean monthly rainfall shows a distinct seasonal distribution with monthly rainfall totals greatest in the wet season extending from December through March. The average monthly evaporation exceeds the average monthly rainfall throughout the year with a maximum of around 238 millimetres average monthly evaporation in December.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	112.2	91.7	61.8	28.6	27.2	29.1	21.0	18.8	17.0	31.9	52.0	87.4
P95	254.1	232.8	187.8	93.6	77.6	97.3	88.5	66.2	72.7	101.6	132.1	178.8
P90	213.7	205.2	152.9	73.8	64.3	73.5	57.5	57.6	53.4	83.2	101.5	154.7
P50	98.1	72.6	42.8	17.6	16.1	18.1	7.3	6.8	6.0	22.8	41.2	74.9
P10	22.7	10.3	3.0	0.0	0.2	0.0	0.0	0.0	0.0	0.5	7.2	24.2
P5	10.5	2.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	17.1

Figure 8-2 Monthly Rainfall (SILO Data Drill, 1889-2018)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	221.1	180.5	185.9	147.8	118.1	94.8	104.9	135.0	175.0	217.5	226.2	237.8
P90	262.7	220.1	229.0	168.9	134.9	107.9	118.2	154.6	197.8	245.8	266.7	273.6
P50	222.2	170.3	185.4	145.4	120.0	94.3	106.0	134.1	177.5	221.5	226.4	238.8
P10	170.6	147.6	144.3	120.3	98.6	82.2	91.7	118.9	146.9	181.5	186.8	196.9

Figure 8-3 Monthly Pan Evaporation (SILO Data Drill, 1970-2017)

By comparing this data, it can be seen that mean evaporation exceeds mean rainfall for all months. This indicates a strongly negative mean annual water balance.

8.4.2 Surface water resources

Catchment context

The Project Site sits within the Isaac River catchment, a sub-catchment of the broader Fitzroy Basin. The Fitzroy Basin covers an area of approximately 142,660 square kilometres (km^2), comprising numerous rivers, streams, waterholes and impoundments (DES, 2018c). It is the largest river catchment flowing to the eastern coast of Australia (Fitzroy Basin Association, 2018). The Fitzroy River discharges to the ocean in Keppel Bay, near Rockhampton, approximately 260 km from the Project Site. Its major tributaries are the Nogoa, Comet, Mackenzie, Isaac, Connors and Dawson Rivers and Callide Creek.

Watercourses

A number of watercourses which are defined as a watercourse under the *Water Act 2000* flow through the Project Site, including Boomerang Creek, One Mile Creek, Hughes Creek, Plumtree Creek, Spring Creek and Phillips Creek. Of these streams, only Boomerang Creek, Plumtree Creek and Hughes Creek intersect the underground mining panels and the proposed area of subsidence. Figure 8-4 shows the regional catchment context of the Project and Figure 8-5 shows the creeks within the Project Site.

Boomerang Creek, Hughes Creek and Plumtree Creek are ephemeral streams whose catchments have been modified by open cut mining operations west of the Project Site. Both Boomerang Creek and Hughes Creek flow through open cut Mining Leases (MLs) and contain diversion reaches. Plumtree Creek commences within the existing Saraji Mine and joins Boomerang Creek within the Project Site. Boomerang Creek and Hughes Creek converge approximately 1 km downstream (east) of the Project Site.

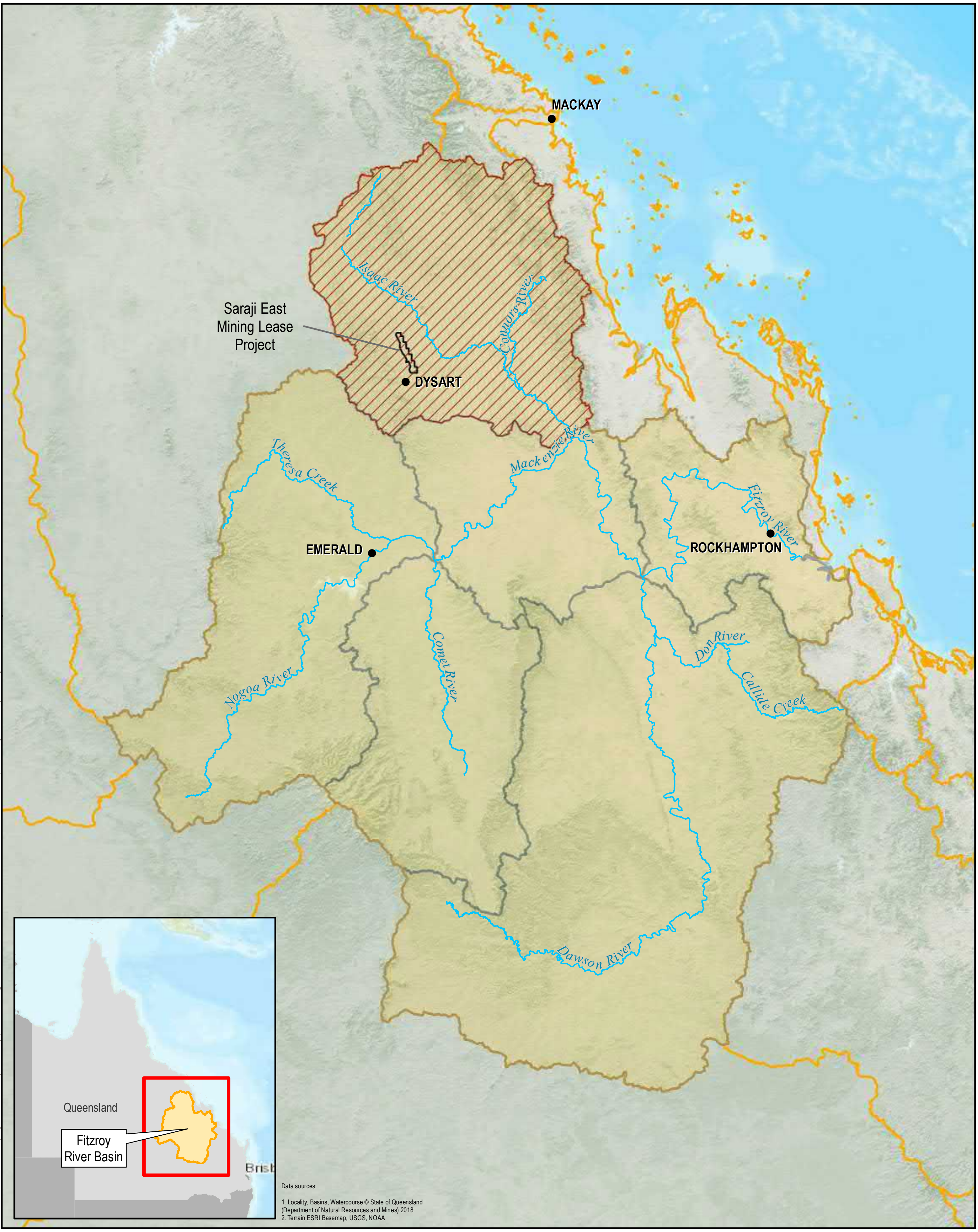
Existing water users

The Project is within the Isaac River catchment. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River. They have 28,621 megalitres (ML) and 62,335 ML of allocated water, respectively. The total catchment area upstream and within the Project Site is about 60 ha, this equates to less than 0.0004 per cent of the total catchment area for these water supply schemes (142,665 km^2).

Existing surface water users were identified through a search of the DNRME database on surface water extraction licences near to the Project Site prior to the confluence with the Isaac River. The search revealed five surface water licences, consisting of two licences for stock watering purposes downstream of the site, with the remaining three licences belonging to BMA to divert a watercourse and for site water management of the existing Saraji Mine. The stock licences are all located within 8 km of the downstream extent of the Project Site. A summary of the stock licences is provided in Table 8.1 and illustrated in Figure 8-5.

Table 8.1 Surface water extraction licences

Lot/Plan	Creek	Purpose
9/CNS98	Ripstone Creek	Stock watering
11/KL135	Ripstone Creek	Stock watering



LEGEND

- Locality
- Watercourse
- Isaac River Catchment
- Tenement
- Fitzroy River Basin
- Drainage Basin

Figure 8-4
Regional Catchment

Environmental Impact Statement
Saraji East Mining Lease Project

0 25 50 100
Kilometres

Scale: 1:3,000,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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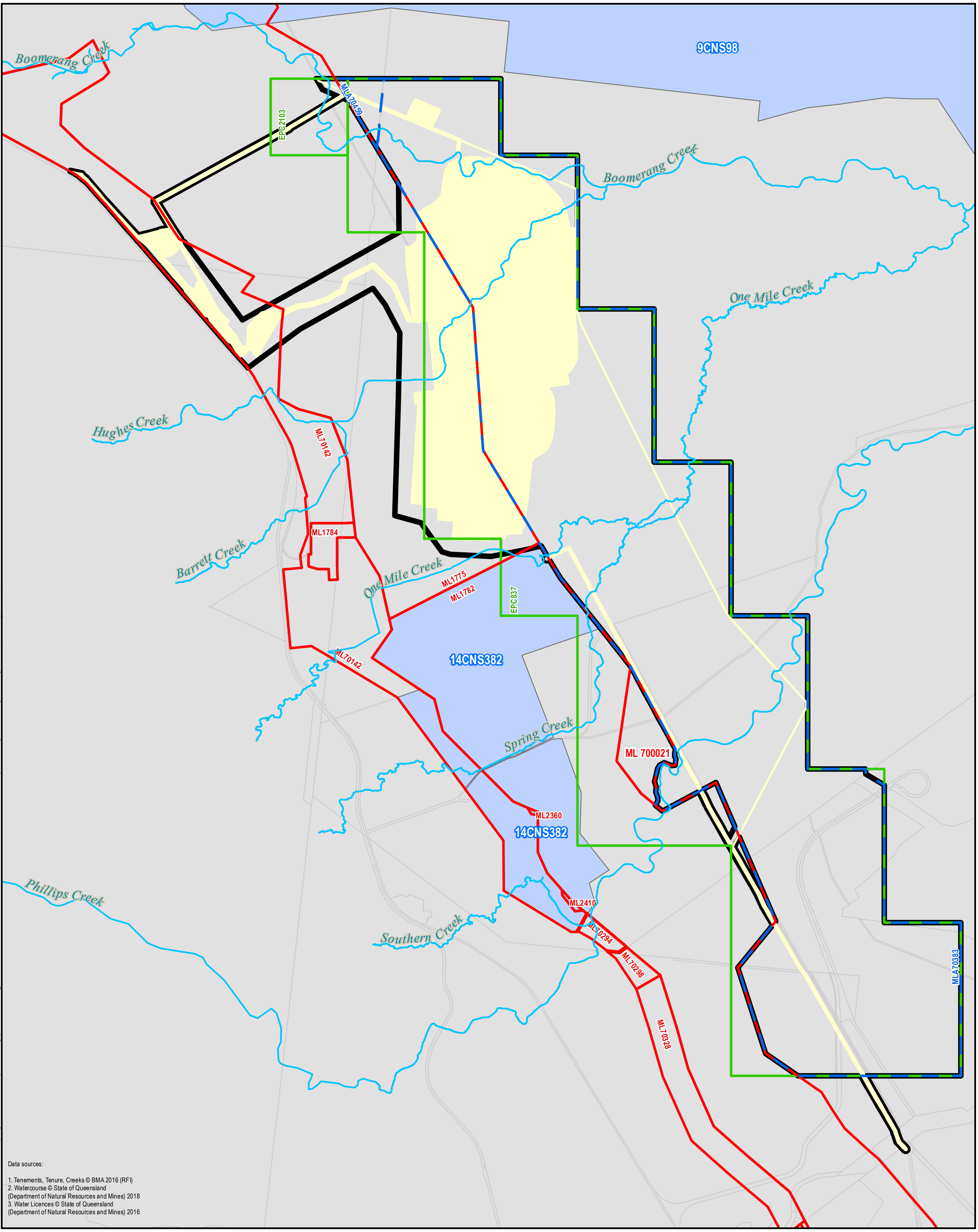

Data sources:

1. Tenements, Tenure, Creeks © BMA 2016 (RFI)
2. Watercourse © State of Queensland (Department of Natural Resources and Mines) 2018
3. Water Licences © State of Queensland (Department of Natural Resources and Mines) 2016

LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Existing Water User
- Cadastre

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Figure 8-5
Existing Surface Water Extraction Users

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:120,139 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Hydrology

Typical of the watercourses in the region, the watercourses in the Project Site flow intermittently through the year in response to rainfall and runoff, with extended periods of no flow. To establish a baseline of hydrologic environmental values (existing conditions), against which potential changes caused by subsidence could be compared, a hydrological analysis (**Appendix E-3 Hydrology, Hydraulics and Geomorphology Technical Report**) was undertaken.

Hydrologic modelling for the Project was undertaken using industry standard software programs and methods. CatchmentSIM, which delineates sub-catchments from a Digital Terrain Model was used to determine sub-catchment properties (area, centroid, stream length) and create output files for use in the hydrologic model. RORB, the hydrologic model, represents the rainfall runoff process occurring in a catchment to estimate flow hydrographs and peak flows at locations of interest.

The term Annual Exceedance Probability (AEP) is used for design events (rainfalls and floods) including rarer (less frequent) than those with a ten per cent AEP. However, the term Annual Recurrence Interval (ARI) is used throughout the Australian Coal Association Research Program (ACARP) criteria for assessing hydraulic parameters of channels and is commonly understood in this context. ARI was used in the hydrology assessment for design events up to the 50 year ARI (i.e. two per cent AEP). Refer to Table 8.2 for a conversion between ARI and AEP.

Table 8.2 ARI to AEP conversion table

ARI (years)	AEP	AEP expressed as %
2	0.393	39
5	0.181	18
10	0.095	10
20	0.049	5
50	0.020	2
100	0.010	1
200	0.005	0.5
500	0.002	0.2
1,000	0.001	0.1
2,000	0.0005	0.05

The estimated peak flows (cubic metres per second) (m^3/s) for key locations are summarised in Table 8.3. These peak flows were used for the subsequent hydraulics assessment.

Table 8.3 Design discharges generated from hydrologic modelling (m^3/s)

Creek	Catchment area (km^2)	2 year ARI	50 year ARI	1% AEP	0.1% AEP
Plumtree Creek	10.1	13.4	51.5	68.3	142.0
Boomerang Creek	106.2	86.6	380.0	450.0	979.0
Hughes Creek (including Plumtree Creek)	131.5	97.8	441.0	531.0	1132.0

8.4.3 Geomorphology

Boomerang Creek

Downstream of Peak Downs Mine, Boomerang Creek meanders gently south then east before joining Hughes Creek and eventually making its way to the Isaac River. It forms a continuous channel with relatively uniform symmetrical cross-section in straights and asymmetrical on bends. The channel bed is severely aggraded with sand in excess of several metres thick smothering all bed forms and limiting habitat diversity. The system is generally accreting as it is in a transport limited state (it receives more sediment than it can transport). The transport limited state often limits the potential for bank erosion. A thick mud drape on the channel banks, generally colonised by fine roots allows for the steep banks to be stable.

Existing cattle grazing does provide disturbance to channel bed and banks and limits potential for regeneration of riparian vegetation. This has led to a relatively dense line of *Melalueca leucadendra* and occasional *Eucalyptus tereticornis* over story lining the banks, with an exotic grass ground cover, the density of which is a direct result of grazing regime. Mid story (shrub) vegetation is largely absent.

Hughes Creek

Hughes Creek is single alluvial continuous channel that has been diverted between open cut pits in the existing Saraji Mine. The diversion has a high angle bend into the most western of the northern panels in the Project Site. This proposed panel will subside 1,300 m downstream of the diversion. The diversion reach is a deeply cut, large channel with no floodplain connectivity. It is cut through dispersive subsoils and has been subject to considerable erosion and recently, rehabilitation effort. These rehabilitation works comprise covering the long and relatively steep diversion batter slopes with pit sourced sandstone. This type of pit sourced sandstone typically completely weathers to constituent parts in two to five years. As these works are recent, there is no vegetation on the batters. Some vegetation has been left in the low flow channel.

There is existing active bank erosion where the channel capacity remains close to the diversion with decreasing erosion and increasing deposition moving downstream. Channel capacity decreases in a downstream direction. Where this occurs, flood connection with Boomerang Creek occurs.

Plumtree Creek

This tributary of Boomerang Creek is relatively short, commencing on the eastern edge of the existing Saraji Mine (the upstream catchment has been mined and no longer contributes flows). It flows east then north-east before its confluence with Boomerang Creek on the northern edge of the proposed underground mine plan. The watercourse is a continuous single-thread, meandering channel with a flatbed grade.

The flat bed grade and low capacity channel results in relatively low stream power, reflecting a low energy system through the Project Site. Longitudinal bed grade is controlled by Boomerang Creek downstream which has led to aggradation of the channel. The open cut operations have modified its catchment, though not directly modified the channel. The reduced flows are reflected in a channel that is inactive and being colonised by terrestrial vegetation in part and blanketed in clay in others, leading to ephemeral wetland development in channel. There are no signs of instability on Plumtree Creek within the Project Site.

8.4.4 Flooding

Modelling was undertaken to determine the nature and extent of flood behaviour under existing conditions. The maximum predicted water depth across the Project Site was mapped for the two year ARI, 50 year ARI, 100 year ARI and 1,000 year ARI events (Figure 8-9 to Figure 8-16).

The lower limit of mapping was set at 0.2 m deep to minimise capturing puddles that result from direct rainfall.

Results indicate that for the two year ARI event, flows are contained within the channels except in the north-east corner of the Project Site, where floodplain inundation occurs near the Hughes and Boomerang Creeks confluence. The extent and depth of inundation increases for each larger flow event modelled. Overland flow paths south of Hughes Creek also become more prominent under larger flows. The construction village is free from flooding. Road access from the south is also likely to be affected by inundation from One Mile Creek in large flow events.

Flood inundation results for the probable maximum flood (PMF) have been assessed and compared against the levels of the conveyor and underground mine entrance. The result is negligible flood risk to the entrance (0 to 15 mm flood depth). Such small depths are considered inconsequential and could be controlled with small barriers around the entrance that would mitigate the small flood impact and present no risk to the conveyor.

8.4.5 Water quality

The **Surface Water Quality Technical Report (Appendix E-1)** was prepared to assess baseline conditions and the potential impacts of the Project on surface water quality in watercourses within and downstream from the Project Site. The assessment was undertaken in the context of identifying applicable environmental values in accordance with Schedule 1 of the EPP (Water), ANZG 2018 and the QWQG 2009 (DEHP 2009).

Environmental values

Environmental values for water are the qualities that make it suitable for supporting aquatic ecosystems and human use. These values need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Environmental values for waters in the Isaac River sub-basin are published in the document entitled ‘Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)’ (DEHP, 2011). The following environmental values were identified for the Isaac Western Uplands Tributaries sub-catchment (within which the Project Site is located):

- aquatic ecosystems
- stock watering (e.g. cattle)
- human consumer (e.g. of wild or stocked fish)
- primary recreation (e.g. swimming)
- secondary recreation (e.g. sailing, fishing)
- visual appreciation (e.g. picnic, bushwalking)
- drinking water (e.g. raw water supplies taken from river)
- cultural and spiritual values (e.g. traditional customs).

Regionally, the Isaac/Connors River System also provides a potable water supply (after treatment).

Water quality objectives and guidelines

Relevant water quality objectives to protect the environmental values identified for the Isaac River catchment are defined within Schedule 1 of the EPP (Water). The ANZECC trigger values for toxicants applied to slightly-moderately disturbed systems. Relevant water quality guidelines are shown in Table 8.4.

Table 8.4 Water quality objectives

Parameter	Unit	Water quality objective	Guideline source
Physico-chemical parameters			
Total suspended solids	milligrams per Litre (mg/L)	55	EPP (Water) (2019)
Turbidity	Nephelometric Turbidity Units (NTU)	50	EPP (Water) (2019)
Electrical conductivity	microSiemens per centimeter (µS/cm)	Base flow: 720 High flow: 250	EPP (Water) (2019)
Sulfate	mg/L	25	EPP (Water) (2019)
pH	-	6.5-8.5	EPP (Water) (2019)
Ammonia (as nitrogen)	Micrograms per Litre (µg/L)	20	EPP (Water) (2019)
Oxidised nitrogen	µg/L	60	EPP (Water) (2019)
Organic nitrogen	µg/L	420	EPP (Water) (2019)
Total nitrogen	µg/L	500	EPP (Water) (2019)
Filterable reactive phosphorus	µg/L	20	EPP (Water) (2019)
Total phosphorus	µg/L	50	EPP (Water) (2019)
Dissolved oxygen	% saturation	85-110	EPP (Water) (2019)
Metals (dissolved)			
Aluminium	µg/L	5,000	EPP Water (2011) Stock watering**
	µg/L	55	ANZG (2018)*
Arsenic (dissolved)	µg/L	500	EPP Water (2011) Stock watering **
		13 (for As(V))	ANZG (2018)*
Chromium	µg/L	1,000	EPP Water (2011) Stock watering**
	µg/L	1	ANZG (2018)*
Copper	µg/L	400	EPP Water (2011) Stock watering**
	µg/L	1.4	ANZG (2018)*
Iron	-	Not provided	EPP (Water) (2019)
	-	Not provided	ANZG (2018)*
Molybdenum	µg/L	150	EPP (Water) (2011) Stock watering**
	µg/L	34	ANZG (2018)*

Parameter	Unit	Water quality objective	Guideline source
Nickel	µg/L	1,000	EPP (Water) (2011) Stock watering**
	µg/L	11	ANZG (2018)*
Selenium	µg/L	20	EPP (Water) (2011) Stock watering**
	µg/L	5	ANZG (2018)*
Uranium	µg/L	200	EPP (Water) (2011) Stock watering**
	µg/L	0.5	ANZG (2018)*
Zinc	µg/L	20,000	EPP (Water) (2011) Stock watering**
	µg/L	8	ANZG (2018)*

*ANZG trigger values for toxicants applied to slightly-moderately disturbed systems
**ANZECC guideline still applicable as ANZG has not been updated for stock watering.

Existing water quality

The existing water quality of the watercourses flowing through the Project Site and the downstream receiving environment of the Project Site was assessed to characterise existing conditions. The assessment was based on a review of water quality data collected at various monitoring locations (identified in Figure 8-1, refer to **Appendix E-1 Surface Water Quality Technical Report** for further detail).

The local watercourses represent a slightly to moderately disturbed aquatic habitat. The water quality data indicates that total suspended solids and turbidity, electrical conductivity, sulfate, nitrogen and phosphorus, and the dissolved metals aluminium, copper, chromium, nickel, uranium and zinc are present at concentrations greater than the water quality objectives defined within Schedule 1 of the EPP (Water) and ANZG (2018) (Table 8.4). These exceedances can occur both upstream and downstream of the Project Site and are likely a function of existing surrounding land uses such as agriculture and open cut mining.

All of the local waterways and the downstream Isaac River have impaired water quality, being highly turbid with elevated nutrient concentrations. However, streams close to the project site (Boomerang, Hughes and One Mile Creeks) show higher electrical conductivity and sulphate concentrations in comparison to the downstream Isaac River.

For metals, streams close to the project site (Boomerang, Hughes and One Mile Creeks) show higher concentrations of aluminium and iron than the downstream Isaac River. One Mile and Phillips Creeks have appreciably higher concentrations of copper, nickel and zinc in comparison to the downstream Isaac River.

A summary of the water quality data results is provided in Table 8.5. This table indicates where statistical were generated from a minimum of 18 sampling events, which is sufficient to meet the requirements of the Queensland Water Quality Guidelines (DEHP 2009) for a reference data set.

Table 8.5 Summary of downstream water quality data for 2010-2020

Water quality parameter	Water quality guideline	Boomerang Creek	Hughes Creek	One Mile Creek	Phillips Creek	Isaac River
Physico-chemical stressors, median value of parameter						
Total suspended solids (TSS)	55 mg/L	101	92	108	698	379
Electrical conductivity (EC)	Base flow: 720 µS/cm High flow: 250 µS/cm	926	536	1,180	336	400
Sulfate (SO_4)	25 mg/L	144	76	75	34	20
pH	6.5-8.5	8.22	7.48	7.91	7.88	7.9
Total nitrogen	500 µg/L	-	(605)	(1,235)	(1,700)	920
Ammonia nitrogen	20 µg/L	(35)	20	30	25	50
Oxidised nitrogen	60 µg/L	(175)	109	929	140	128
Total phosphorus	50 µg/L	-	(104)	(61)	(600)	(353)
Filterable reactive phosphorus	20 µg/L	-	(9)	(1)	(-)	(28)
Dissolved oxygen	85% -110 % saturation	103	87.5	113.0	85.6	97
Turbidity	50 NTU	(281)	1,379	1,980	1,200	3,230
Toxicants (dissolved metals), 95th percentile of parameter						
Aluminium	55 µg/L	(4483)	4,500	1,255	2,485	1,248
Arsenic	13 µg/L	(2)	1	2	4	1
Chromium	1 µg/L	(4)	1	2	4	2
Copper	1.4 µg/L	(4)	2	12	6	3
Iron	No guideline	(1940)	2,300	2,396	725	730
Molybdenum	150 µg/L (stock) 34 µg/L (ecosystem)	(5)	2	9	2	2
Nickel	11 µg/L	(4)	5	39	18	3
Selenium	20 µg/L	(10)	10	10	3	10
Uranium	200 µg/L (stock) 0.5 µg/L (Ecosystem)	(1)	2	1	4	1
Zinc	8 µg/L	(9)	5	13	66	6

Result indicates that the guideline is exceeded.
Result from dataset comprising a minimum of 8 sampling events, sufficient to comprise an interim reference dataset in accordance with the requirements of the Queensland Water Quality Guidelines (2009).
(Result) indicates that fewer than 8 sampling events contribute to the dataset for that parameter.

Site-specific water quality objectives

The water quality monitoring indicates a slightly to moderately disturbed aquatic habitat within the Project Site, which is influenced by upstream mining and agricultural land uses in the catchment. Therefore, it is necessary to develop site specific water quality objectives against which upstream and downstream water quality can be monitored during the Project.

The relevant environmental values as defined under *EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP, 2011) will be considered during the establishment of site-specific water quality objectives in general accordance with *Deciding aquatic ecosystem indicators and local water quality guidelines* (DES, 2018d).

Prior to construction, REMP monitoring will be carried out to collect a minimum of 18 data values over at least two years to inform the development of site-specific surface water quality objectives to be adopted for the Project. Prior to construction, BMA will develop site-specific water quality objectives to be incorporated into a REMP for the Project (refer to Section 8.7.5).

8.5 Mine water management

8.5.1 Baseline water management

Mine water is a defined in the Model Mining Conditions (DEHP, 2017b) and typically includes, but is not limited to:

- pit water, tailings dam water, processing plant water
- water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2019 if it had not formed part of the mining activity
- rainfall runoff which has been in contact with any areas with the potential to be contaminated by mining activities, such as haul roads used by trucks but not including unsealed roads used only by light vehicles
- groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated
- groundwater from the mine's dewatering activities (BHP, 2017b).
- Sources of potentially MAW were assumed as follows:
- Process area runoff – surface runoff associated with the following areas is assumed to be mine affected and will be contained at each respective source and transferred to the process water dam:
  - Run of Mine (ROM) coal stockpile pad
  - product stockpile pad (including the train load out)
  - Coal Handling and Preparation Plant (CHPP) and Mine Infrastructure Area (MIA)
  - catchment reporting to the underground mine portal
- Groundwater – water from both the bore field and underground mine dewatering was assumed to be mine affected and will be transferred to the process water dam as soon as practical. Dewatering of the underground mine will initially discharge to the portal sump. From there it will be transferred to the process water dam
- Underground mining operations effluent – water reclaimed from underground mining operations is assumed to be mine affected and will similarly be initially discharged to the portal sump and from there transferred to the process water dam.

An important aspect of the operational strategy for the Project mine WMS is to reuse mine water wherever possible as a priority over use of external pipeline raw water supply. This has sustainability benefits in making the mine as self-sufficient as possible and to minimise the mine's reliance on external water supplies. It is also important to manage the storage inventory (total mine water volumes) in the mine WMS to ensure adequate storage can be made available for containment of wet and very wet seasonal conditions.

Not all of the mine operational water requirements can be supplied with mine water. Some of the water requirements for the operations require high quality water sourced from external pipeline raw water supply. These raw water demands form a very small portion of the overall site water use.

8.5.2 Mine water system objectives

The objective of the WMS is to minimise the quantity of water that is mine affected and released by Project activities. This will broadly be achieved by:

- managing the generation, storage, distribution, and reuse of all potentially MAW (including groundwater) captured and generated by the Project
- handling the conveyance of natural runoff originating from undisturbed clean catchments through the Project Site
- managing the storage and distribution of raw water.

Under normal operating conditions, the Project mine water system will operate independently of the existing Saraji mine water system. However, should sufficient MAW not be available for CHPP process and dust suppression at the Project, this may be imported from the existing Saraji Mine water system, following water quality testing to confirm that water is of an appropriate quality for the intended use. Similarly, where additional water demands at the existing Saraji Mine need to be met, or where there is excess water in the Project site that needs to be stored at the existing Saraji Mine, water that satisfies water quality testing may be exported from the Project.

8.5.3 Proposed mine water management system components

The below sections discuss the proposed mine WMS components for the Project.

Process water dam

Runoff from disturbed areas of the Project, including the MIA, the CHPP, stockpiles (ROM and product coal), rail loop and spur, will be collected from disturbed areas and transferred to the process water dam. A process water dam is proposed for the Project to provide the storage required to contain the estimated volume of MAW generated over the production schedule. The dam design will be confirmed during detailed design.

The conceptual design and operational rules applied to the process water dam for the assessment were:

- water will be transferred to the process water dam following localised containment and collection in one of the various process area runoff dams or sumps located around the Project Site
- the process water dam will be used to preferentially supply water to various consumptive water demands for which the reuse of MAW is appropriate (CHPP process supply, dust suppression in active mining areas)
- in the event of a spillway discharge from the process water dam, water will, as far as practical, be directed via existing drainage pathways to the receiving environment.

Temporary gas dewatering storage

The pre-drainage of incidental mine gas will result in the production of water. This water will be collected in local facilities near the well head. These facilitates will act as a balancing storage to allow transfer at a constant rate to the process water dam.

Process areas runoff collection system

Runoff from several operational areas and facilities is expected to potentially generate MAW. It is proposed that runoff originating from these process areas be collected in dams assigned to each location via gravity inflow. Process areas within the Project Site are the CHPP, ROM pad and product stockpile.

Conceptual design and operational rules for the process area runoff collection system applied within the assessment were:

- Runoff from each process area will be conveyed by gravity flow to its respective containment dam. Pumping of runoff to the containment dams is not considered practical due to the high degree of variability in rainfall volume and intensities
- Potentially clean runoff originating outside of the process areas will, as far as practical, be passively diverted around the process areas by way of catch drains as required to reduce the total volume of water requiring containment
- Water will be transferred from each process area dam to the process water dam as soon as possible in order to ensure that capacity to contain additional inflows is maximised.

Portal sump

Both groundwater ingress and process (effluent) water return are considered to be mine affected and will be collected as required within the underground mine and pumped to the open cut portal sump. In addition, incidental water captured via the advanced gas drainage bore field is also considered to be potentially mine affected and will also be transferred to the portal sump. Stormwater runoff from the portal entry ramps as well as any additional runoff generated within the pit was similarly considered to be mine affected and will also be collected in the portal sump.

Conceptual design and operational rules for the portal sump were as follows:

- pumped inflows to the portal sump will come from dewatering of the underground mine (groundwater ingress and process effluent) and from the gas drainage bore field
- runoff from the underground mine portal ramp and existing open cut pit will enter the portal sump via gravity inflow
- water will be transferred from the portal sump to the process water dam as required.

CHPP process and dust suppression water supply

It is proposed that processing and washing of coal will be conducted onsite with the Project CHPP located within Mining Lease (ML) 70142. The CHPP will be designed to process ROM coal at a rate of 800 tonnes per hour (tph), equivalent to a yield of up to five million tonnes per annum (Mtpa) of metallurgical product coal (or up to 7 Mtpa of ROM coal) which will be delivered to the train load out bin at a rate of approximately 4,500 tph. The CHPP will require a raw water supply of approximately 1,500 megalitres per year (ML/yr) to achieve this production rate. Water will be preferentially sourced from the process water dam. Water for dust suppression (of areas that drain to MAW dams or where water will evaporate) will also be preferentially sourced from the process water dam.

Conceptual design and operational rules for the CHPP process and dust suppression water supply are as follows:

- reuse of Saraji East mine MAW to be prioritised over raw water use whenever sufficient supply available in the process water dam
- if there is a shortage of water, imported water would be used of a similar quality
- dust suppression demand reduced to zero when daily rainfall exceeds evaporation
- no quality restrictions have been imposed on reuse of MAW.

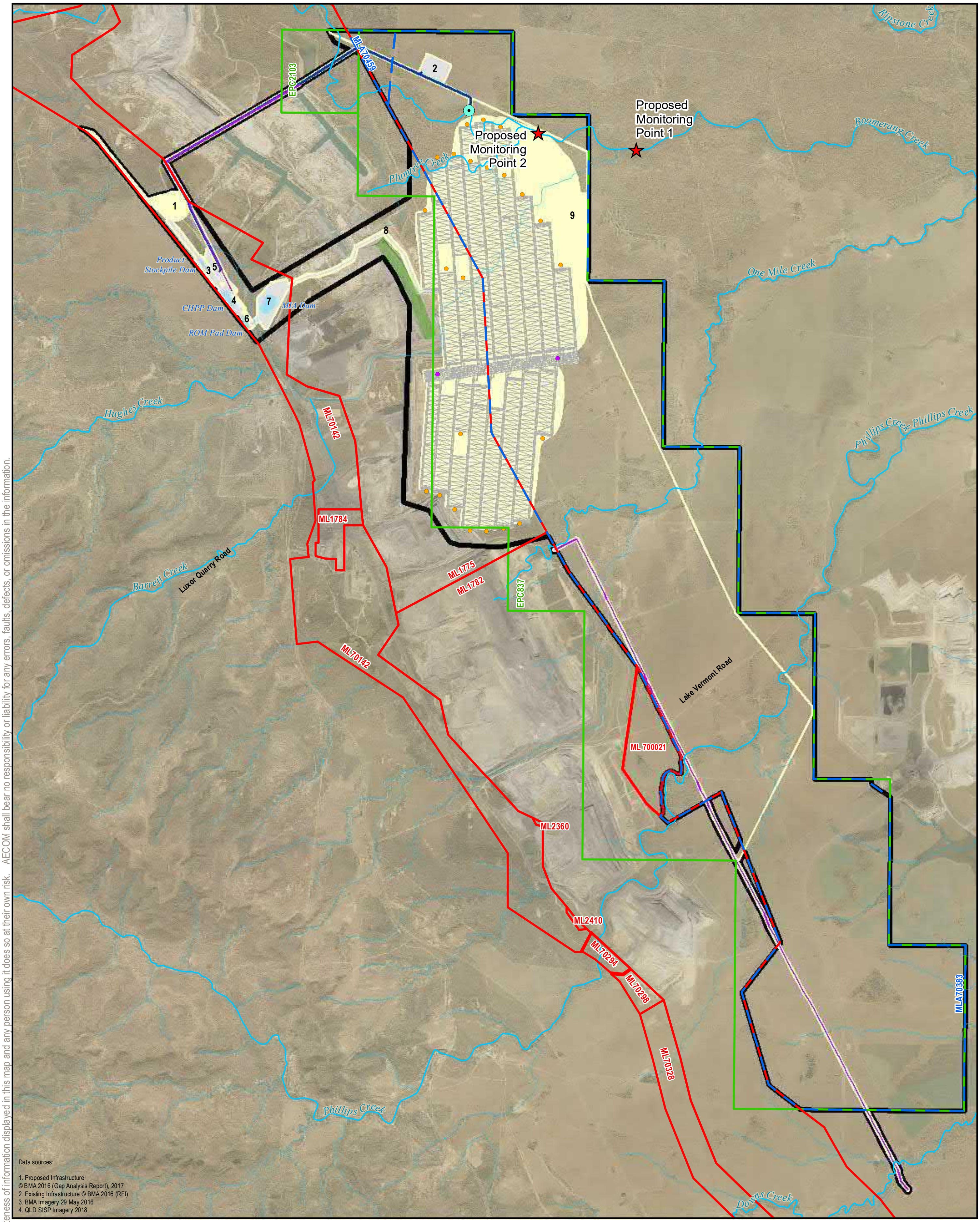
Raw water system

To supply Project water demands for which reuse of MAW is unsuitable (potable, washdown, underground mine process), or for when MAW is unavailable, a raw water dam (RWD) is proposed for the Project Site. The conceptual sizing of the RWD is such that it can provide approximately one month’s supply of water for all Project water demands including potable, processing and operations in the absence of alternative sources such as the reuse of MAW. This will be confirmed in the detailed design stage.

The locations of these proposed WMS components are provided in Figure 8-6. A schematic of the conceptual mine water management processes is shown in Figure 8-7

Sewage Treatment Plant

A package sewage treatment plant (STP) will be installed prior to commencement of construction works and will be used to service both construction and operation of the Project. The STP will be sized to provide sufficient capacity for the construction workforce and the operational mine workforce and will discharge treated effluent to the process water dam. Treated effluent that does not meet the desired water quality will be recycled through the STP until it meets a standard which is safe for reuse, in accordance with the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NWQMS, 2006). The volume of effluent will be such that any potential impact on dam levels will be negligible and the effluent will be treated to a level such that the water quality in the process dam will not be adversely impacted. Biosolids will be removed from site and disposed of at a licenced facility.



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground layout (optimised)
- 66kV Powerline
- Pipeline
- Flare
- Vent
- Minor Waterway
- Major Waterway
- Indicative Dam Location
- Bauhinia Pit Portal Sump Catchment
- Indicative proposed monitoring point location
- Indicative Proposed Mine Water Release Point

Surface Infrastructure

1 Rail Loading Balloon Loop
2 Process Water Dam
3 Product Stockpiles
4 CHPP
5 Raw Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village

N

Figure 8-6
Proposed Water Infrastructure

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 24/07/2020 VERSION: 2

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\08 Surface Water\60507031_G272_v2_A4P.mxd

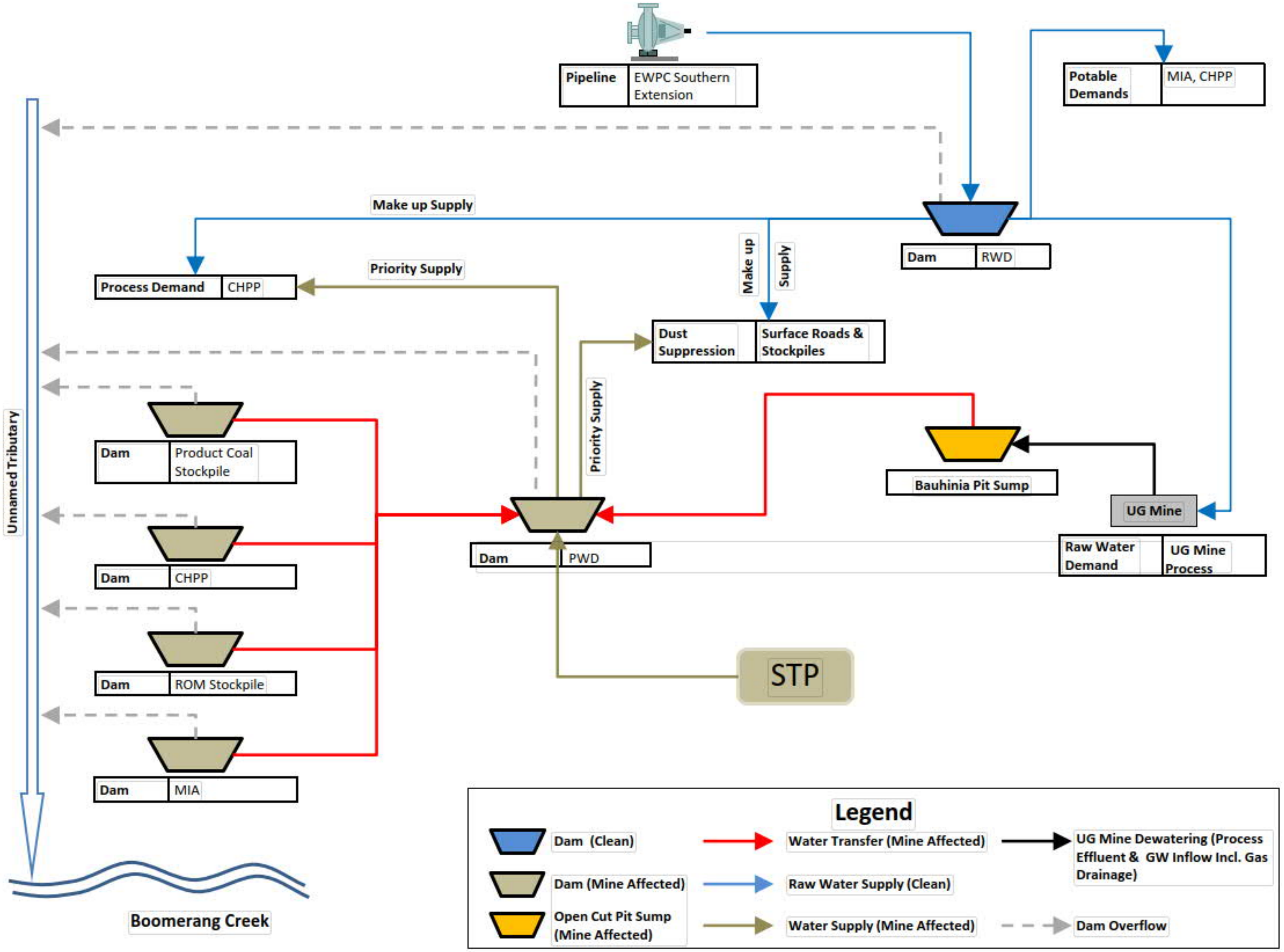


Figure 8-7 Mine water balance schematic

8.5.4 Consequence category for dams

A consequence category assessment (CCA) report must be completed during the detailed design stage for all proposed Project dams as per guidance provided by the DES *Manual for assessing consequence categories and hydraulic performance of structures* (2016) (DES Manual). The specific design characteristics of the Project dams proposed as part of the Project will be progressed as part of the detailed design phase. A CCA report will be prepared during the detailed design phase.

According to the DES Manual, all structures which are dams or levees associated with the operation of environmentally relevant activities (ERAs) must, unless otherwise stated in the DES Manual, have their consequence category assessed based on the potential environmental harm that would result from the failure event scenarios.

For dams determined to be regulated structures, the consequence category to be applied is the consequence category determined from the ‘dam break’ scenario and ‘failure to contain’ scenarios. This includes all mine affected water dams except for the raw water dam.

Three types of failure scenarios must be considered, namely:

- failure to contain – seepage: releases to ground or groundwater via seepage through the floor or sides
- failure to contain – overtopping: surface releases due to the structure spilling without structure failure. That is, the capacity of the structure is exceeded either by severe rainfall or by pumping in too much fluid
- dam break: geo-mechanical failure of an embankment causing release of contained fluid.

As noted in the DES Manual, “early identification of the consequence potential of these structures is important in determining the standard of reliability required for design, construction and operation of the structure”. This clarifies that assessment is made of the likely consequences if the structure failed, not of the likelihood of such failure occurring. The consequence category assessment provides design criteria to ensure that the likelihood of failure scenarios occurring is consistent with the severity of potential consequences.

The hydrologic/hydraulic design criteria applicable to each failure scenario would be:

- seepage – minimisation, monitoring and collection of seepage
- overtopping – wet season containment (DSA) and storm event containment (ESS/MRL)
- dam break – spillway capacity and embankment crest levels.

The hydraulic performance objectives for dams that are regulated structures in relation to “dam break” scenario are to be achieved by selecting an appropriate design AEP for spillway capacity in accordance with Table 6 of the DES 2016 Manual.

Each of the environmental harm categories set out in the DES Manual, comprising: ‘harm to humans’, ‘general environmental harm’ and ‘general economic loss or property damage’, have defined criteria that relate to potential consequences (impact, adverse effects, damage or loss) associated with the release of dam waters to the environment.

The typical receiving environment features that must be considered for each category of harm are summarised in Table 8.6 below.

Table 8.6 Environmental harm criteria and receiving environment considerations

Criteria	Receiving environment considerations
Harm to humans	
Presence of people in the failure path Waters used for human consumption	• Occupied residences • Likelihood that people will be routinely present in the failure path. 'Routinely' is considered to mean on a regular basis – i.e. that there is a reasonable chance that people could be present at the time of failure, whether on public roads, in recreation areas, residences or places of employment (e.g. farming) • Location of groundwater bores registered for water supply. • Location of dams associated with dwellings that could potentially be used as water supply for human consumption • Water quality of dams in relation to drinking water quality guidelines
General environmental harm	
Release of contaminants causing adverse impacts to areas of Significant Value or Moderate Value.	• MNES • MSES • High ecological value waters • Dam water quality in relation to water quality criteria and receiving environment water quality
General economic loss or property damage	
Third party property damage	• Location of third party assets in the failure path • Non-BMA owned infrastructure (e.g. roads, mining infrastructure, agriculture, public amenity)

An initial review of the likely consequence category classifications for water management system and mine affected water storages was undertaken, considering the factors described in Table 8.6. The review considered the following proposed storages:

- process water dam
- raw water dam
- water storages including sediment dams to capture run-off from operational areas including the CHPP, underground mine portal sump, the proposed MIA as well as the rom and product coal pad areas.

The initial review identified that the following provisional classifications are likely to apply:

- generally, mine affected water dams are likely to be allocated a 'significant' consequence category, on the basis of:
  - Harm to humans:
    - under the dam break scenario, the consequence category is provisionally considered low due to the lack of public infrastructure or private homesteads within a reasonable distance (taken as 5 km) from the proposed dam location. there are rarely people routinely present within the assessed flood extents. furthermore, there is no surface water extraction for the purposes of human consumption in proximity to the structure which means that in terms of health, no people would be affected
    - the consequence category from the failure to contain seepage scenario has been conservatively assessed as significant based on the available information. This rating may be revised based on further assessment of geotechnical and groundwater parameters undertaken to inform detailed design

    - the consequence category resulting from the overflow scenario is considered low as any possible downstream contamination would likely result in less than 10 people being affected.
  - General environment harm:
    - the consequence category under both the overflow and dam break scenarios is considered significant as the likely quality of water stored in mine affected water dams could result in environmental harm
    - the consequence category from the failure to contain seepage scenario has been conservatively assessed as significant based on the available information. this rating may be revised based on further assessment of geotechnical and groundwater parameters undertaken to inform detailed design.
  - General economic loss or property damage:
    - under both the overflow and dam break scenarios the consequence category is considered low. estimated economic damage to third party assets (e.g. downstream use for stock watering) would be expected to require less than $1 million in rehabilitation, compensation or rectification costs
    - the consequence category from the failure to contain seepage scenario has been conservatively assessed as significant based on the available information. This rating may be revised based on further assessment of geotechnical and groundwater parameters undertaken to inform detailed design. Estimated economic damage to third party assets were assumed to be greater than $1 million but less than $10 million in rehabilitation, compensation and repair costs.

As per the *Manual for assessing consequence categories and hydraulic performance of structures* (DES, 2016), dams assessed as being in the 'significant' or 'high' consequence category for failure scenarios are regulated structures and are required to incorporate a number of hydraulic performance criteria as outlined in Table 8.7 below.

Table 8.7 Hydrological and hydraulic design criteria for mine WMS dams

Failure to contain – overtopping		
Consequence category	Wet season containment (Design Storage Allowance (DSA))	Storm Event Containment (Extreme Storm Storage (ESS))
Significant	1:20 wet season volume	1:10 AEP 72hr duration
Failure to contain – dam break		
Consequence category	Flood passage - spillway event capacity	Flood level for embankment crest level
Significant	1:100 AEP to 1:1,000 AEP	Spillway design flood peak level + wave run-up allowance for 1:10 AEP wind.

Consequence categories and design criteria for all proposed dams will be confirmed during detailed design.

8.5.5 Water supply

Assumed water demands for the Project are shown in Table 8.8 below.

Modelled dust suppression demand has been based on the following assumptions:

- stockpile dust suppression (ROM and product coal) – five millimetres per metre squared per day ($mm/m^2/d$) over 15.4 ha
- six kilometres of access road (light vehicle) from portal entrance to ROM pad – 3.5 $mm/m^2/d$ assuming that the road is eight metres wide with one metre shoulders.

Dust suppression demand is assumed to be zero on days where rainfall is in excess of evaporation (where rainfall is in excess of five millimetres per day (mm/d), dust suppression is assumed to be zero, if less rain falls then some dust suppression is required to make up the difference).

Table 8.8 Assumed Saraji East Mine water Management System Water Demands

Mine Year	CHPP Net Demand* (ML/d)	Underground Mine Process (ML/d)	Stockpile Dust Suppression (ML/d)	Access Road Dust Suppression (ML/d)	Raw Water incl. Potable (ML/d)
1	0	1.5	0	0.1	0.66
2-21	1.5	3.36	0.462	0.1	0.66

* Inclusive of all return water

8.5.6 Modelling results

The mine WMS outlined in Section 8.5.3 was assessed using water balance simulation to confirm the containment and release design objectives. Sufficient system containment and transfer capacity has been provided to avoid controlled of MAW and uncontrolled releases (i.e. spillway overflow) of water to the receiving environment.

The estimated preliminary capacities and a summary of dam performance for the Project WMS dams are provided in Table 8.9.

All dams within the WBM as well as the entire model have been subjected to water and mass balance checks to confirm model continuity and mass balance.

Modelling of the process water dam produced the following results:

- the volume of water stored in the process water dam shows a distinct seasonal fluctuation with volumes increasing during the summer wet season and reducing during the winter dry season. the median volume of water in the process water dam is approximately 350 ML.
- the spread of values around the median is a direct result of the input climate data used (this is the only model input variable to change between each realisation) and represents the estimated range of potential outcomes resulting from the variability associated with rainfall and runoff inflows and evaporative losses
- estimated water quality in the process water dam is subject to seasonal evaporative concentration, however, the median and average electrical conductivity values remain within a range of 4,000 μS/cm to 5,000 μS/cm.

8.5.7 Preliminary design

Preliminary design details of all the proposed dams are presented in Table 8.9.

Table 8.9 Preliminary dam design and capacities

Dam	Dam capacity (ML)	Spillway (ML)	DSA** (ML)	MRL^^ (ML)	Dam Crest (ML)
Process water dam	1,050	1,050	920	1030	1150
CHPP dam	80	80	63	72	85
Product coal stockpile pad dam	135	135	113	129	147
ROM coal stockpile pad dam	45	45	35	41	51
MIA dam	100	100	80	95	110
RWD	200	200	-	-	224

** DSA – Design storage allowance ^^ MRL – Mandatory reporting level

The concept design of mine water dam options includes the hydrology and hydraulic calculations completed to estimate the wet season containment (DSA), storm event containment (MRL), spillway capacity and flood level for embankment crest levels in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structure* (March 2016).

Mandatory Reporting Level (MRL) – The level estimated as the lowest level required to contain either:

- the runoff from the contributing catchment of the particular pond for a 72-hour duration storm at the AEP, using 100% runoff of rainfall and making documented conservative assumptions regarding the operability of equipment during the event, or
- a wave allowance at the AEP has been estimated using a recognised engineering method.

If water reaches this level, DES must be notified in accordance with the EA.

Design Storage Allowance level (DSA) - The legislated maximum level allowed at the beginning of the wet season (November 1) to ensure the entire DSA volume is available. The DSA volume is designed with the capacity to contain both the critical wet season rainfall below the spillway. It is noted that the calculated DSA excludes the associated pumped flows from pits in the wet season.

The key components of the proposed dams are shown in Figure 8-8 below.

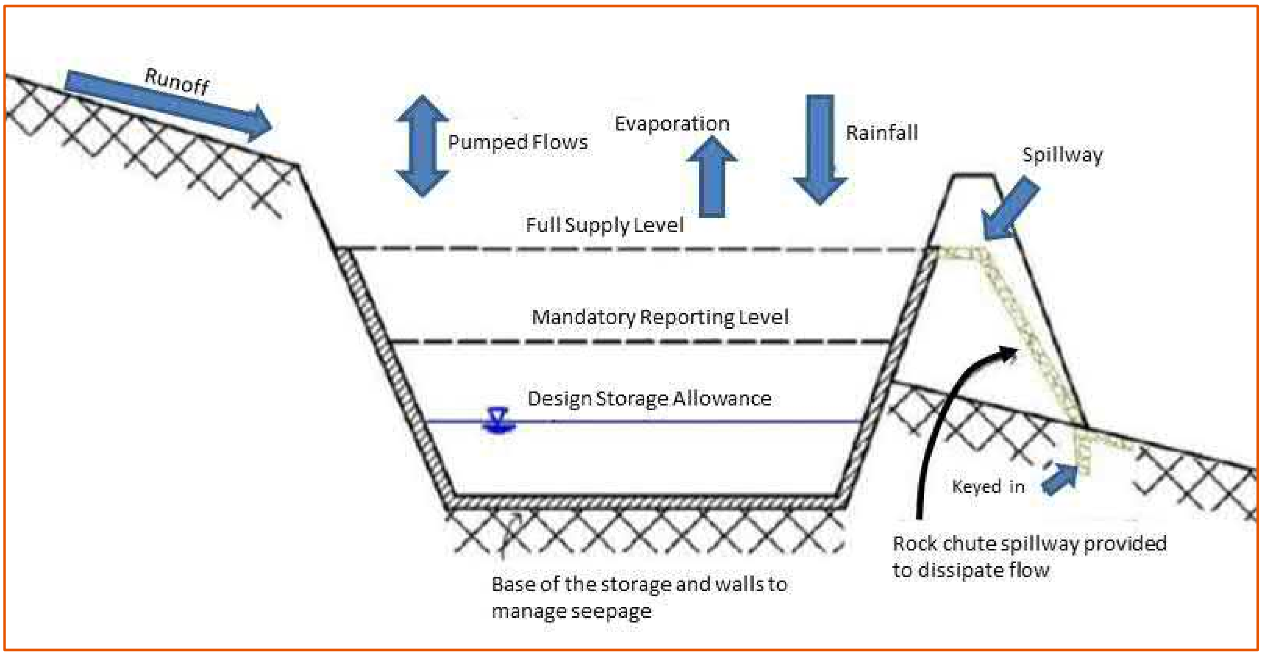


Figure 8-8 Cross Section of the proposed dams showing key components

8.6 Potential impacts

8.6.1 Erosion and sedimentation

Construction and operational impacts

Erosion and sediment mobilisation can lead to adverse impacts on downstream water quality and aquatic habitats. At certain times during construction, bare earth and uncovered stockpiles will be present that may generate silt and contaminant-laden runoff. Vegetation clearance, ground disturbance and soil compaction associated with the construction of the Project may also expose soils.

During the operational stage, the installation and operation of incidental mine gas management infrastructure poses the most significant risk in terms of mobilisation of sediment, as disturbance will occur across the area of the underground mine footprint, and access tracks and gas well pads will remain exposed for some time. Subsidence resulting from underground mining operations is another factor that could lead to increased sediment loads in streams.

Suspended sediments in the water column reduce light penetration, consequently affecting the primary productivity of benthic ecosystems. Such impacts may exacerbate the already high turbidity concentrations in the receiving waterways. Background concentrations of suspended solids in streams adjacent to the Project (median 280 mg/L) were well above applicable water quality objective for upper Isaac River catchment waters (55 mg/L), indicating that the streams are quite turbid in their existing condition. While a large, long term increase in suspended solids may further degrade aquatic ecosystems, short term increases in storm events are unlikely to have any significant impact.

Deposition of suspended sediment within watercourses can lead to geomorphological changes within the streams. However, given the relatively high existing sediment loads that have already influenced the bed characteristics of these streams, short-term impacts from runoff from construction areas during storm events is unlikely to significantly change the geomorphological characteristics of these streams.

Cumulative impacts resulting from surrounding land uses

Land uses surrounding the Project site have the potential to contribute to sediment loads and turbidity. These land uses, and contributing factors, include:

- Existing Saraji Mine operation– open cut mine, exposed soils
- Nearby mine developments:
  - Winchester South Project – open cut metallurgical coal mine, exposed soils
  - Olive Downs Project - open cut metallurgical coal mine, exposed soils
- Agricultural land use – soil disturbance due to livestock and /or tilling
- Construction/development – soil disturbance due to construction and earthworks.

Given the potential for cumulative impact on stream health resulting from sediment load and turbidity, it is essential that measures be put in place to limit and control sedimentation during construction of the Project.

8.6.2 Chemicals and contaminants

Salt

Land uses surrounding and upstream of the Project site have the potential to contribute to salts in surface runoff. Salt input to the receiving environment via overflows is zero under normal operating conditions, since modelling predicts that overflows are unlikely to occur. However, salts such as sodium chloride can be liberated from exposed sub-soils during construction and earthworks, or from mined materials during operation. There is the potential for cumulative impacts on stream health resulting from salts, and it is therefore necessary that measures be put in place to limit and control the erosion of subsoils during construction and to limit erosion of stockpiled materials during the operation of the Project. To prevent accidental discharge of salts to the environment, MAW dams would be de-silted on a regular basis.

Groundwater ingress into the pit represents the largest salt input over the operation of the mine at approximately 24,000 tonnes or 1,194 tonnes per year (t/yr). The summary salt balance for the Project is presented in Table 8.10.

Table 8.10 Mine Salt Balance Summary

	Life of Mine					Annual				
	Units	Mean	Median	10th	90th	Units	Mean	Median	10th	90th
WMS Inputs										
Total runoff	Tonne	10,919	11,228	7,423	13,163	Tonne/yr	546	561	371	658
Raw water input	Tonne	4,293	4,273	4,148	4,478	Tonne/yr	215	214	207	224
Groundwater input	Tonne	23,873	23,873	23,873	23,873	Tonne/yr	1,194	1,194	1,194	1,194
Total salt input	**Tonne**	**39,085**	**39,370**	**35,788**	**41,200**	**Tonne/yr**	**1,954**	**1,969**	**1,789**	**2,060**
WMS Outputs										
CHPP	Tonne	12,737	12,579	10,680	13,847	Tonne/yr	637	629	534	692
Total water demand	Tonne	40,052	40,354	37,004	41,944	Tonne/yr	2,003	2,018	1,850	2,097
External overflows	Tonne	0	0	0	0	Tonne/yr	0	0	0	0
Total salt output	**Tonne**	**40,052**	**40,354**	**37,004**	**41,944**	**Tonne/yr**	**2,003**	**2,018**	**1,850**	**2,097**

Fuels and Oils

Potential impacts to surface water quality may arise from accidental spills and leaks. The main contaminants of concern in this regard are fuels and oils. While some other chemicals will be utilised during construction, the quantities and natures of these chemicals is such that the risk of significant environmental harm in the event of a spill is low.

Accidental spills of fuel stored onsite or any other chemicals could enter the drainage lines and waterways. Contaminants may be mobilised during construction activities through chemical and fuel spills from:

- temporary refuelling facilities
- temporary chemical storage facilities (including oil and waste oil)
- installation and operation of the incidental mine gas system
- temporary vehicle washdown areas
- construction and commissioning of permanent fuel and chemical storage facilities.

Without appropriate mitigation measures, potentially contaminated drainage generated through these activities could enter into drainage lines, altering the physical and chemical characteristics of the receiving waters. This in turn may have acute or chronic toxicity effects on aquatic plants and animals. These pollutants can also have the potential to be a public health and safety issue if moderate to large quantities are released directly to watercourses.

The significance of potential impacts on surface waters will depend on the quantity and nature of contaminants as well as whether the contaminants are directly released to surface waters.

Small quantities of aqueous waste will be generated from removal of stormwater and contaminants from bunded areas and sumps. Provided this is treated in accordance with the proposed management measures, this is unlikely to cause any impact on surface water quality.

Likely quantities of fuel or oils that may be spilled would be low, typically in the order of 10 L to 20 L. If spills occur to soils, mobilisation of contaminants to surface waters are unlikely to reach a receiving aquatic environment and hence unlikely to result in any significant water quality degradation. Spills occurring within or immediately adjacent to watercourses may cause localised water quality degradation, but this is likely to be short lived.

8.6.3 Mine water management

All mine water from dewatering the underground mine and from incidental mine gas production will be stored and managed through the proposed mine WMS.

Mine dam structures have been designed to have sufficient capacity to contain all MAW. Uncontrolled releases are only likely to occur if the rain event is beyond the design capacity of the dam, or if there has been mismanagement in the operation of the dams. Therefore, the basis of the proposed mine WMS is that there will be no controlled or uncontrolled releases of MAW under normal operating conditions, based on historical climate data.

In the unlikely event that uncontrolled dam releases occur, this could result in contaminated water entering the receiving environment where mine water is able to migrate from the containment area into Boomerang Creek. Key potential contaminants include suspended solids/turbidity and salts.

A conservative approach has been taken towards controlled and uncontrolled releases of MAW from the Project. Preliminary capacity estimates for all dams and the water transfer network (using the water balance assessment described in Section 8.3.2) within the Project conceptual mine WMS have been based on the containment of all potential inflows using historical climate data and under a set of assumed operational rules. This conservative approach ensures that:

- Infrastructure capacity and operations capability are sufficient to mitigate the uncontrolled (spillway) discharge of MAW to the receiving environment
- The Project has sufficient storage capacity to cater for maximum mine water volumes that could occur (based on climate extremes evident in available historical data)
- Water allocations of external water sources are sufficient to meet shortfalls in site demands
- Based on the water balance model outcomes, controlled releases of MAW to the receiving environment are not required.

The proposed WMS has been designed with adequate capacity to avoid releases. The preliminary dam capacities presented herein are relevant to the input data, assumptions and adopted operational rules. However, any open system has the potential for uncontrolled discharge of MAW as a result of extreme rainfall events (wet conditions). As such, BMA will seek authority and licence conditions to conduct the controlled release of MAW from the Project site. The indicative location for controlled release of MAW is located on Boomerang Creek adjacent to the proposed process water dam (Figure 8-6). Spillway discharges (uncontrolled) from the process water dam are also proposed to be directed to Boomerang Creek.

Spillway (uncontrolled) discharges from the remaining process area dams will be directed to the receiving environment based on existing topographical constraints. Where dam overflow locations cannot deliver flows directly to Hughes Creek or its tributaries, conveyance channels are proposed to convey the discharge.

As mine dam structures have been designed to have sufficient capacity to contain all MAW, uncontrolled releases are only likely to occur if the rain event is beyond the design capacity of the dam, or if there has been mismanagement in the operation of the dams. Therefore, the basis of the proposed mine WMS is that there will be no controlled or uncontrolled releases of MAW under normal operating conditions, based on 128 years of historical climate data. A risk-based assessment of hypothetical MAW releases shows that no impacts on the receiving environment are expected from these events. This assessment is detailed in Section 7.2.1 of Appendix E-1 Surface Water Quality Technical Report (AECOM, 2021).

These impacts were analysed for three climate scenarios (dry, normal and wet conditions), based on:

- Expected MAW water quality characteristics (based on water balance modelling results and data from existing release at Saraji Mine)
- Expected receiving environment water quality characteristics (based on existing REMP data at Boomerang Creek)
- Data from historical MAW release events at Saraji Mine from 2016 and 2017, showing changes to salinity and pH levels in the receiving environment based on grab samples taken during the events.

This assessment indicates that impacts from managed MAW release during normal climate conditions will be similar to those from MAW releases from the current Saraji operations, which comply with the regulator requirements set out in Environmental Authority conditions.

Water transfer system

The water transfer network provides the ability to move MAW from the various collection dams to the process water dam, as well as the subsequent transfer of MAW to the various consumptive demand points (e.g. CHPP and dust suppression uses). The operating rules for the WMS have been developed in support of the other mine WMS objectives. They are summarised as follows:

- Inflows to the various collection dams will be transferred to the process water dam as soon as practical, provided capacity is available in the process water dam. This will ensure that the containment capacity of each collection dam is maximised.

- Nominal pump capacities will be selected to ensure that pumped transfers from each collection dam to the process water dam are sufficient to support the above objective.

An indicative controlled MAW release point from the Project is proposed for use in emergency conditions. This will discharge to Boomerang Creek via an unnamed tributary (Figure 8-6). Some instances of emergency conditions may include (but are not limited to) the following:

- water inventory levels nearing capacity or overflowing following extreme rainfall events
- structural damage such as deep cracking visible in water storages
- leakage or seepage noticed from water storages.

A review of the potential risks and associated controls in relation to the potential release of mine water during operation of the mine is documented in Table 8.11.

Table 8.11 Review of potential risks associated with mine water management

Event	Description	Hazard	Likelihood	Potential Controls
Storage containment failure leading to overtopping of spillway	Storage containment failure caused by inadequate storage capacity, overfilling of storage, inadequate diversion of clean catchment or extreme storm events	Discharge of MAW to receiving environment where it would then migrate to Hughes Creek or Boomerang Creek via unnamed tributaries	Unlikely	• Automated monitoring of water levels • Uncontrolled dam releases will be minimised by ensuring sufficient freeboard is maintained • Trigger Action Response Plans for high rainfall events and pumping failure – with the ability to procure mobile pumps to initiate pumping from the dam to mitigate any discharge to the receiving environment
Storage containment failure imminent, leading to controlled release	High water level in storage embankment and urgent need to prevent failure Seepage from embankment wall and from foundation of the dam Leads to piping through wall and subsequent contaminant release	Discharge of MAW to receiving watercourse at Hughes Creek or Boomerang Creek Seepage from mine water dams giving rise to salinity in the drainage and potential impacts on surface water quality and aquatic habitat	Very unlikely	• Controlled releases will be minimised by directing water to dust suppression and other process uses, where feasible • Such releases are only likely to occur during periods of high rainfall, which would likely lead to increased flows (and subsequent dilution) in nearby streams • Intercept seepage at necessary locations to reduce risk of unacceptable environmental impact • Seepage collection and treatment structures aim to reduce volumes of water entering surface water systems. • Install piezometers and monitoring of water level
Storage embankment failure	Embankment failure caused by piping failure (related to poor construction of embankment maintenance) or overtopping	Catastrophic failure leading to MAW discharge to receiving environment and risk of flash flooding	Very unlikely	• Freeboard between MRL level and spillway level at perimeter embankment identified as a Critical Operating Parameter with Trigger Action Response • Undertake regular routine and intermediate surveillance inspections during operation
WMS infrastructure failure	Including pipeline, pumps, drains, bunds and/or levee failures (caused by machinery damage, weathering, channel erosion,	Failure of surface water management system within/around the site impeding ability to achieve	Unlikely	• Regular inspections of the WMS infrastructure and surrounds • Trigger Action Response Plans may be developed for high rainfall events and pumping failure –

Event	Description	Hazard	Likelihood	Potential Controls
	incorrect placement or during relocation).	acceptable downstream water quality		recognising the ability to procure mobile pumps to initiate pumping from the dam • Design allows for rock armouring of toe of embankment levee adjacent to waterway and drains.
Insufficient water demand	Estimated water demand leading to overfilling of storage containment	Risk of overtopping	Very unlikely	• Ongoing frequent monitoring of water level and surface water in proximity to the Boomerang Creek and downstream • Freeboard between the DSA and MRL and operating level identified as a Critical Operating Parameter with Trigger Action Response • Plan to be documented in Dams OMS manual • Adaptive management allows for contingency planning and remediation if unacceptable impacts on the receiving environment are predicted or measured • Transfer of water to existing Saraji Mine storages
Mine water use exceeds water available in the process water dam	Insufficient water available for CHPP process and dust suppression	Risk of shortage of water	Unlikely	• Import water of a similar quality • Water treatment
Reduction in storage due to siltation	Siltation in dams leading to disposal of saline sludge	Saline leachate impacting groundwater	Unlikely	• Dry out sludge using natural or mechanical means to reduce volume of saline spoil • Selection of site for saline spoil disposal to minimise potential for impact on groundwater • Design of disposal site for saline spoil to minimise potential for mobilisation of leachate

8.6.4 Overland flows and diversions

There are no new diversions planned as part of the Project; overland flow will continue to be managed through a series of existing diversion drains designed to provide conveyance of clean water flows for the existing Saraji Mine.

8.6.5 Subsidence

The subsidence resulting from the Project's underground mining may create surface cracks and buckling. This is likely to cause tensile cracking, thus resulting in erosion responses in colluvial and alluvial sediments. Cracks in erodible sediment pose the greatest threat when orientated downslope and have the potential to cause rill erosion or gully formation.

Subsidence can potentially alter the interactions between surface water and groundwater due to goaf induced fracturing, which could increase groundwater to surface water hydraulic connections. This interaction can potentially increase salinity levels in surface water if groundwater is more saline than the surface water. An assessment of groundwater resources, levels and seasonality in the shallow aquifers (Quaternary alluvium and Tertiary sediments) across the Saraji Mine Lease indicates limited shallow groundwater resources (dry bores), seasonal potential surface water discharge to groundwater, and thick clay-rich Tertiary sediments. Thus, as groundwater across the Saraji Mine lease is representative of groundwater across the Project site, the risk of enhanced hydraulic connection due to subsidence is limited.

Assessing the potential impacts of the Project on the waterways and flooding characteristics of the Project Site involved modelling of the post-subsidence terrain using the maximised layout and comparing results with those from pre-subsidence (existing conditions) modelling.

Direct effects of subsidence

Differences in pre- and post-subsidence terrain models were used to estimate and map the depth of subsidence along each longwall panel of the maximised footprint. Subsidence depth is more variable in the southern panels with typical differentials from panel to pillar of several metres. The subsidence in the eastern half of the northern panels is relatively atypical with no differential subsidence predicted between pillars and panels, creating a large single depression (refer **Chapter 5 Land Resources**).

Subsidence of around 2 m is substantial where watercourse depth shallows to a similar magnitude and floodplain connectivity occurs. The formation of preferential flood flow paths and closed basins in the subsidence troughs/voids is likely. These may provide both positive and adverse environmental outcomes.

A summary of the potential impacts of subsidence on the relevant waterways are provided below.

Boomerang Creek

Subsidence of just over one metre is anticipated as the creek traverses above the Project. Towards the downstream end of the subsided reach, the predicted subsidence is just under 0.5 m. The greatest subsidence is towards the upstream end of its interception with the mine plan where the subsidence is predicted to be approximately one metre. Most of the area that will be subject to subsidence has a flatter bed grade than upstream. Impacts to Boomerang Creek stability and flow behaviour are expected to be local and minor from subsidence of its channel.

Plumtree Creek

Approximately 3.25 km of Plumtree Creek will be subsided by the Project. Subsidence is predicted to be just over one metre for most of the impacted reach. Subsidence is predicted to be less than 0.3 m through the upstream 500 m of the impacted reach. Some incision of the channel bed upstream from subsidence would be expected where the steepening of bed grade into the panels is greatest, however, the current catchment area is very small at this location due to upstream open cut mining, hence impacts will be minor. The downstream two kilometres of Plumtree Creek is likely to become a pool one metre in depth with potential increase in depth over time as deposition at its confluence with Boomerang Creek is likely to build the confluence level.

Hughes Creek

Approximately 5.6 km of the waterway will be affected by the Project.

Instabilities are likely to develop in Hughes Creek diversion at the upstream limit of subsidence, where the channel bed will subside by nearly three metres. In the absence of in-situ bedrock controls this will initiate channel bed deepening to propagate upstream which will destabilise channel banks. Downstream of the subsided zone, bedload sediment starvation could be expected for a period which may result in local lower bank erosion when the sand bed is lowered. The subsidence zone is approximately five kilometres long at approximately 2 metres deep. Until the subsidence is filled over time by transport of sediment from upstream, there will be some impact downstream of the mine footprint through to Boomerang Creek confluence for a period of years to possibly decades. This impact may also provide positive outcomes in the form of pool creation. Deposition will be a dominant response in the panels, and erosion on pillars is likely.

Predicted geomorphic response to subsidence

Hydraulic modelling was undertaken to provide quantification of the geomorphic assessment of subsidence impacts during the 2-year ARI and 50-year ARI events. Modelling predicts only moderate changes in hydraulic values resulting from subsidence.

The pre- and post-subsidence terrain models were also used to determine potential changes to surface flow paths in the Project Site, resulting from subsidence. The three streams being assessed all pass across the northern panels. The southern panels do not intercept any mapped watercourses. However, minor flow paths are present across all panels.

The subsidence associated with longwall mining creates panel catchments on the floodplain with flow paths generally forming down the centre of the panel. This appears to be a likely scenario for the southern half of the southern panels. These realignments appear to affect only minor flow paths with most larger flow paths continuing along their original course. Realignment of flow paths in the northern panels appears a less likely scenario, due to the shallower subsidence predicted and less differential in subsidence between panel and pillar.

Some panel catchments will pond water until they fill and spill. Despite the creation of subsidence troughs, the spill point in most cases is similar to the pre-subsidence flow path due to the overriding topography. Subsidence may have local attenuation effects on low flows through temporary storage in panels, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible.

The development of avulsion paths, meander cut offs and head cuts may occur in areas where the energy gradients are increased by subsidence, particularly flow paths which drop into subsided panel zones over pillars or end walls. Hughes Creek diversion will have a drop of nearly three metre into the first panel it intercepts with the potential for major instability when the channel bed responds by attempting to regrade to a more stable gradient.

The subsidence will create an undulating bed profile, thus causing variations in localised hydraulics.

8.6.6 Flooding

Impact on flood levels

A comparison of pre- and post-subsidence modelling of the maximised mine layout demonstrates expected response to subsidence (Figure 8-9 to Figure 8-16). Ponding will occur in all panels but there is negligible change to the flooding extents. The two most significant changes include an increased depth of water ponding upstream of the confluence of Boomerang and Hughes Creeks during large events and an increase in flow across the southern end of the southern panels following subsidence.

Water depth increases by up to one to two metres during the 1,000-year ARI event in the north-east corner of the panels within a large area of floodplain inundation that extends to the confluence of Boomerang and Hughes Creeks, though there is little change in extents resulting from subsidence.

Figure 8-16 includes the Project Footprint which highlights the location of the construction village in relation to the estimated 1,000-year ARI flood extent. Road access from the south will continue to be affected by inundation from One Mile Creek in large flow events.

The subsided landscape will change flow behaviour from upstream to downstream of the Project Site. This will have different effects at different magnitude flow events.

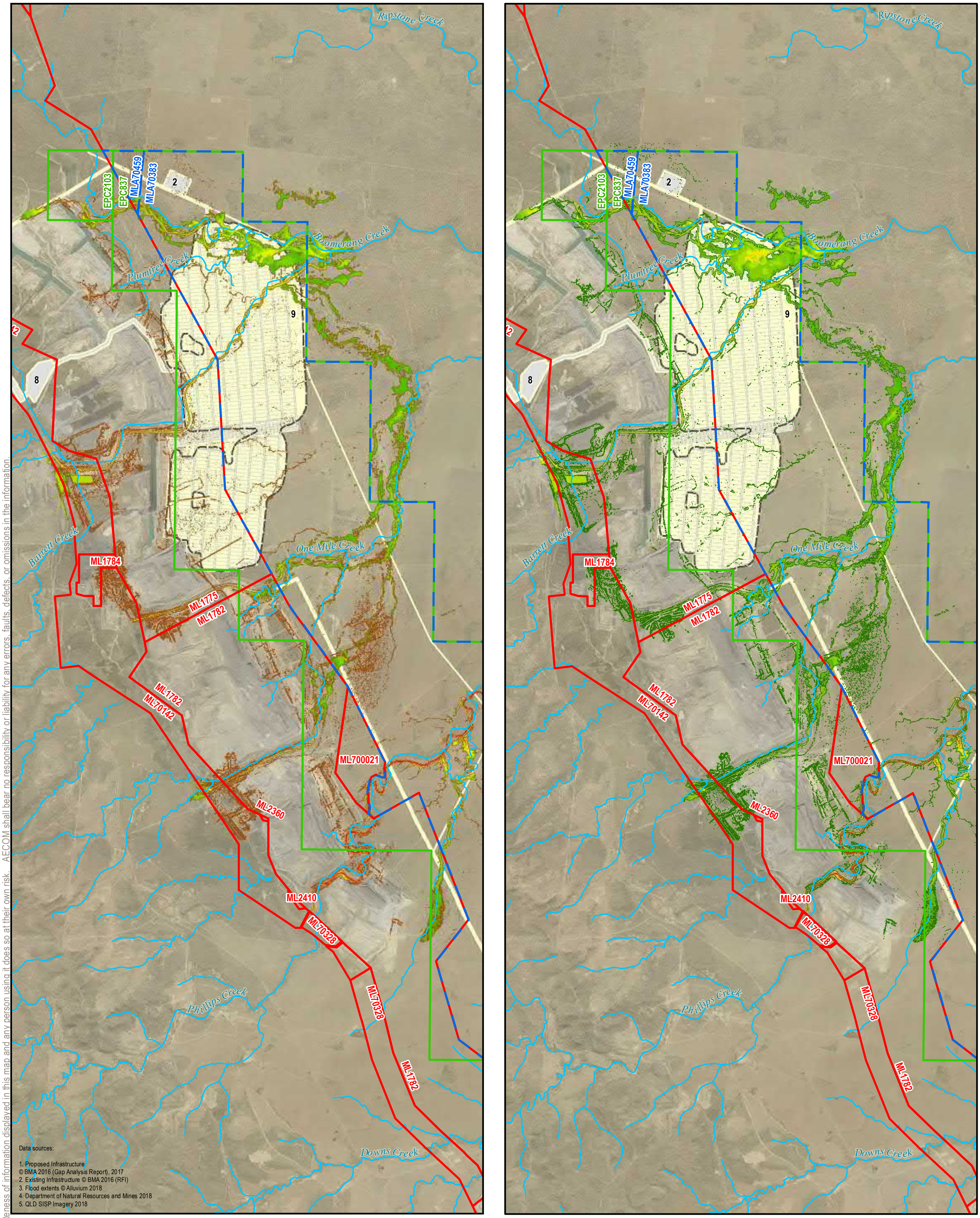
The general effects are a reduction in total flow, more notable for the most frequent and extreme events and a delay in flow associated with the increased attenuation capacity of the subsided landscape. Residual pools will occur in parts of the landscape post-subsidence (without erosion or management intervention, which is not modelled). This will account for the reduction in flow volume leaving the Project Site. In time, with sediment movement in the system, these ponded volumes will decrease.

Residual pools in the system are generally seen as a positive environmental impact as most ephemeral wetlands or in-channel pooling has been lost to erosion and deposition. In time, subsidence pools in Boomerang and Hughes Creek will be infilled with bedload sediment.

Flooding of mine infrastructure

The flood model was developed and was utilised to predict the influence of mine infrastructure on flooding and to assess the effectiveness of flood mitigation measures in the protection of the mining operation.

Modelled peak flood levels around the mine entrance and the conveyor are within ten to 35 mm water depth for the pre- and post-subsidence cases. Peak flood levels of this depth are unlikely to be consequential to the operation of mine infrastructure and, where required, flood mitigation measures such as bunding would be implemented at the entrance to mitigate localised flooding.



LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 2yr ARI 0.2m Depth pre-subsidence
- 2yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

2yr ARI max depth pre-subsidence (m) - on the left

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

2yr ARI max depth post-subsidence (m) - on the right

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

Surface Infrastructure

2 Process Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village

N

Figure 8-9

Water depth for 2-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:130,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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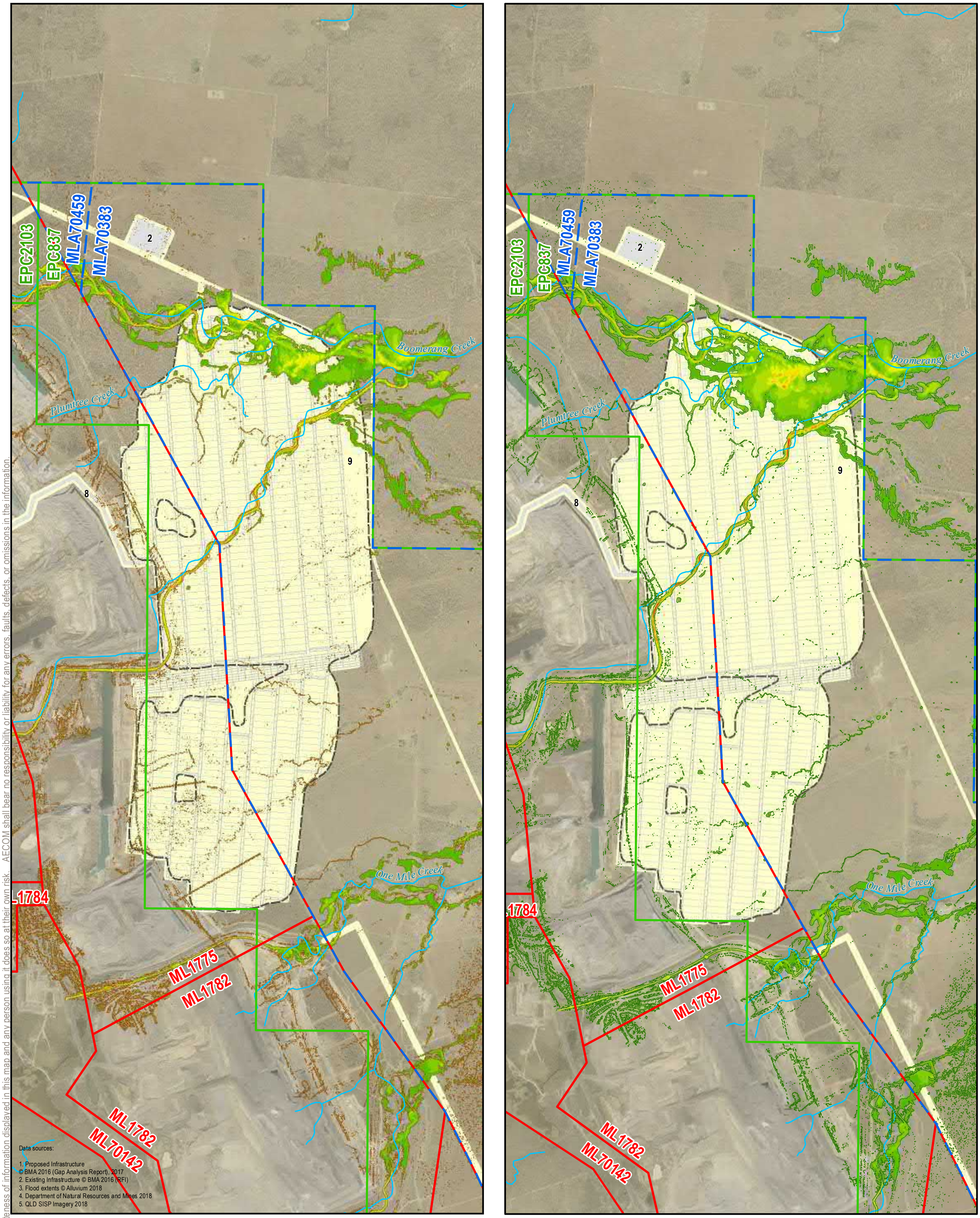

LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 2yr ARI 0.2m Depth pre-subsidence
- 2yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

2yr ARI max depth pre-subsidence (m) - on the left	**2yr ARI max depth post-subsidence (m)** - on the right
0.2 - 0.5	0.2 - 0.5
0.5 - 1.0	0.5 - 1.0
1.0 - 1.5	1.0 - 1.5
1.5 - 2.0	1.5 - 2.0
2.0 - 2.5	2.0 - 2.5
2.5 - 3.0	2.5 - 3.0
3.0- 3.5	3.0- 3.5
3.5 - 4.0	3.5 - 4.0
4.0 +	4.0 +

Surface Infrastructure

2 Process Water Dam
8 Conveyor
9 Construction Village

N

Figure 8-10

Water depth for 2-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:75,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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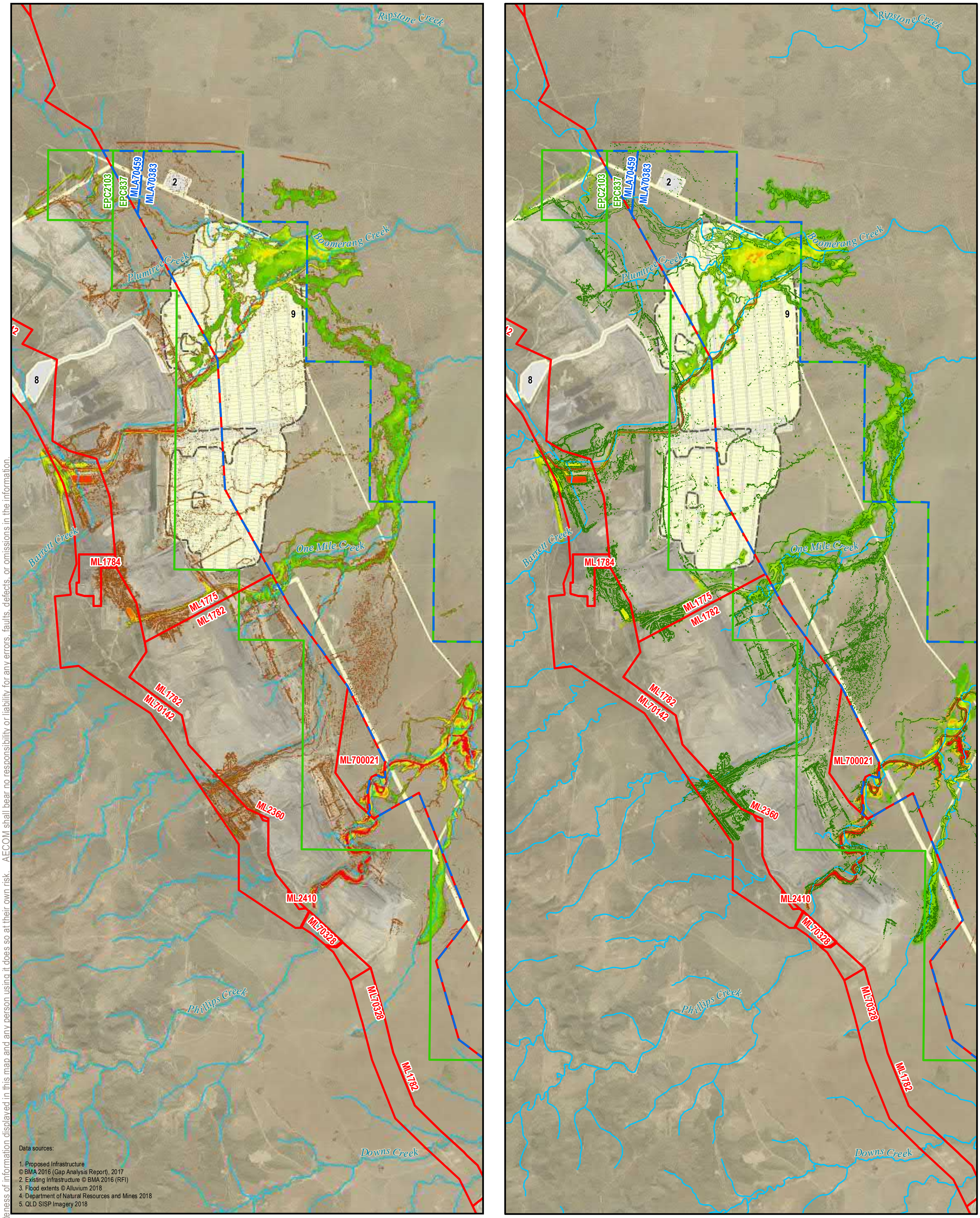

LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 50yr ARI 0.2m Depth pre-subsidence
- 50yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

50yr ARI max depth pre-subsidence (m) - on the left

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

50yr ARI max depth post-subsidence (m) - on the right

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

Surface Infrastructure
2 Process Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village

N

Figure 8-11

Water depth for 50-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:130,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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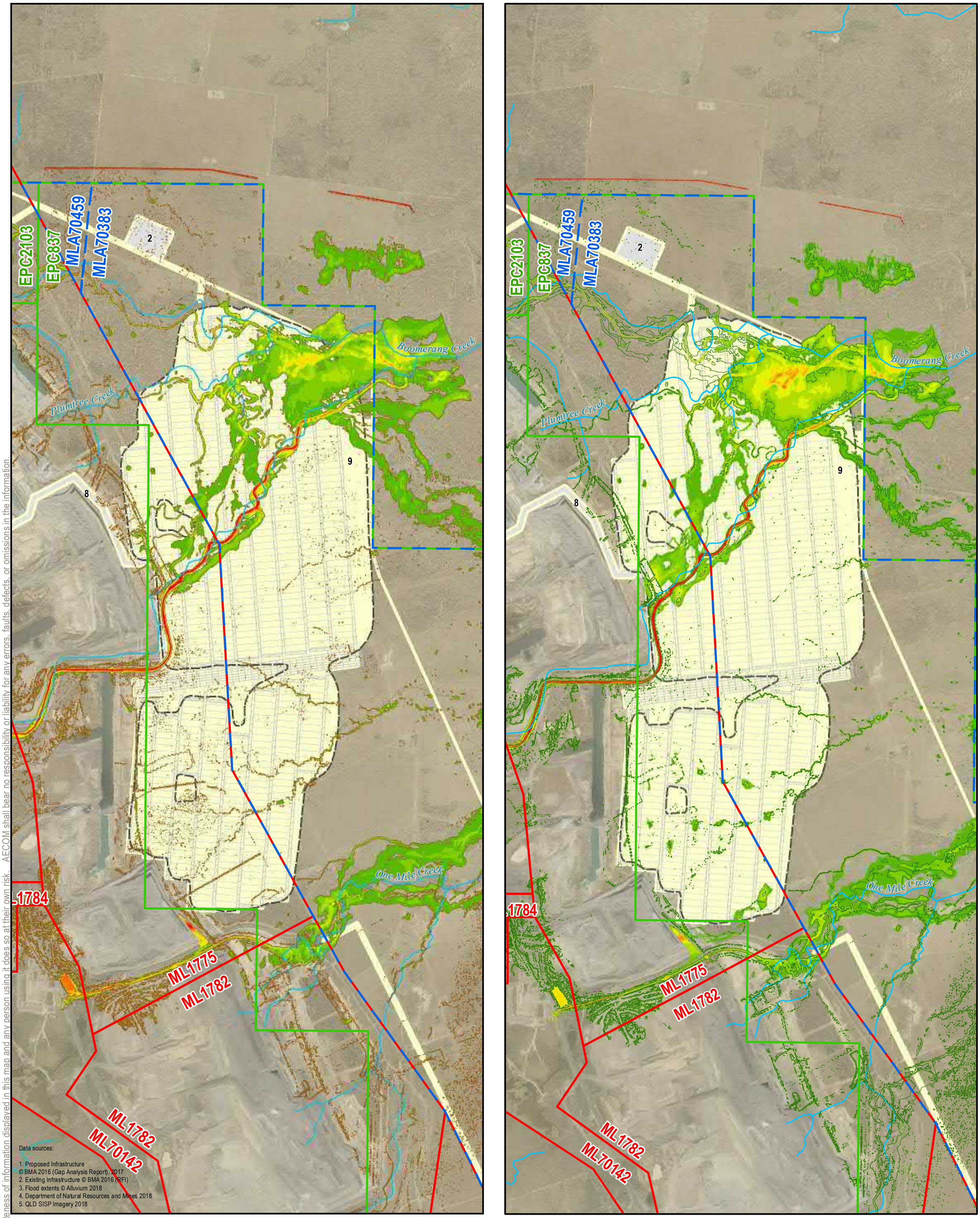

LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 50yr ARI 0.2m Depth pre-subsidence
- 50yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

50yr ARI max depth pre-subsidence (m) - on the left

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

50yr ARI max depth post-subsidence (m) - on the right

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

Surface Infrastructure

2 Process Water Dam
8 Conveyor
9 Construction Village

N

Figure 8-12

Water depth for 50-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:75,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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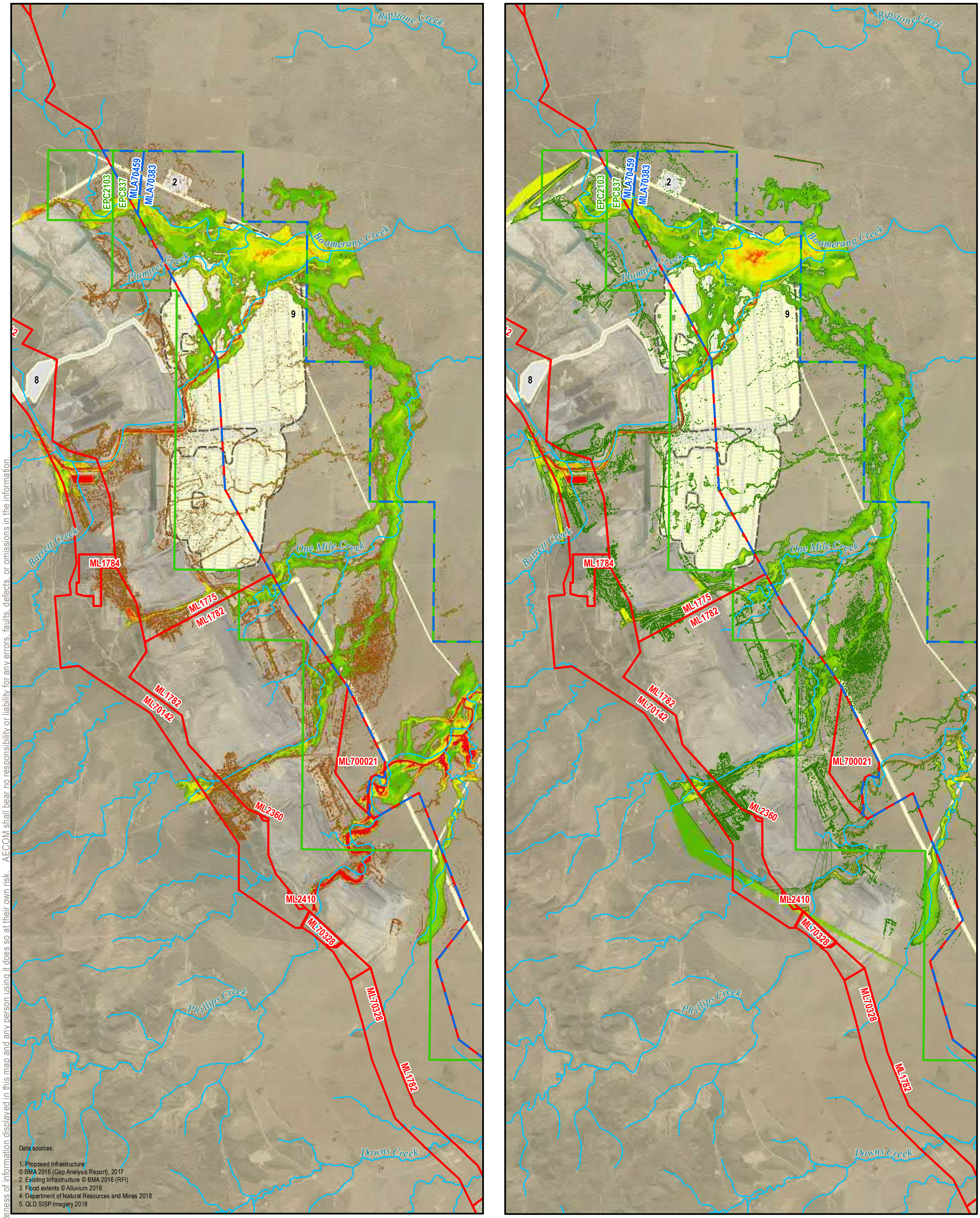

LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 100yr ARI 0.2m Depth pre-subsidence
- 100yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

100yr ARI max depth pre-subsidence (m) - on the left	100yr ARI max depth post-subsidence (m) - on the right
0.2 - 0.5	0.2 - 0.5
0.5 - 1.0	0.5 - 1.0
1.0 - 1.5	1.0 - 1.5
1.5 - 2.0	1.5 - 2.0
2.0 - 2.5	2.0 - 2.5
2.5 - 3.0	2.5 - 3.0
3.0- 3.5	3.0- 3.5
3.5 - 4.0	3.5 - 4.0
4.0 +	4.0 +

Surface Infrastructure

2 Process Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village

N

Figure 8-13

Water depth for 100-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

Scale: 1:130,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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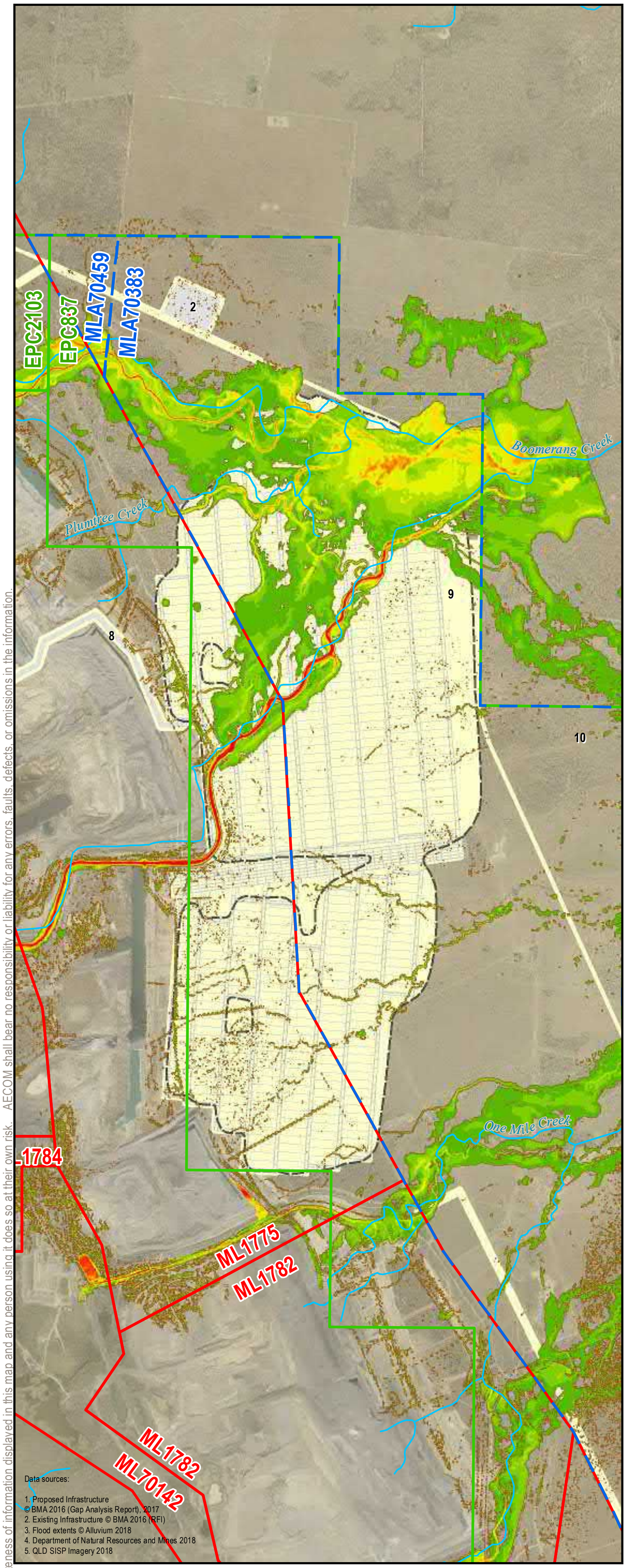
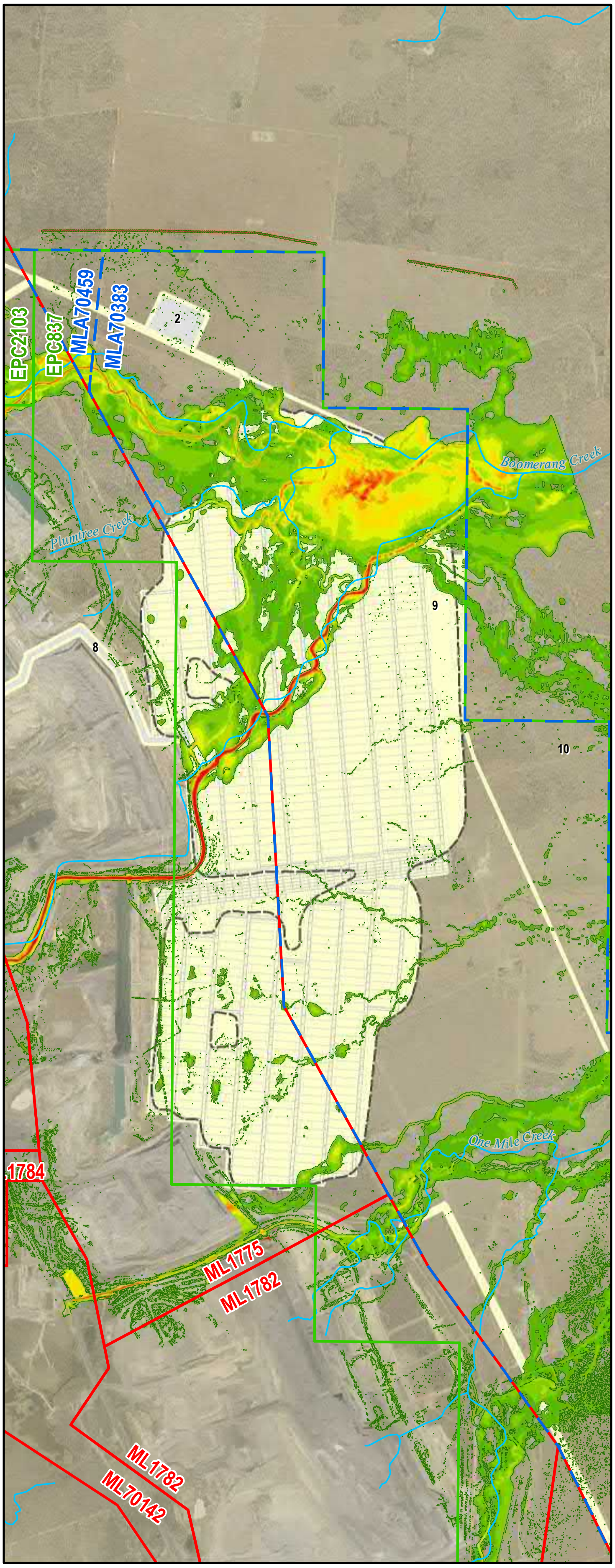




LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 100yr ARI 0.2m Depth post-subsidence
- 100yr ARI 0.2m Depth pre-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

100yr ARI max depth pre-subsidence (m) - on the left

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

100yr ARI max depth post-subsidence (m) - on the right

- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0- 3.5
- 3.5 - 4.0
- 4.0 +

Surface Infrastructure

2 Process Water Dam
8 Conveyor
9 Construction Village

N

Figure 8-14

Water depth for 100-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

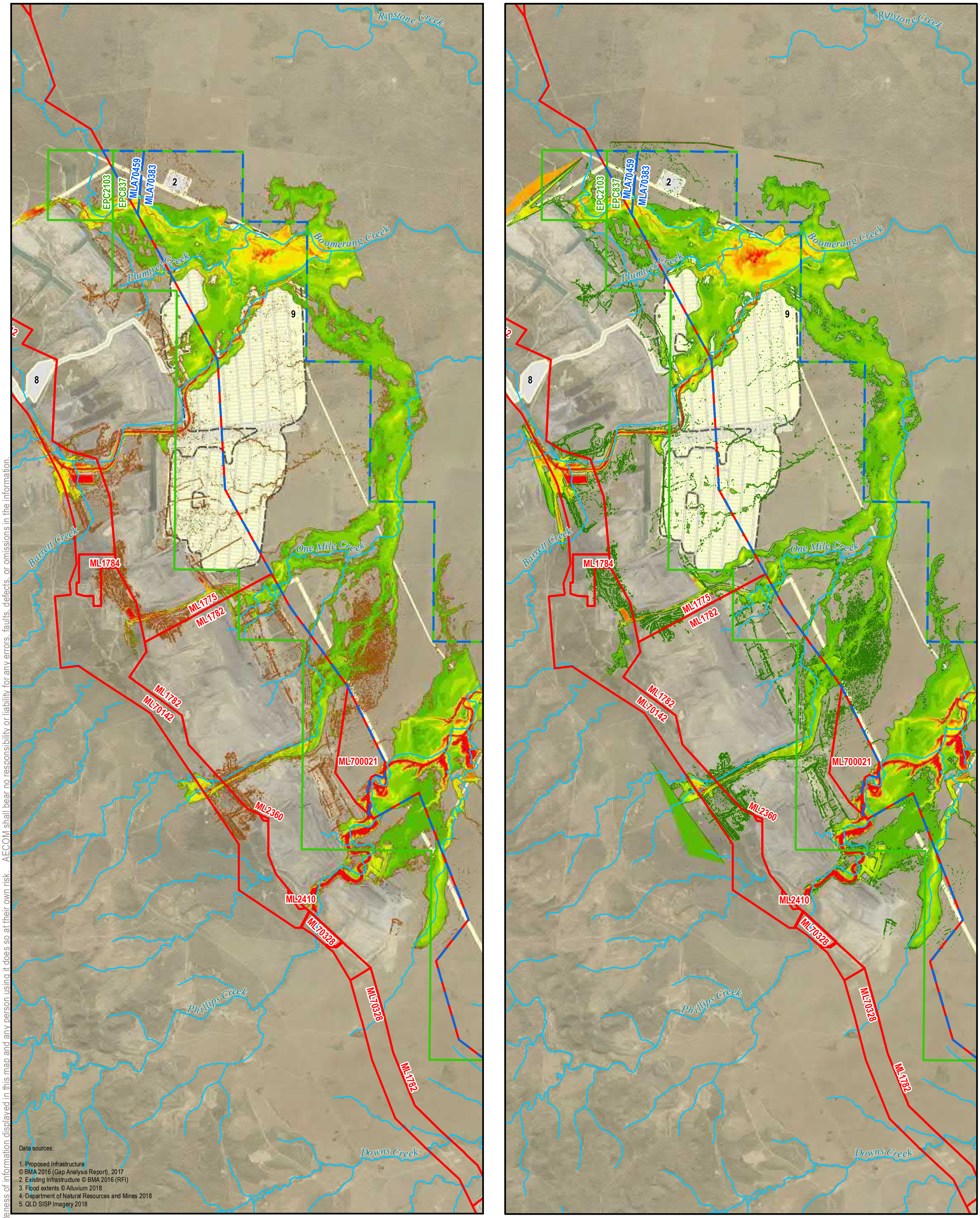
Scale: 1:75,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 30/11/2020 VERSION: 3

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\08 Surface Water\60507031_G338_v3_A4P.mxd



LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 1000yr ARI 0.2m Depth post-subsidence
- 1000yr ARI 0.2m Depth pre-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

1000yr ARI max depth pre-subsidence (m) - on the left	1000yr ARI max depth post-subsidence (m) - on the right
0.2 - 0.5	0.2 - 0.5
0.5 - 1.0	0.5 - 1.0
1.0 - 1.5	1.0 - 1.5
1.5 - 2.0	1.5 - 2.0
2.0 - 2.5	2.0 - 2.5
2.5 - 3.0	2.5 - 3.0
3.0- 3.5	3.0- 3.5
3.5 - 4.0	3.5 - 4.0
4.0 +	4.0 +

Surface Infrastructure
2 Process Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village

N

Figure 8-15

Water depth for 1000-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.75 1.5 3
Kilometres

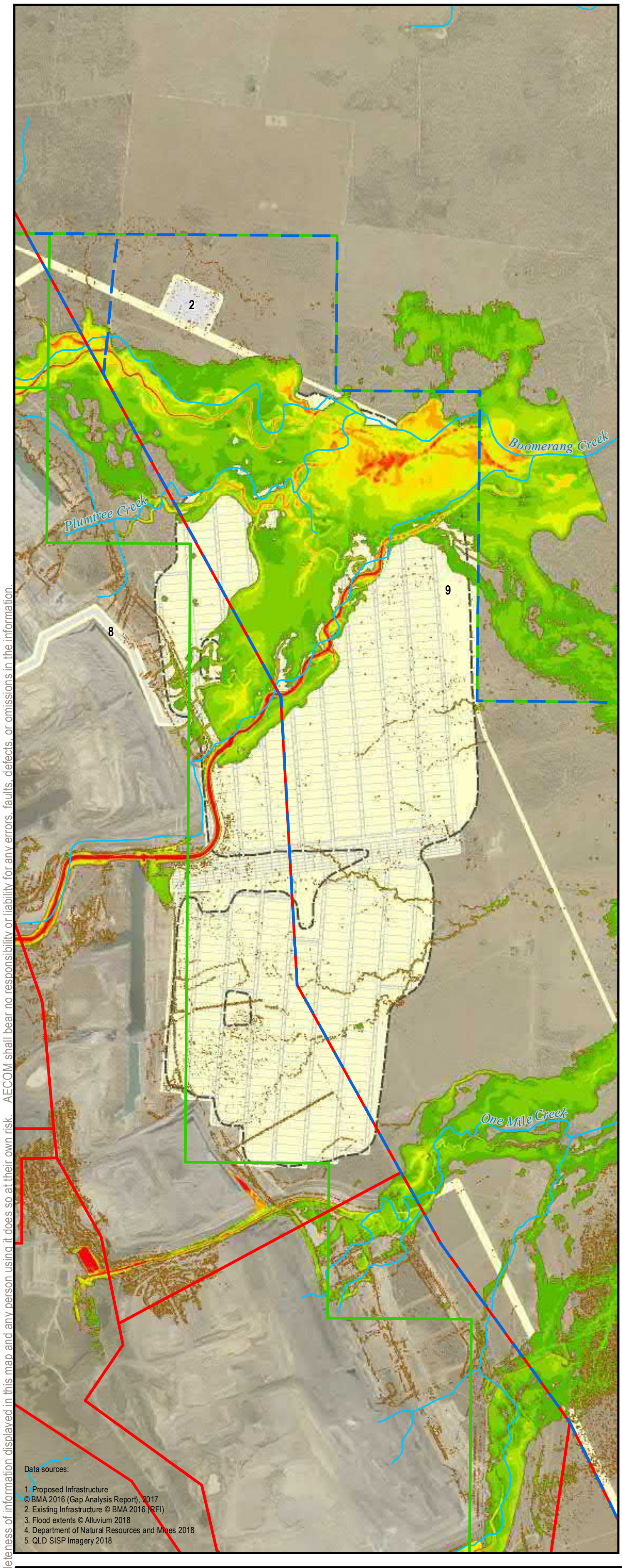
Scale: 1:130,000 (when printed at A4)

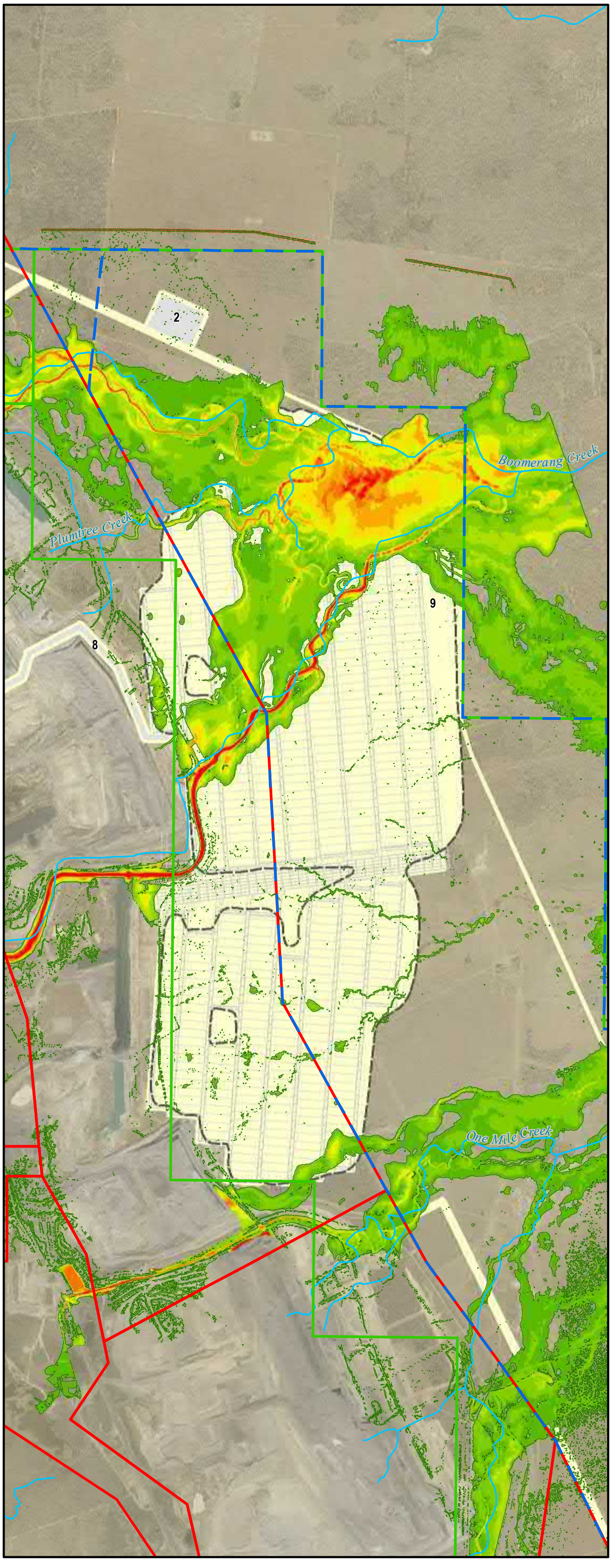
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 30/11/2020 VERSION: 3

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\08 Surface Water\60507031_G339_v3_A4P.mxd





LEGEND

- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- 1000yr ARI 0.2m Depth pre-subsidence
- 1000yr ARI 0.2m Depth post-subsidence
- Surface Infrastructure
- Proposed Underground Mine Layout (Maximised)
- Limit Of Subsidence

1000yr ARI max depth pre-subsidence (m) - on the left	1000yr ARI max depth post-subsidence (m) - on the right
0.2 - 0.5	0.2 - 0.5
0.5 - 1.0	0.5 - 1.0
1.0 - 1.5	1.0 - 1.5
1.5 - 2.0	1.5 - 2.0
2.0 - 2.5	2.0 - 2.5
2.5 - 3.0	2.5 - 3.0
3.0- 3.5	3.0- 3.5
3.5 - 4.0	3.5 - 4.0
4.0 +	4.0 +

Surface Infrastructure
2 Process Water Dam
8 Conveyor
9 Construction Village

N

Figure 8-16

Water depth for 1000-year ARI event pre-subsidence (left) and post-subsidence (right)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:75,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 30/11/2020 VERSION: 3

8.7 Mitigation measures

8.7.1 Subsidence

A subsidence management plan (SMP) has been prepared for the Project. It provides a plan for documenting and reporting annual progress and management of impacts against objectives. The SMP can be found in **Appendix K-2 Subsidence Management Plan** of the EIS. The key components of the SMP are:

- ongoing subsidence monitoring, evaluation, review and improvement program
- managing bed and bank stability
- vegetation management
- panel catchment management, including rehabilitation of subsidence cracking
- infrastructure protection or relocation, where necessary.

The SMP identifies a number of mitigation measures for managing the impacts of subsidence upon surface waters. These include:

- ripping
- tyning
- grading
- compaction
- crack infilling with concrete or clay
- progressive rehabilitation
- embankment arming
- bed stabilisation such as pervious weirs
- geomorphological modelling to predict high energy areas of the subsided landform
- additional grazing access / controls to mitigate vegetation stripping and bank damage
- channel re-profiling and construction of contour banks
- vegetation planting
- erosion control matting in high energy or erosive areas
- construction of drop structures at head cut erosion features.

8.7.2 Erosion and sediment control

During construction

Potential impacts to surface water will be mitigated through the implementation of an Erosion and Sediment Control Plan (ESCP), to align with the principles of International Erosion Control Association (IECA) Best Practice Erosion & Sediment Control guidelines, during construction and operation of the Project. The ESCP will be developed prior to construction and include the following:

- sediment dams will be constructed prior to vegetation clearing and earthworks
- vegetation clearing and earthworks will be undertaken in incremental stages over the life of the mine where practical
- timing of clearing and earthworks for construction of creek crossings or drainage and overland flow works to occur in the dry season where practical

- where necessary, erosion control devices will be placed in ditches and drainage lines running from cleared areas, especially on slopes and levee banks
- where necessary, contour banks, ditches or similar will be formed across cleared slopes to direct runoff towards surrounding vegetation or sediment dams, and away from creeks
- where appropriate, buffer zones will be retained to maintain and enhance riparian vegetation
- ongoing, proactive erosion and sediment control will be undertaken, including in-stream controls at strategic locations (such as stream crossings) during significant earthworks, installation and operation of incidental mine gas management infrastructure to minimise release of sediment to waterways
- routine inspection and monitoring to ensure the effective implementation of erosion and sediment controls.

With design and mitigation measures in place, water quality impacts associated with erosion and sedimentation on the downstream creeks are expected to be minimal.

During operation

Erosion and sediment control practices will be applied to mining operations, to mitigate the generation of sediment and its transport to waterways. Areas of disturbed or exposed soil will be managed to reduce sediment mobilisation and erosion. The following general mitigation measures are proposed:

- permanent stormwater management systems will be installed as early as possible in the construction program
- erosion and sediment control structures will be regularly inspected and maintained
- topsoil will be stockpiled away from drainage lines to protect it from erosion by surface water runoff
- dust suppression measures will be implemented
- vehicle washdown will take place in designated areas away from flood plains and drainage lines
- water from vehicle washdown areas should be treated to remove seeds, oils and other contaminants before reuse for dust suppression or other on-site use or directed to the mine complex water management system for reuse
- road crossings of streams should be stabilised to minimise wash outs and bank erosion
- stabilisation may include placement of matting along banks
- regular inspections of road and pipeline alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to mitigate erosion from occurring or worsening.

The operational areas will be inspected regularly to check that stormwater management systems are effective and concentration of flow or scouring is not occurring. Detailed design of the MIA and CHPP will address design of stormwater collection and retention systems to ensure that stormwater can be captured and adequately treated.

The SMP prepared for the Project (**Appendix K-2 Subsidence Management Plan**) provides a plan for documenting and reporting annual progress and management of impacts against objectives.

8.7.3 Chemicals and contaminants

The following general mitigation measures are required to manage impacts of spills and leaks of fuels, oils and other contaminants on receiving waters:

- Refuelling to occur within contained, hardstand areas in accordance with AS1940 The Storage and Handling of Flammable and Combustible Liquids where practical. Where this is not possible, refuelling activities should be located away from streams and drainage lines and be supervised by an appropriately trained operator equipped with a spill kit at all times
- Spill clean-up kits will be located in appropriate locations, based on the risk of a spill occurring and potential volume of material that might be spilled at the particular location
- All fuel and chemical storages will be designed and operated in accordance with Australian Standards, including AS1940 The Storage and Handling of Flammable and Combustible Liquids and AS3780 The Storage and Handling of Corrosive Substances
- Spills are to be contained and cleaned up as soon as practical to mitigate the mobilisation of pollutants in drainage lines or watercourses
- Wastewater from vehicle washdown areas should be directed through oil and grease separators and effluent utilised for dust suppression or other use, or directed to the mine WMS for reuse.

8.7.4 Site water management

Preliminary capacity estimates for all mine WMS dams and the water transfer network have been determined through water balance assessment using historical climate conditions and conceptual operational rules. For the purpose of this assessment, a conservative approach has been adopted to the sizing of each conceptual mine WMS storage such that:

- controlled releases of MAW to the receiving environment are not required during typical operating conditions
- capacities are sufficient to mitigate the uncontrolled (spillway) discharge of MAW to the receiving environment.

The proposed WMS has been designed with adequate capacity to avoid releases. The preliminary dam capacities presented are relevant to the input data, assumptions and adopted operational rules. However, any open system has the potential for uncontrolled discharge of MAW should a weather event cause a dam spill. As such, BMA will be seeking authority and conditions to conduct the controlled release of MAW from the Project Site during emergency scenarios (e.g. extreme rainfall events). The indicative location for controlled release of MAW is located on Boomerang Creek adjacent to the proposed process water dam (Figure 8-6). Spillway discharges (uncontrolled) from the process water dam are also proposed to be directed to Boomerang Creek. Monitoring during such events will be undertaken in accordance with the Trigger Action Response Plan (TARP) as described in Section 0.

The following mitigation strategies will be considered to address WMS failure risk:

- mine water storages should be designed with consideration given to the predictions of the water balance model which considers all inputs and outputs, and which has run through a long-term period of climatic data to test storage capacities particularly in high rainfall wet seasons
- all MAW dams for the Project will be constructed in accordance with the DES *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES, 2016). Pipes and pump systems will be designed with consideration to volume requirements predicted from water balance modelling and designed by a suitably qualified engineer
- regular inspections of mine water storages, pipeline, drain, bund and levees will be undertaken, particularly in relation to integrity of constructed embankments.

8.7.5 Monitoring

Receiving environment monitoring program

A REMP will be developed and implemented prior to construction to monitor potentially affected waterways and assess effectiveness of management strategies, including but not limited to:

- confirm location of release point for controlled discharge of mine-affected water (MAW) (indicatively located on Boomerang Creek adjacent to the proposed process water dam)
- include additional baseline data on surface water flows and quality, to further develop water quality objective and trigger levels for investigations and a monitoring program
- monitoring EC and pH (acidity or alkalinity) and other water parameters in potentially affected waterways (upstream and downstream of impact)
- development of a Trigger Action Response Plan (TARP) to identify the corrective actions and responses required in the event that operations result in exceedances in surface water quality or adverse changes in stream health.

For Boomerang Creek, a mine water release point is proposed downstream of the Boomerang Creek (downstream) site, and hence new monitoring points are proposed further downstream (refer Figure 8-17).

The REMP will incorporate a baseline water quality monitoring program to monitor pH, electrical conductivity, total suspended solids and total dissolved solids at upstream and downstream locations. New monitoring locations will be established downstream of the Project Site (refer to Figure 8-17) and existing upstream locations will continue to be monitored. REMP data will also continue to be collected via the adjacent sites' REMPs during wet weather.

Monitoring will be undertaken in accordance with the 'Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009' (DES, 2018b) (or guideline current at the time of construction). Field monitoring equipment, such as electrical conductivity and pH meters will be calibrated. QA/QC laboratory samples will be collected. All external laboratories will be National Association of Testing Authorities (NATA) accredited for the analytical procedures they are performing.

Baseline water quality monitoring will inform the development of site specific surface water quality trigger values based on 20th and 80th percentiles. Queensland Water Quality Guidelines (2009) recommend a minimum of 18 data values collected over two years to derive guidelines. While the Queensland Water Quality Guidelines (2009) permits the derivation of guidelines based on less than two years of monthly sampling, this should be considered as interim—until a full data monitoring program can be undertaken. Monitoring will be carried out for at least two years and will incorporate both upstream and downstream locations. Site specific water quality objectives will be developed for the Project based on the results of the REMP monitoring program.

The relevant environmental values as defined under 'EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives' (DEHP, 2011) are outlined in Section 8.4.5 and will be confirmed based on a review of 'Deciding aquatic ecosystem indicators and local water quality guidelines' (DES, 2018d). Prior to the development of site specific water quality objectives, these will be as defined for the Isaac River catchment within Schedule 1 of the EPP (Water).

Monitoring during construction

During construction, surface water that becomes ponded in excavations would be tested and managed in accordance with the stormwater management system to determine whether suitable for discharge to the receiving environment or otherwise disposed of at a licenced facility.

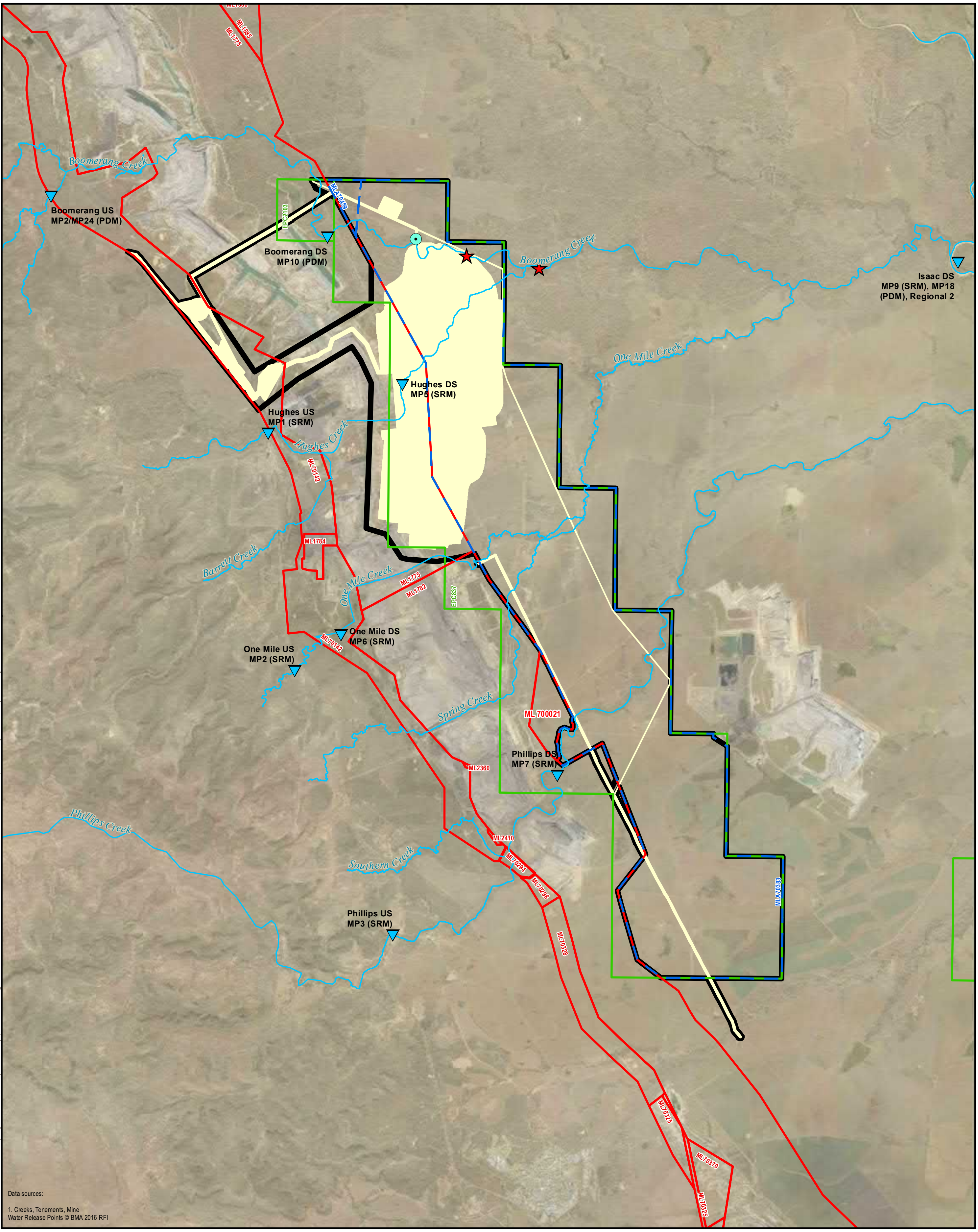
Monitoring of the receiving water during construction will be in accordance with the REMP, which will be developed and implemented prior to construction.

Monitoring during operation

Monitoring of dam water levels for MAW dams (not including sedimentation dams) will be automated and dam water levels will be managed in accordance with the WMS to minimise uncontrolled releases (refer to Section 8.6.3).

Where safety and access permit, the receiving water will be monitored at upstream and downstream locations during emergency release events. Monitoring will also be carried out during normal operation of the mine in accordance with the 'Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009' (DES, 2018b).

The subsidence monitoring program will (as detailed in **Appendix K-2 Subsidence Management Plan**) monitor erosion and sedimentation, surface cracking across the subsidence impacted areas.



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Monitoring Locations
- Indicative Proposed Monitoring Point Location
- Indicative Proposed Mine Water Release Point
- Watercourse

N

Figure 8-17
Proposed monitoring points

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:150,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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8.7.6 Preliminary Response Plan

The actions that would be taken in response to an exceedance of water quality criteria are outlined in Table 8.12, including the timing, responsibilities and reporting requirements.

A TARP will be developed prior to construction, as part of the Water Management Plan, with the primary objective of providing trigger values for further investigation and outlining the corrective actions and responses required in the event that:

a) monitoring identifies the potential for an exceedance of water quality objectives or overtopping of water storages

b) water quality monitoring identifies an exceedance of water quality objectives or an adverse change in stream health; or

c) overtopping of the process water dam spillway occurs.

Under normal conditions the mine will operate as a closed system, so discharges to the downstream catchment are considered unlikely to occur.

The TARP will apply to the construction, operation and decommissioning stages of the Project. Site-specific water quality objectives or trigger values will be developed for the Project in line with the REMP (refer to Section 8.7.5). Criteria to be monitored through the TARP may also include ground condition, vegetation cover, erosion and other rehabilitation completion criteria described in the Project's Rehabilitation Management Plan (**Appendix K-1**).

Table 8.12 Preliminary response plan for exceedance of water quality objectives

Trigger	Response	Timing	Outcome / reporting
Water quality monitoring in the receiving environment identifies exceedance of water quality objectives	**STEP 1** Review potential causes of exceedance via the following: • Visual inspection of potential diffuse sources (e.g. seepage from reject disposal areas or waste rock dumps). Where a potential source of an exceedance is identified, samples may be collected for testing where feasible and practicable. • Visual inspection of site infrastructure to identify any visible damage (e.g. a damaged pipe or broken monitoring equipment) • Visual inspection of site equipment and plant, and review of maintenance records • Review of recent weather and rainfall data (Note that some physico-chemical parameters such as conductivity and turbidity may be influenced by large rainfall).	As soon as practicable, once the exceedance is identified	Record exceedance in the REMP reporting period
	STEP 2 Determine the extent of the exceedance or impact on receiving waters: • Carry out additional water quality testing sufficient to delineate extent of impacts and assess trends.	**STEP 2** As soon as reasonably possible	**STEP 2** Record additional water quality testing results in the REMP
	STEP 3 If it is identified that the exceedance is a result of construction or operation of the Project and has resulted in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the EA, BMA must notify DES by written notification within 24 hours of becoming aware, or in accordance with the EA conditions at the time.	**STEP 3** If the exceedance meets reporting requirements, notify DES within 24 hours of becoming aware	**STEP 3** • Document correspondence in the site Environmental Management System • Carry out incident reporting requirements as prescribed by the EA

Trigger	Response	Timing	Outcome / reporting
Overtopping of process dam spillway	**STEP 1** Determine impact on receiving waters: • Carry out water quality testing of impacted water bodies to determine if trends are present and to delineate extent of impacts.	**STEP 1** Carry out water quality testing as soon as reasonably possible (where safety and access permits)	**STEP 1** Record water quality testing results in the REMP
	STEP 2 If it is identified that overtopping has resulted in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the EA, BMA must notify DES by written notification within 24 hours of becoming aware, or in accordance with the EA conditions at the time.	**STEP 2** If the release of contaminants meets reporting requirements, notify DES within 24 hours of becoming aware	**STEP 2** • Document correspondence in the site Environmental Management System • Carry out incident reporting requirements as prescribed by the EA.

8.8 Residual impacts

The creeks within the Project Site are part of the Isaac River catchment which flows into the Fitzroy River. The total catchment area for all creeks and tributaries upstream and within the Project Site is approximately 590 km^2. Therefore, the total catchment area represents less than 3.0 per cent of the Isaac River catchment and approximately 0.4 per cent of the Fitzroy River catchment (142,665 km^2).

The Lower Fitzroy River and Fitzroy Barrage Water Supply Schemes have 28,621 ML and 62,335 ML of allocated water, respectively. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are approximately 250 km downstream of the confluence with Isaac River. The total catchment area upstream and within the Project Site is less than 0.0004 per cent of the total catchment area for these water supply schemes. Therefore, the Project is not expected to result in a significant residual impact for these water supply schemes.

The development of the conceptual mine WMS does not include any significant loss of catchment area reporting to Hughes Creek or its tributaries. The combined disturbed catchment area of the process area dams is 31.7 ha (0.317 km^2) which represents 0.3 per cent of the Hughes Creek (including Plumtree Creek) catchment and any potential loss in flow would likely be immaterial.

8.9 Summary and conclusions

Hydrology, hydraulics and geomorphology

The Project will directly cause subsidence of three watercourses leading to a number of impacts and risks across the Project Site and some impacts off site, downstream:

- changes to surface water quantities as some water is ponded in panel catchments
- potential changes in overland flow paths
- development of instabilities in bed and banks of the three watercourses and minor tributaries
- creation of ponding in watercourses beds, which may take years or decades to fill with sediment from upstream. This may also result in instabilities propagating downstream as sediment starved reaches deepen
- potentially beneficial habitat creation through development of pools in subsidence areas within watercourses
- surface tension cracking at panel edges which may instigate terrestrial erosion and affect vegetation.

Water quality

Data showed that water quality was above the relevant water quality objectives defined within Schedule 1 of the EPP (Water) and ANZG (2018) for a number of parameters. The results indicate that these values occur both upstream and downstream of the Project Site and are likely a function of existing land uses such as agriculture and mining. Mitigation measures required to address surface water quality involve development and implementation of erosion and sediment control measures and spill prevention (including documented and managed response procedures).

A water quality monitoring program and REMP will be developed prior to construction.

Based on the implementation of appropriate management and mitigation measures (the outcomes of which would be validated through monitoring), existing creek conditions, (which have been influenced by surrounding land uses) and the limited potential for the Project to impact on water quality conditions, the residual risk of the Project having an adverse impact on receiving surface waters is expected to be minor.

Mine water management

Preliminary capacity estimates for all mine WMS dams and the water transfer network have been determined through water balance assessment using historical climate conditions and conceptual operational rules. For the purpose of this assessment, a conservative approach has been adopted for sizing of each conceptual mine WMS storage such that:

- infrastructure capacity and operations capability are sufficient to mitigate the uncontrolled (spillway) discharge of maw to the receiving environment
- the project has sufficient storage capacity to cater for maximum mine water volumes that could occur (based on climate extremes evident in available historical data)
- water allocations of external water sources are sufficient to meet shortfalls in site demands
- based on the water balance model outcomes, controlled releases of maw to the receiving environment are not required.

The proposed WMS has been designed with adequate capacity to avoid releases. The preliminary dam capacities presented are relevant to the input data, assumptions and adopted operational rules. However, any open system has the potential for uncontrolled discharge of MAW should a weather event cause a dam spill. As such, BMA will be seeking authority and conditions to conduct the controlled release of MAW from the Project Site during emergency scenarios (e.g. extreme rainfall events). The indicative location for controlled release of MAW is located on Boomerang Creek adjacent to the proposed process water dam. Spillway discharges (uncontrolled) from the process water dam are also proposed to be directed to Boomerang Creek.

Spillway (uncontrolled) discharges from the remaining process area dams will be directed to the receiving environment based on existing topographical constraints. Where dam overflow locations cannot deliver flows directly to Hughes Creek or its tributaries, conveyance channels are proposed to convey the discharge.

A risk-based assessment of hypothetical MAW releases shows that no impacts on the receiving environment are expected from these events.