BARALABA SOUTH

Baralaba South Project

Environmental Impact Statement

CHAPTER 4

Surface Water

arc ENVIRONMENTAL SOLUTIONS

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4 Surface Water

This chapter assesses the surface water impacts of the Project on the existing environmental values, and the mitigation and management measures that will be implemented to minimise impacts. The assessment of flood impacts and regulated dams has been addressed separately in Chapter 6. The assessment of groundwater has been addressed separately in Chapter 5.

The following related studies have been undertaken and have provided input in evaluating the potential impacts of the Project on surface water:

- Surface Water Impact Assessment (Appendix A);
- Groundwater Modelling and Assessment (Appendix B);
- Flood Impact Assessment (Appendix C);
- Geomorphic Impact Assessment (Appendix D);
- Geochemical Assessment (Appendix E);
- Terrestrial Ecology Assessment (Appendix F); and
- Aquatic Ecology Assessment (Appendix G).

The Surface Water Impact Assessment has been peer reviewed by the suitably qualified expert Greg Roads, WRM Water and Environment. The peer review report is provided in Attachment 6.

The information requirements of the Independent Expert Scientific Committee (IESC) relating to surface water are addressed in Chapter 9 and a reconciliation checklist has been provided in Attachment 4. Matters of National Environmental Significance and a checklist has been provided in Attachment 5.

4.1 Environmental objectives and performance outcomes

This chapter has been prepared to assist in the assessment of the following relevant environmental objectives prescribed in the Project TOR and Schedule 8, Part 3, Division 1 of the EP Regulation (collectively, the surface water environmental objectives):

- the equitable, sustainable, and efficient use of water resources;
- the maintenance of environmental flows, water quality, instream habitat diversity, and naturally occurring inputs from riparian zones (including groundwater-dependent ecosystems) to support the long-term maintenance of the ecology of aquatic biotic communities (including stygofauna);
- that the condition and natural functions of water bodies (e.g., lakes, springs, watercourses, and wetlands) are maintained—including the stability of beds and banks of watercourses;
- the Project will be operated in a way that protects the environmental values of waters; and
- the Project will be operated in a way that protects the environmental values of wetlands (including soaks and springs).

The detailed assessment presented in this chapter and in the relevant appendices demonstrates that the Project will achieve the performance outcome for each surface water environmental objective.

Specifically, the Project will achieve item 2 of the performance outcome for each surface water environmental objective in satisfaction of section 2(4) of Schedule 8 to the EP Regulation, as follows:

- the water performance outcomes will be achieved because the Project will be operated in a way that achieves all of the following:

    - the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;
    - contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;
    - the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;
    - acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;
    - any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland; and
    - the activity will be managed so that adverse effects on environmental values are prevented or minimised;
- the Project will achieve item 2 of the wetlands performance outcomes because it will be managed in a way that prevents or minimises adverse effects on wetlands.

4.2 Description of environmental values

This section describes the baseline water quality data and the water quality of the local and regional surface water resources, to assist in describing the environmental values relating to surface water. The following technical studies are particularly relevant and have been relied upon to support the description of surface water values in this section:

- Surface Water Impact Assessment (Appendix A); and
- Aquatic Ecology Assessment (Appendix G).

Figure 4.1 and Figure 4.2 provide the regional context and regional catchments respectively. The Project is located within the Lower Dawson River Sub-basin—WQ1309 (Lower Dawson Main Channel—Regulated Reaches) as depicted in Figure 4.3.

Environmental values for these areas are nominated broadly in the 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019', 'Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment' (DEHP, 2011). A summary of the relevant environmental values is presented in Table 4.1 and the environmental values are discussed further in the Surface Water Impact Assessment (Appendix A).

To define specific environmental values and Water Quality Objectives (WQOs) for the Project, baseline water quality data and the water quality of local and regional surface waters are discussed in section 4.2.6.3. Environmental flow objectives for the Project are described in section 4.2.1.

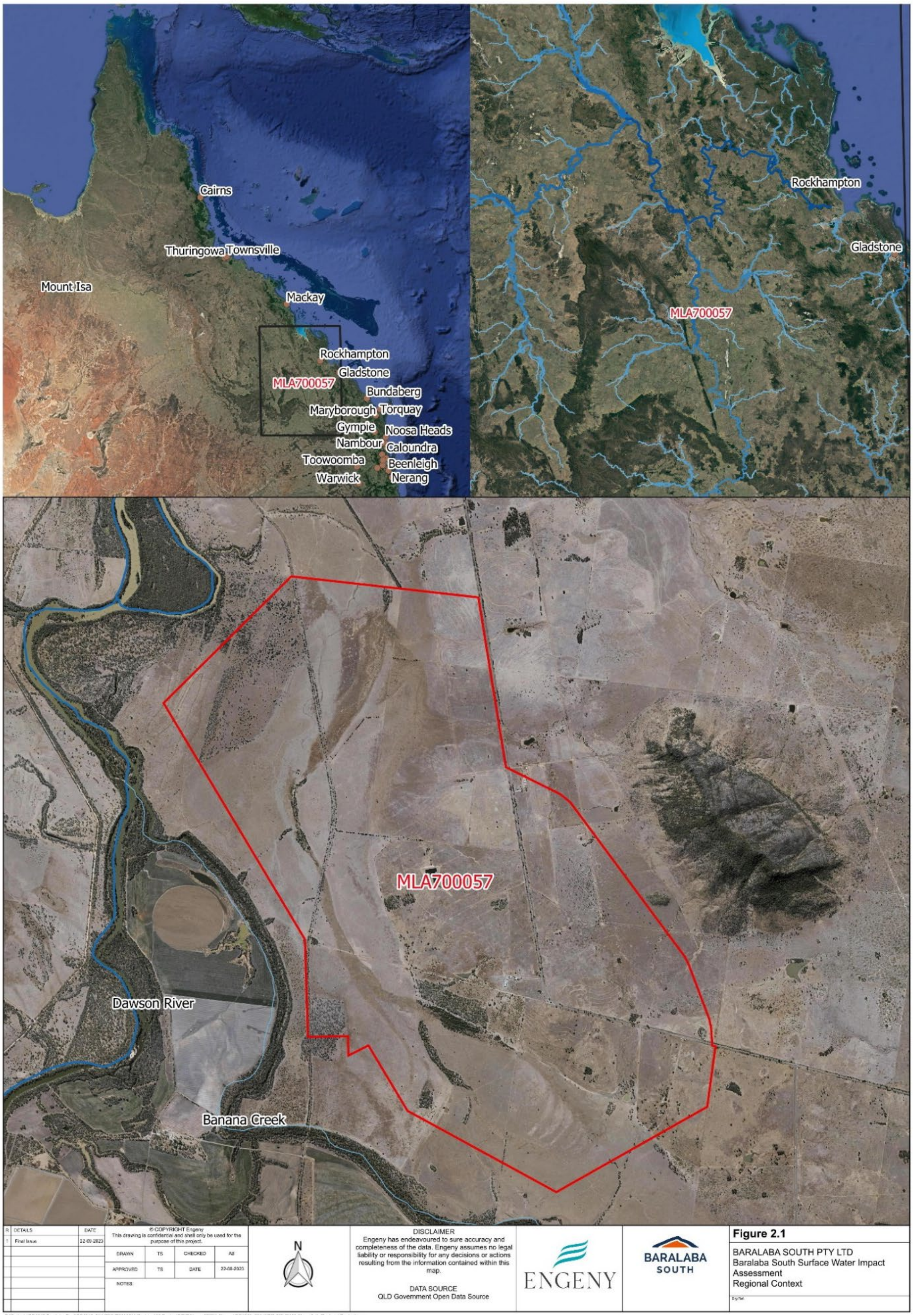

Figure 4.1: Regional context

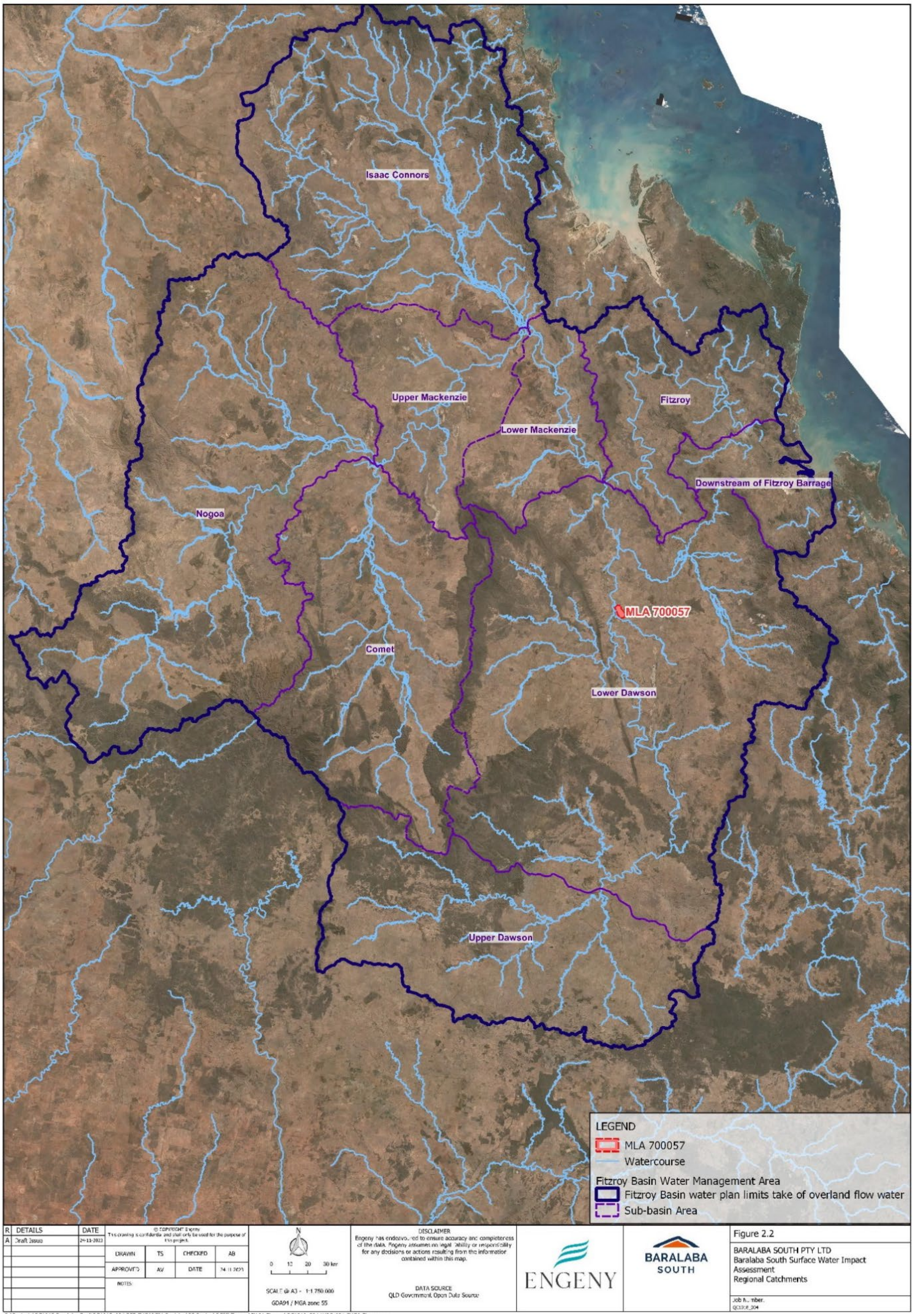

Figure 4.2: Regional catchments

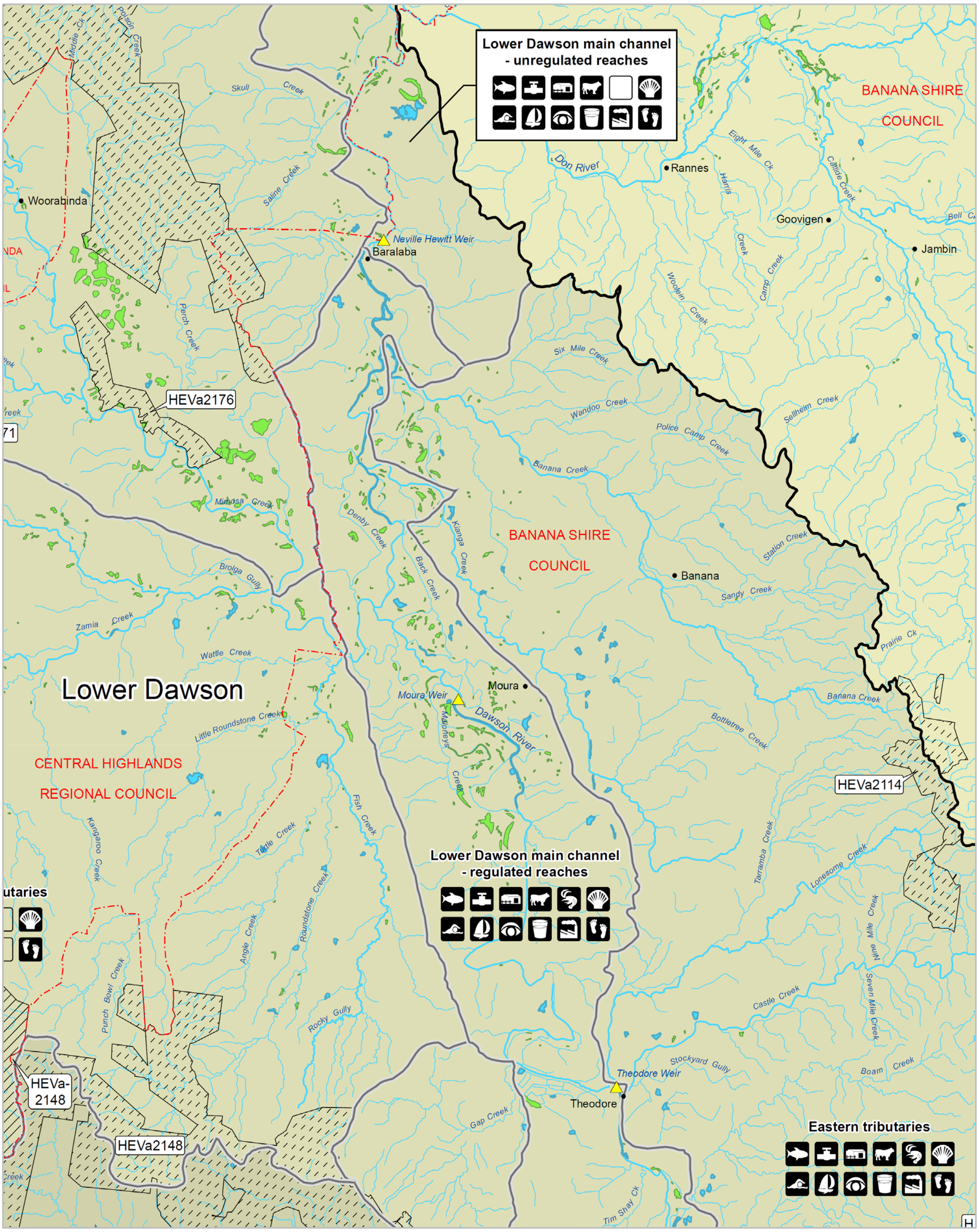

Figure 4.3: Environmental values—Lower Dawson River Sub-basin—WQ1309

Table 4.1: Environmental values—surface waters relevant to the Project

Environment value	EPP Water and Wetlands [Schedule 1] Surface waters Lower Dawson River Sub-Basin—WQ1309 Lower Dawson Main Channel—regulated reaches
Aquatic ecosystem	✓
Irrigation	✓
Farm supply	✓
Stock water	✓
Aquaculture	✓
Human consumer	✓
Primary recreation	✓
Secondary recreation	✓
Visual recreation	✓
Drinking water	✓
Industrial use	✓
Cultural and Spiritual Values	✓

4.2.1 Environmental flow objectives

The Water Plan (Fitzroy Basin) 2011 outlines the minimum environmental flow objectives for various flow regimes in each season for the Dawson River. Environmental flow objectives which define the flow durations and mean flows for a range of conditions, including seasonal base flow, medium to high flow and first post-winter flow events, are developed to sustain the natural ecosystem within the watercourse. The environmental flow objectives for the Dawson River at Beckers Gauging Station (Node 2) outlined in the Water Plan (Fitzroy Basin) 2011 are summarised in Table 4.2, Table 4.3, Table 4.4 and Table 4.5. The seasonal base flow objectives are not mandatory and are not met in the approved hydrology model used for the Water Plan (Fitzroy Basin) 2011 at Node 2. The percentage of the total number of days in a water flow season in the simulation period that the base flow is equalled or exceeded should be between 0.8 and 1.2 times the percentage stated for the water flow season.

Table 4.2: Base flow environmental flow objectives identified for the Project

Base flow (ML/d)	January–April water flow season	May–August water flow season	September–December water flow season
86	64%	27%	35%

Source: Table 1, Schedule 6, Water Plan (Fitzroy Basin) 2011

Table 4.3: Annual medium to high environmental flow objectives identified for the Project

Environmental flow objective	Description	Value
Mean annual flow	Minimum simulation mean annual flow as a percentage of pre-development flow pattern.	>65%
Median annual flow ratio	Minimum simulation median annual flow as a percentage of pre-development flow pattern.	>48%
Annual proportional flow deviation	Maximum annual proportional flow deviation.	<3.1
Mean wet season flow	Minimum simulation mean wet season flow as a percentage of pre-development flow pattern.	N/A

Table 4.4: Daily medium to high flow environmental flow objectives identified for the Project

	10% daily exceedance duration flow	4% daily exceedance duration flow	2-year daily flow volume	5-year daily flow volume	20-year daily flow volume
Simulation period minimum % of pre-development	>45%	>53%	>55%	>69%	>80%

Table 4.5: First post-winter flow environmental flow objectives identified for the Project

Environmental flow objective	Description	Value
Number of first post-winter flows	The number of first post-winter flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>80%
Number of flows within five weeks of the pre-development	The number of five-week lag events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%
Number of flows within two weeks of the pre-development	The number of two-week lag events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>70%
Average flow volume	The average of the volume ratios for the post-winter flow years in the simulation period	N/A
Average peak flow	The average of the peak flow ratios for the post-winter flow years in the simulation period	>60%
Flow duration (2-times base flow)	The number of 2-times base flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%
Flow duration (5-times base flow)	The number of 5-times base flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%

4.2.2 Water quality objectives

Environmental values and WQOs for Queensland waters are prescribed in Schedule 1 of the 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019'. WQOs are long-term goals for water quality management that protect environmental values.

WQOs for the receiving environment are shown in Table 4.6. Where multiple relevant environmental values specify different WQOs for the same parameter, the most conservative value has been adopted. The receiving environment water quality criteria approved under the Baralaba North Mine Environmental Authority and the Dawson Mine Environmental Authority are also shown in Table 4.6, providing a comparison of the identified regional WQOs against local approved water quality limits.

As described in section 4.2.6.3, baseline monitoring data shows existing exceedances of pH, EC, turbidity, aluminium and iron. Site specific WQOs will be reviewed for the Project once a statistically sufficient dataset of baseline local water quality data has been obtained, in accordance with the requirements outlined in the 'Queensland Water Quality Guidelines' (DEHP, 2009), 'National water quality management strategy guideline' (ANZG, 2018) and 'Information guidelines explanatory note: Deriving site-specific guideline values for physio-chemical parameters and toxicants' (IESC, 2019). The IESC guideline recommends that baseline data is collected from local reference sites for a minimum of 2 years to ensure data captures natural variability (IESC, 2019). The 'Queensland Water Quality Guidelines 2009' (DEHP, 2009) recommends that a minimum of 18 samples are to be collected from one to two reference sites over a period of two years to capture two complete annual cycles.

As described in section 4.2.6, the water quality conditions of the Dawson River at Beckers (130322A) have exhibited exceedances of the WQOs for several parameters in monitoring undertaken between 1964 and 2023 (DNRME, 2019). The site-specific water quality samples collected as part of the baseline water monitoring program for the Project have also exhibited exceedances of WQOs.

The 'Reef discharge standards for industrial activities' guideline (DES, 2023) outlines additional requirements for any proposed discharges to water that drain into the Great Barrier Reef. The guideline sets out the objective that fine point source releases to the Great Barrier Reef of sediment and dissolved inorganic nitrogen from the Project will not have a residual impact.

Table 4.6: Receiving environment water quality objectives and other local criteria

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	**Dawson Mine**	**Aquatic ecosystems**	**Drinking water**	**Irrigation (long-term)**	**Irrigation (short-term)**	**Stock watering**
pH	Drinking water	6.5–8.5	6.5–9	6.5–8.5	6.5–8.5	—	—	—
Conductivity (base flow)	Aquatic ecosystems	500 µS/cm	1,000 µS/cm	340 µS/cm	400 µS/cm	Variable based on soil type and crop. Minimum of 1,000 µS/cm.		Cattle: 2,500 µS/cm Sheep: 5,000 µS/cm
Conductivity (high flow)	Aquatic ecosystems			210 µS/cm				
Ammonia N	Aquatic ecosystems	900 µg/L		20 µg/L	—	—	—	—
Oxidised N	Aquatic ecosystems	—	—	60 µg/L	—	—	—	—
Organic N	Aquatic ecosystems	—	—	420 µg/L	—	—	—	—
Total nitrogen	Aquatic ecosystems	—	—	500 µg/L	—	—	—	—
Filterable reactive phosphorus	Aquatic ecosystems	—	—	20 µg/L	—	—	—	—
Total phosphorus	Aquatic ecosystems	—	—	50 µg/L	—	—	—	—
Chlorophyll	Aquatic ecosystems	—	—	5 µg/L	—	—	—	—
Dissolved oxygen	Aquatic ecosystems	—	—	85%–110% saturation	< 4 mg/L at surface	—	—	—
	Drinking water							
Turbidity	Aquatic ecosystems	—	—	50 NTU	—	—	—	—
Suspended solids	Aquatic ecosystem	350 mg/L	500 mg/L	10 mg/L	—	—	—	

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Sulphate	Aquatic ecosystem	250 mg/L	250 mg/L	25 mg/L	—	—	—	—
Cryptosporidium	Drinking water	—	—	—	0 cysts	—	—	—
Blue-green algae	Drinking water	—	—	—	5,000 cells/mg	—	—	—
Algal toxin	Drinking water	—	—	—	Level 1: > 1 µg/L	—	—	—
				—	Level 1: > 10 µg/L	—	—	—
Colour	Drinking water	—	—	—	50 hazen units	—	—	—
Total hardness	Drinking water	—	—	—	Level 1: > 150 mg/L	—	—	—
				—	Level 1: > 200 mg/L	—	—	—
Sodium	Drinking water	—	—		30 mg/L	—	—	—
Aluminium	Aquatic ecosystems	0.055 mg/L	0.055 mg/L	0.055 mg/L	—	5 mg/L	20 mg/L	5 mg/L
Arsenic	Aquatic ecosystems	0.013 mg/L	0.013 mg/L	0.013 mg/L	—	0.1 mg/L	2 mg/L	0.5-2 mg/L
Beryllium	Irrigation	—	—	—	—	0.1 mg/L	0.5 mg/L	ND
Boron	Aquatic ecosystems	0.37 mg/L	0.37 mg/L	0.37 mg/L1	—	0.5 mg/L	0.5 mg/L2	5 mg/L

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Cadmium	Aquatic ecosystems	0.2 µg/L	0.2 µg/L	0.2 µg/L1	—	10 µg/L	50 µg/L	10 µg/L
Chromium	Aquatic ecosystems	0.001 mg/L	0.001 mg/L	0.001 mg/L1	—	0.1 mg/L	1 mg/L	1 mg/L
Cobalt	Irrigation	1.4 µg/L	90 µg/L	—	—	50 µg /L	100 µg /L	1,000 µg /L
Copper	Aquatic ecosystems	2 µg/L	2 µg/L	1.4 µg/L1	—	200 µg /L	5,000 µg /L	400 µg/L (sheep), 1,000 µg/L (cattle)
Fluoride	Stock watering	2 mg/L	2 mg/L	—	—	1 mg/L	2 mg/L	2 mg/L
Iron	Aquatic ecosystems	0.3 mg/L	0.3 mg/L	—	—	0.2 mg/L	10 mg/L	Not sufficiently toxic
Lead	Aquatic ecosystems	4 µg/L	4 µg/L	3.4 µg/L1	—	2,000 µg/L	5,000 µg/L	100 µg/L
Lithium	Irrigation	—	—	—	—	2.5 mg/L	2.5 mg/L	—
Manganese	Aquatic ecosystems	1.9 mg/L	1.9 mg/L	1.9 mg/L1	—	0.2 mg/L	10 mg/L	—
Mercury	Aquatic ecosystems	0.2 µg/L	0.2 µg/L	—	—	2 µg/L	2 µg/L	2 µg/L
Molybdenum	Irrigation	34 µg/L	34 µg/L	—	—	20 µg/L	50 µg/L	—
Nickel	Aquatic ecosystems	0.011 mg/L	0.011 mg/L	0.011 mg/L1	—	—	—	1 mg/L
Selenium	Aquatic ecosystems	10 µg/L	10 µg/L	11 µg/L1	—	10 µg/L	50 µg/L	20 µg/L

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Uranium	Irrigation	1 µg/L	1 µg/L	—	—	10 µg/L	100 µg/L	—
Vanadium	Irrigation	10 µg/L	10 µg/L	—	—	100 µg/L	500 µg/L	—
Zinc	Aquatic ecosystems	8 µg/L	8 µg/L	8 µg/L1	—	2,000 µg/L	5,000 µg/L	—

4.2.3 Climate

The regional climate of the area is described as sub-tropical with wet season dominated rainfall and mild, dry winter months. Rainfall is highly seasonal and is typically associated with thunderstorm and cyclonic weather patterns.

Regional climate is described in full in Chapter 2, Project Description.

4.2.4 Regional hydrology

The Project is located in Central Queensland within the Fitzroy Basin, a sub-basin of the greater North-East Coast Basin (Figure 4.2). The Fitzroy Basin has a total catchment area of 142,900 km^2 with the main tributary rivers being the Mackenzie River, Isaac River, Dawson River and Comet River. The Fitzroy River is located within the Great Barrier Reef catchment and flows north-east, discharging into the Coral Sea, south-east of Rockhampton (Figure 4.1).

The Project is located near the confluence of Banana Creek and the Dawson River (Figure 4.1). The Dawson River is one of the major tributaries to the Fitzroy River and with a sub-basin catchment area of 50,800 km^2, it makes up 35% of the Fitzroy Basin catchment. The Dawson River headwaters rise within the Carnarvon Range and generally flow towards the north-east to the Fitzroy River before discharging into the Coral Sea near Rockhampton (approximately 380 km downstream of the Project area). Approximately 35 km downstream of the Project, the Dawson River confluences with Don River, which has a catchment size equivalent to 25% of the Dawson River catchment area at the confluence.

Banana Creek is a 5th order watercourse which flows in a north-westerly direction from south of the Banana township towards the Project. Banana Creek flows into the Dawson River to the west of the MLA. The western and northern MLA boundaries lie roughly parallel to Banana Creek and the Dawson River respectively.

4.2.5 Local hydrology

4.2.5.1 Dawson River

The Dawson River is the most significant watercourse near to the Project, with a catchment of approximately 40,500 km^2 at the Baralaba township.

The Dawson River is a perennial watercourse that experiences consistent flows throughout the year due to inflow from groundwater sources along its length. The river is subject to seasonal flooding. Mean daily and annual flows in the Dawson River are approximately 2,790 ML and 1,020 GL respectively. The Dawson River typically experiences significant seasonal variations in high flows with flooding typically occurring during the wet season (October to April).

Adjacent to the Project, the Dawson River has a main channel approximately 150 m wide and 10 m deep, bordered by a lower floodplain extending 1.5–3 km on either side. It is laterally an active river, with several anabranch channels both upstream and downstream of the Project (AECOM, 2016). At the closest point, the Dawson River is located approximately 700 m west of the Project and an anabranch of the Dawson River (the Dawson River Anabranch) flows approximately 400 m to the north-east of the Project boundary.

Water resources are managed in the lower Dawson River with water supply storages. The nearest upstream and downstream storages are Moura Weir (40 km to the south) and Neville Hewitt Weir near Baralaba (8 km to the north) respectively. Supplemented water entitlements for water extraction from the Dawson River are managed through the Dawson Valley Water Supply Scheme and the Water Plan (Fitzroy Basin) 2011.

Stream flow characteristics of the Dawson River are detailed below in section 4.2.6.1.

4.2.5.2 Banana Creek

Banana Creek is defined as a watercourse under the Water Act. Banana Creek is an ephemeral, fifth order tributary to the Dawson River with a catchment area of approximately 1,000 km^2 at its confluence with the Dawson River (approximately 1 km west of the Project). Banana Creek flows in a north-westerly direction from the south of the Banana township towards the Project within 500 m of the Project boundary, at the closest point. The south-western Project boundary closely follows Banana Creek, at less than 2 km away.

There are no gauging stations monitoring flow in Banana Creek, however, Banana Creek only flows in response to large rainfall events typically during the wet season (October to April). In the vicinity of the Project, Banana Creek has a main channel approximately 120 m wide 10 m deep, bordered by a lower floodplain extending approximately 1 km on either side. Streamflow in Banana Creek adjacent the Project, is heavily influenced by flooding and associated flows in the Dawson River.

4.2.5.3 Minor waterways and drainage lines

Adjacent to and downstream of the Project area is Shirley's Gully, the reach of the main unnamed waterway closest to the confluence with the Dawson River Anabranch, which is mapped as a third order stream (DNRME, 2019). Shirley's Gully is not mapped under the Water Act.

A number of ephemeral, unnamed minor waterways (mapped as first and second stream orders) are present and flow through the Project area, as tributaries of one unnamed (third stream order) waterway (Figure 4.4) (DNRME, 2019). The unnamed waterway catchments extend from Mount Ramsay to the east and to the Dawson River to the west. The 1st order streams flowing through the MLA area have catchment areas ranging from <100 ha to as large as 1,300 ha. Flow paths are not well defined with no obvious bed or banks and channel widths are generally less than 20 m. The largest unnamed waterway which intersects the MLA has a catchment area of approximately 5,000 ha and a channel width of around 30 m at its confluence with the Dawson River.

All the minor waterways in the vicinity of the MLA area are ephemeral and experience flows only in response to rainfall. These unnamed watercourses are classed as drainage features under *Water Act 2000*.

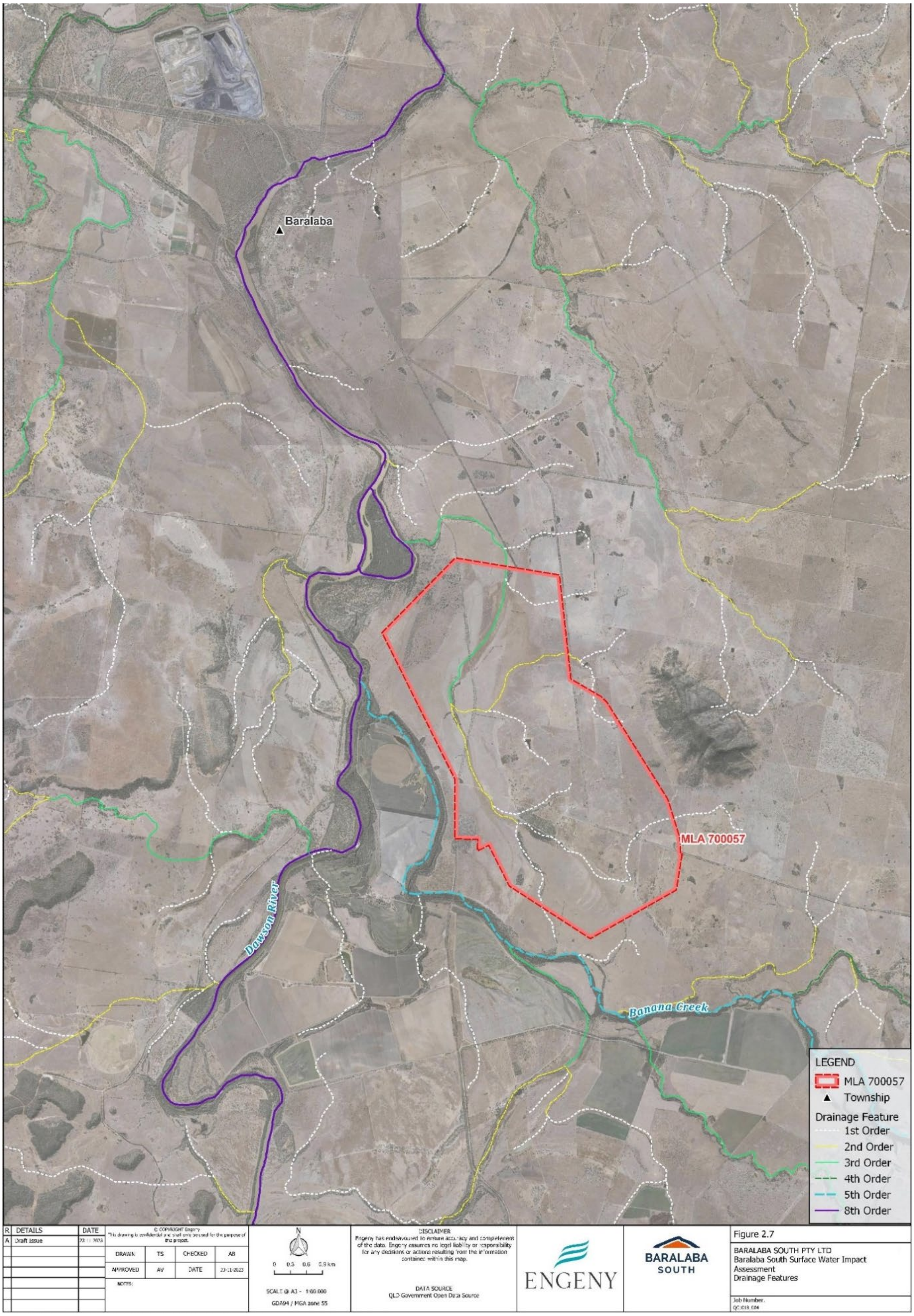

Figure 4.4: Waterways within the MLA and surrounds

4.2.6 Baseline surface water characteristics

A Surface Water Monitoring Program has been developed and established in accordance with the Queensland Water Quality Guidelines (DEHP, 2009) and the National Water Quality Management Strategy Guideline (ANZG, 2018), with the intent of collecting baseline water quality data representative of the local receiving environment. Reference sites for the Surface Water Monitoring Program have been selected to capture spatial and temporal variations in water quality due to natural variations and surrounding land uses. Surface water monitoring has been undertaken at sites listed in Table 4.7 and shown on Figure 4.5 between June 2019 and August 2023.

Monitoring data from the Baralaba North Coal Mine and the Beckers gauging station has also been compared to Dawson River WQOs to better describe baseline water quality characteristics for the broader system.

Table 4.7: Surface water quality monitoring locations

Monitoring location (ID)	Easting (GDA94)	Northing (GDA94)
U/S Banana Creek	149.897	–24.3091
U/S Dawson River	149.794	–24.3254
MP1 Banana Creek	149.844	–24.2763
D/S Dawson River	149.819	–24.2081
Dawson River at Baralaba DR1 (Baralaba North Mine SWMP)	149.805	–24.1825
Dawson River at Beckers (130322A)	149.822	–24.0873

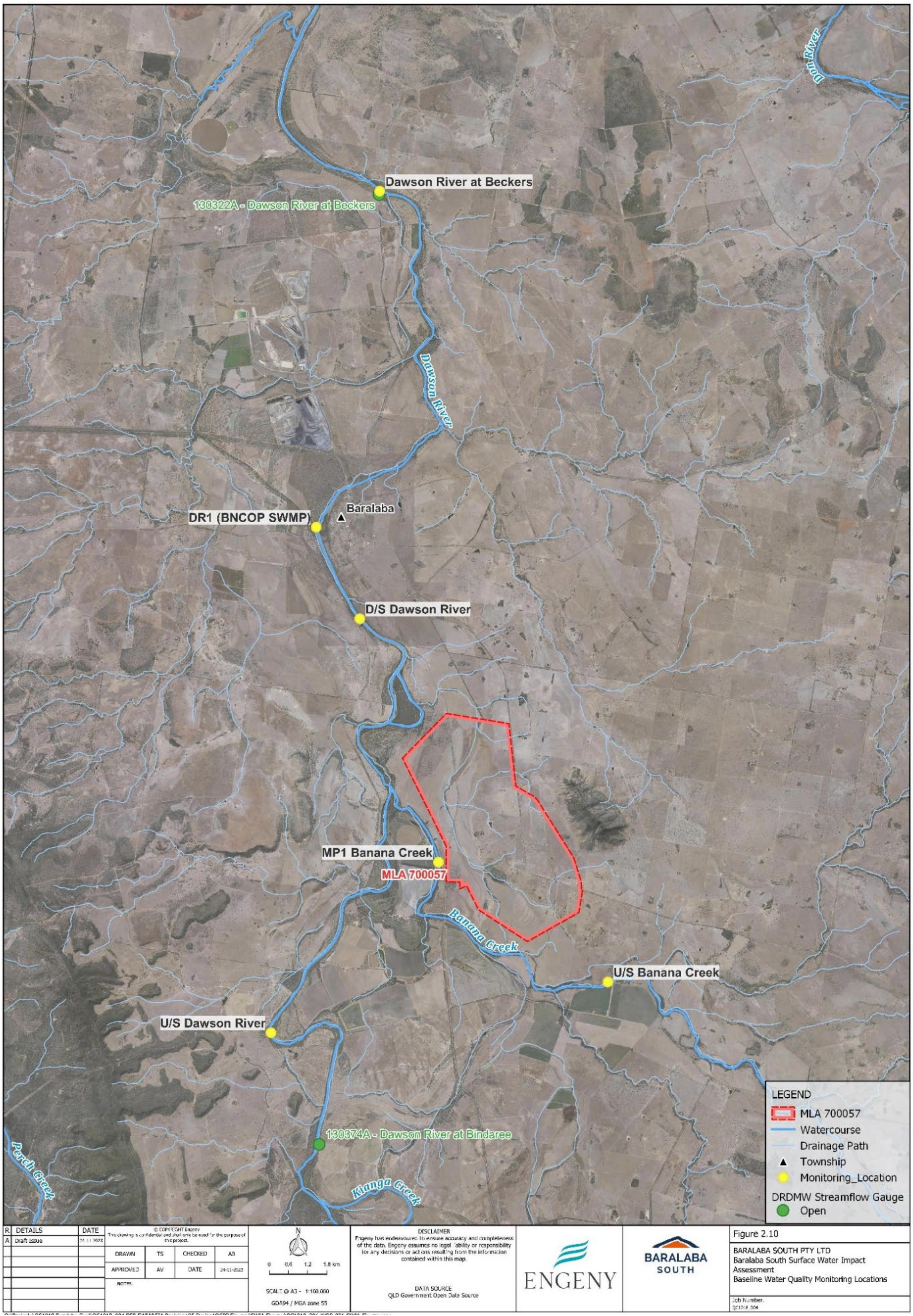

Figure 4.5: Water quality monitoring locations

4.2.6.1 Stream flow

A number of gauging stations exist on the Dawson River to monitor streamflow. The closest DoR (previously the Department of Natural Resources, Mines and Energy [DNRME]) Dawson River streamflow gauging stations are at Bindaree (130374A) upstream south of the Project and the Beckers gauging station (130322A) downstream, north of the Project. Historical streamflow data has been recorded at Beckers gauging station since 1964 and at the Bindaree gauging station since 2005. Streamflow duration characteristics are similar between the Bindaree gauging station and the Beckers gauging station, as shown in Figure 4.6.

There are no streamflow gauging stations located along Banana Creek.

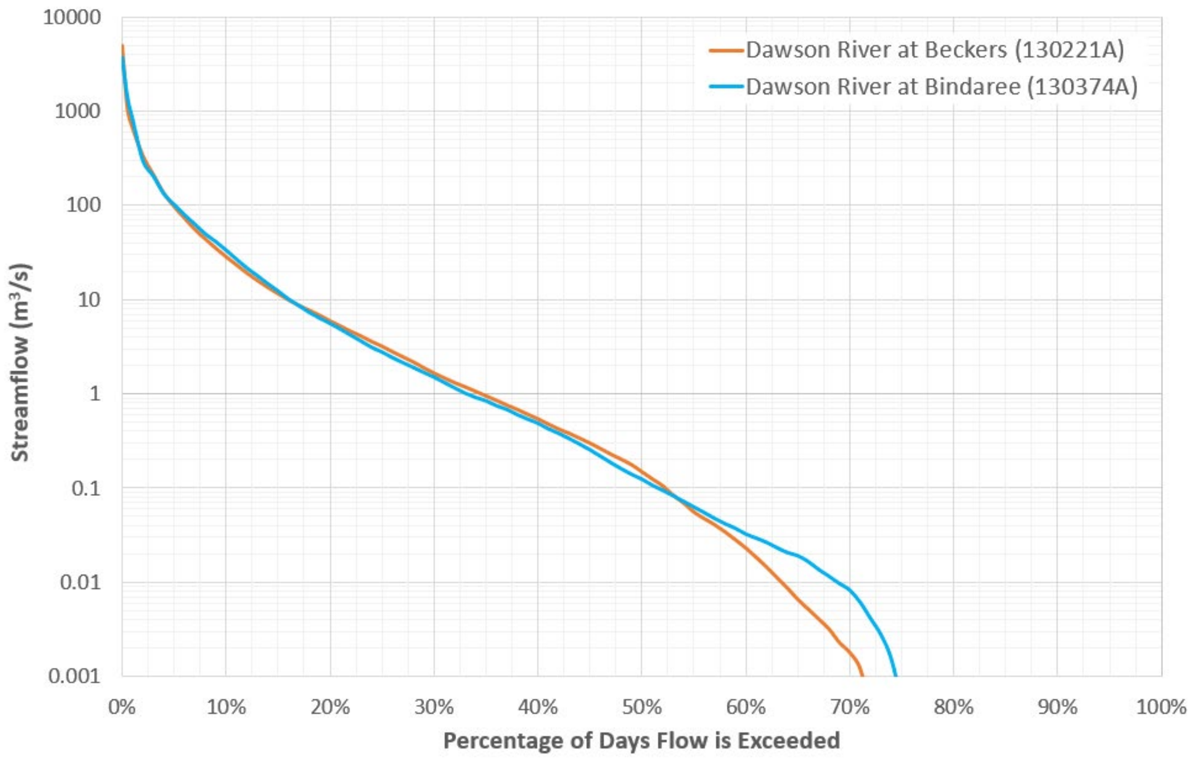

Figure 4.6: Dawson River at Beckers (130322A) and Dawson River at Bindaree (130374A) Flow Duration Curves

4.2.6.2 Flooding behaviour

An existing case flood model has been developed to assess the flooding behaviour across a range of events, between 20% AEP and a PMF, for areas within and surrounding the MLA (Appendix C, Flood Impact Assessment). The flood model development and results are described in Chapter 6, Flooding and Regulated Dams.

4.2.6.3 Water quality

Water quality data from several sources have been analysed to best characterise baseline conditions of the Project and its receiving environment, including:

- surface water quality data from existing and previous sampling programs on the Dawson River and the Dawson River anabranch for Baralaba North Mine;
- ongoing, automated, in situ monitoring (telemetric monitoring) of electrical conductivity (EC) at Beckers gauging station (130322A) since 1993, and sampling of a wider range of water quality parameters at the gauging station since 1964 by the DoR;

- surface water quality data (Appendix G, Aquatic Ecology Assessment) collected by Ecological Service Professionals (2023) from:
    - the Dawson River;
    - the Dawson River Anabranch;
    - Shirley's Gully;
    - the un-named tributary of the Dawson River situated within the Project area;
    - Banana Creek;
    - two wetlands located within the ML (HES wetland and a Palustrine wetland); and
- surface water quality data collected from the Project surface water quality monitoring program.

Baralaba North Mine water quality

A baseline water quality monitoring program was undertaken as part of the Environmental Impact Statement process for the Baralaba North Continued Operations Project, located approximately 11 km north of the Project. The data was predominantly collected between 2011 and 2013, with some sampling back to 2009 (WRM, 2014). The locations of the Baralaba North Mine water quality monitoring sites are shown in Figure 4.7.

Detailed summaries of water quality data for Dawson River (upstream and downstream of Baralaba North Mine), Dawson River Anabranch (upstream and downstream of Baralaba North Mine) and Saline Creek are provided in Appendix A, Surface Water Impact Assessment. Data from the Baralaba North Mine water quality monitoring program has been considered when defining the WQO for the Project.

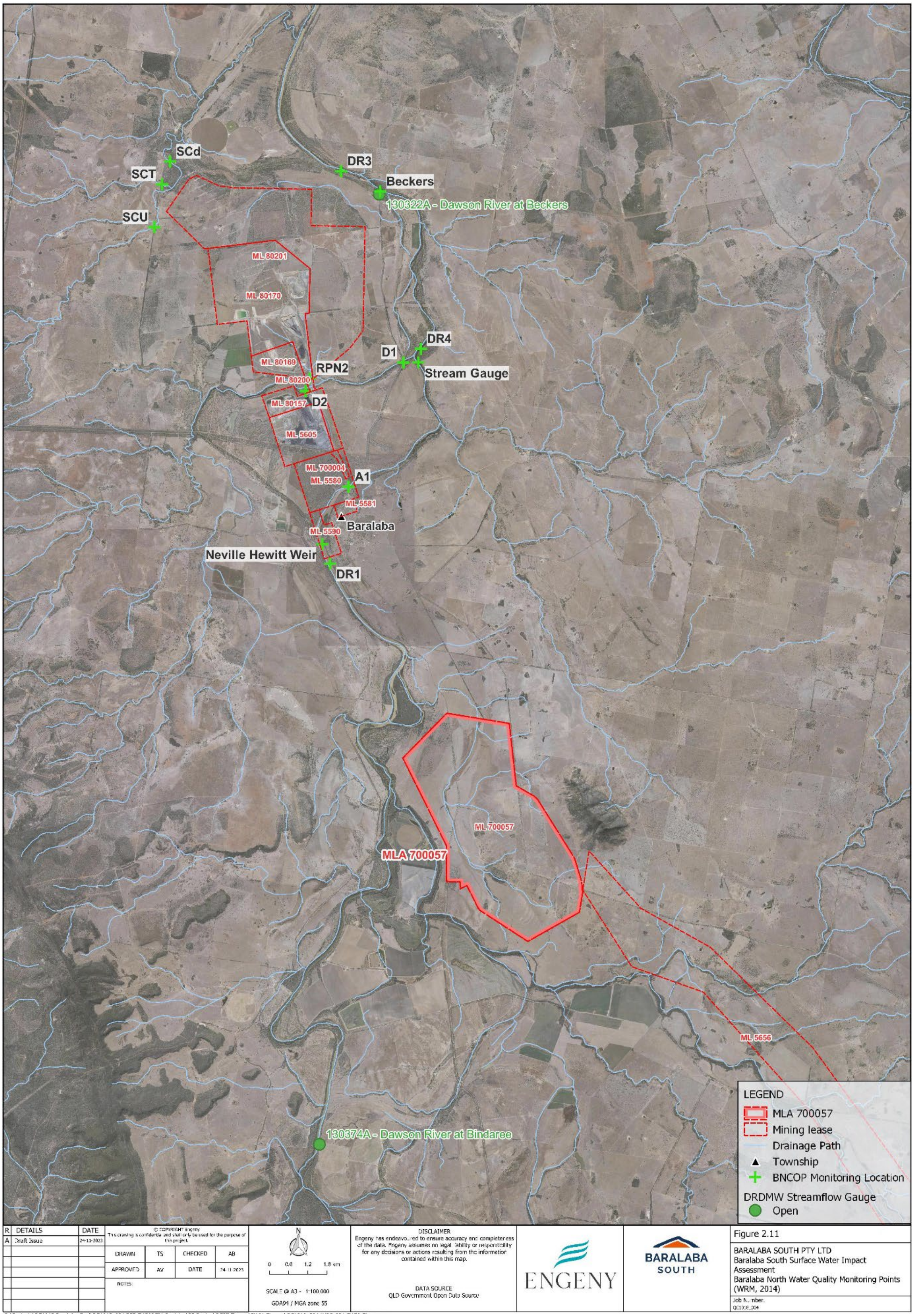

Figure 4.7: Baralaba North Mine water quality monitoring sites

Water quality monitoring at Beckers gauging station

Water quality of the Dawson River has been monitored at streamflow gauging station 130322A (Dawson River at Beckers) since 1993 (DNRME, 2019). Telemetric monitoring of EC and streamflow produces daily readings which are reflected in Figure 4.8. The data shows EC is fairly constant during medium flows (150 µS/cm to 250 µS/cm); however, increases following large stream flow events are evident in 1998, 2011 and 2013 (Appendix A, Surface Water Impact Assessment).

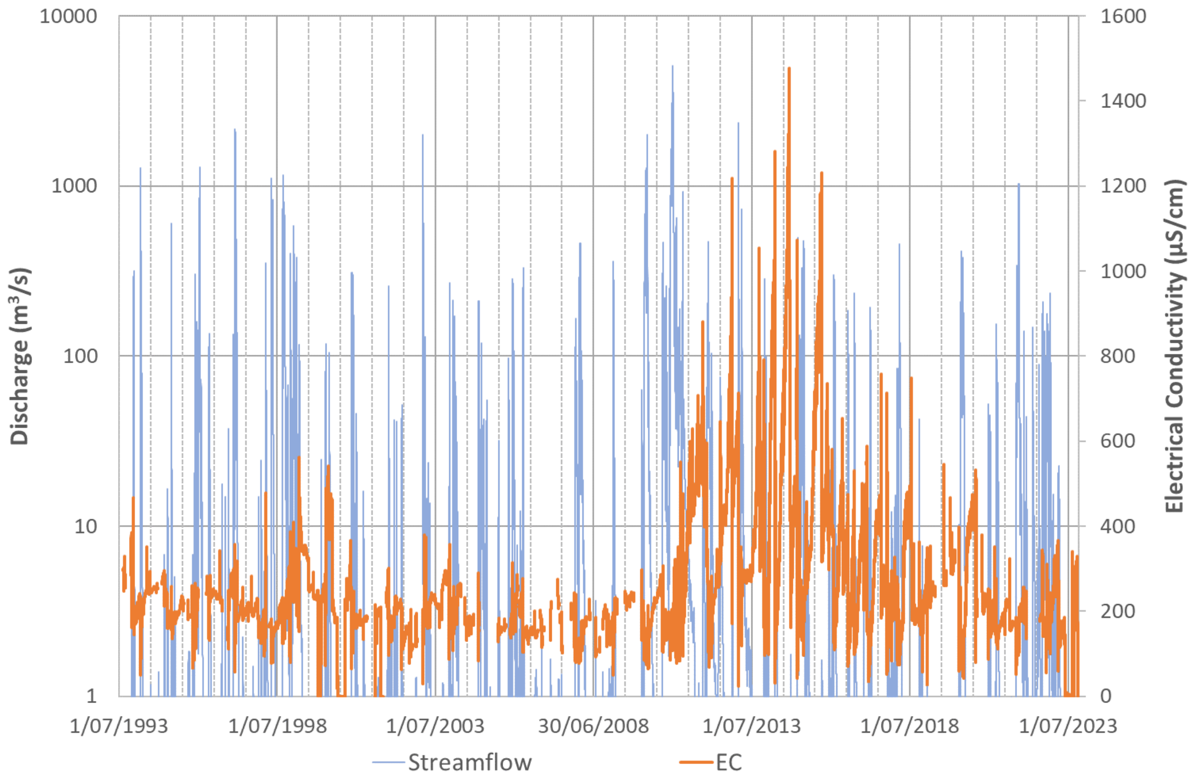

Figure 4.8: Station 130322A (Dawson River at Beckers) streamflow and water quality time series

Analysis of a wider range of water quality indicators has been undertaken since 1964 through a water quality sampling program at Beckers gauging station on the Dawson River (DNRME, 2019). A statistical summary of the water quality data for each water quality parameter collected as part of this program is provided in Appendix A, Surface Water Impact Assessment. Table 4.8 provides a statistical summary of the key water quality parameters including pH, EC, turbidity, total suspended solids, total nitrogen and total phosphorous.

The water quality of the Dawson River at the Beckers gauging station (130322A) has exceeded several WQOs in the monitoring undertaken between 1964 and 2013 (DRDMW, 2023). For example:

- EC exceeded low and high flow WQOs for aquatic ecosystems in the 95th percentile;
- turbidity and total suspended solids exceeded aquatic ecosystem WQOs in greater than median and 20th percentiles respectively; and
- median total phosphorus and total nitrogen measurements exceeded the WQOs for aquatic ecosystems.

Table 4.8: Water quality data (Gauging station 130322A—Dawson River at Beckers)

	Electrical conductivity (uS/cm)	pH (pH units)	Turbidity (NTU)	Total phosphorus (mg/L)	Total nitrogen (mg/L)
WQO	340/210 (baseflow/high flow)1	6.5–8.5 [1,2]	501	0.051	0.51
Minimum	70	6.8	1	0.04	0.3
5th Percentile	114	6.9	5	0.06	0.4
20th Percentile	150	7.2	27	0.09	0.5
Median	204	7.6	100	0.20	0.8
80th Percentile	266	7.8	240	0.39	1.1
95th Percentile	413	8.0	600	0.55	1.3
Maximum	790	8.3	1120	0.72	2.0

[1] Aquatic Ecosystems, [2] Drinking Water

Baralaba South Project Aquatic Ecology Assessment

As a component of the Aquatic Ecology Assessment (Appendix G), local water quality data have been collected in June 2017 and/or March 2018 and August 2023 by Ecological Service Professionals (2023) from sites located within and adjacent to the MLA. The local water quality sampling sites are shown in Chapter 7, Flora and Fauna, and the data is summarised in Table 4.9. Water quality has been generally characterised as:

- neutral to alkaline pH, except for the lacustrine wetland (dam) site which exhibited a consistent but slightly alkaline pH;
- low EC, with one Banana Creek site above the relevant objective in the June 2017 and August 2023 surveys, and the lacustrine wetland (dam) site above the relevant objective in the March 2018 and August 2023 surveys;
- low dissolved oxygen typically below the WQO range for aquatic ecosystems, except for the lacustrine wetland (dam) site which exhibited dissolved oxygen above the WQO in the August 2023 survey;
- high turbidity and concentrations of suspended solids typically above the WQOs for aquatic ecosystems;
- low concentrations of ions, with one Banana Creek site above the relevant objective for sulphate in the June 2017 survey;
- high concentrations of nutrients (nitrogen and phosphorous) with the bioavailable fractions of nutrients also generally higher than relevant WQOs; and
- various metals and metalloids, dissolved concentrations of most metals and metalloids were low at most sites, except for aluminium, copper, and iron.

Baralaba South Project Surface Water Monitoring Program

A Surface Water Monitoring Program has been developed to supplement the existing available data for the Project in accordance with the 'Queensland Water Quality Guidelines' (DEHP, 2009) and the 'National Water Quality Management Strategy' (ANZG, 2018).

Surface water quality sampling has been undertaken at sampling sites on the Dawson River and Banana Creek between June 2019 and July 2023. The results of the sampling are provided in Table 4.10 - Table 4.13 and are generally consistent with the water quality recorded in aquatic ecology surveys.

The water quality results are considered representative of the broader region and indicate that the waterways and wetlands of the Project area are already moderately disturbed and influenced by surrounding land uses, particularly agriculture.

The baseline water quality monitoring program for the Project has shown exceedances of WQOs for the following parameters:

- pH was slightly exceeded at the downstream Dawson River monitoring location in the October, November and December 2020 samples.
- Electrical conductivities at all sites were recorded to be below 500 µS/cm for all samples, however, all monitoring locations at times have exceeded the high flow WQO for aquatic ecosystems and 40% of monitoring events exceeded the low flow WQO for aquatic ecosystems.
- Laboratory readings of turbidity showed consistent exceedances compared with the WQO for aquatic ecosystems at all sites.
- Sampling in all locations at all sampling dates showed consistent exceedance compared to the aquatic ecosystems WQOs for aluminium, ammonia, and iron.

Table 4.9: Project surface water quality data collected by Aquatic Ecology Surveys

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1	BC1	BC2	LW1	PW2	SG1	DA1	DR1	BC1	LW1	DA1	DR1
Physical																				
Temperature	ºC	10.9	12.6	14	15.9	9.6	13.3	17.3	19	25.7	23.8	27.6	25.4	27.3	27.6	26.4	16.8	20.5	16.7	19.4
EC	µS/cm	506	144	88.1	158.9	136.8	98.7	93	93.4	193.3	156.2	294.4	236.3	157.1	143.5	145.7	466.9	437.7	275.7	272.7
pH	pH units	7.52	7.45	7.15	8.49	7.01	7.26	6.67	6.92	7.34	6.85	8.47	7.01	7.26	7.42	7.41	7.59	8.61	7.43	7.9
DO	% sat.	63.7	91.1	69.7	104	55.4	85.4	42	35.3	64	6	100	46	46	74	67	85.9	121.1	71.1	94.3
Turbidity	NTU	6	14	123	22	62	40	83	91	95.9	71.3	20.3	110	417.8	165.7	172.8	15.8	15.5	63.5	20.8
Total suspended solids	mg/L	8	32	54	26	280	14	16	14	56	42	16	20	84	48	44				
Ions																				
Total hardness	mg/L	224	89	54	86	80	41	35	41	53	44	79	69	41	35	35				
Sulphate	mg/L	35	3	< LOR	< LOR	< LOR	5	4	4	< LOR	< LOR	< LOR	< LOR	2	2	2				
Fluoride	mg/L	0.3	0.2	< LOR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	< LOR	0.1	0.1	0.1				
Calcium	mg/L	55	21	15	23	24	10	9	10	13	11	20	21	10	9	9				
Magnesium	mg/L	21	9	4	7	5	4	3	4	5	4	7	4	4	3	3				
Sodium	mg/L	101	18	8	10	19	20	20	17	11	10	10	14	12	12	12				
Nutrients																				
Ammonia	µg/L	20	60	70	160	60	20	20	20	40	60	80	40	30	40	30				
Nitrite	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	20	< LOR	< LOR	< LOR	< LOR				
Nitrate	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	160	170	< LOR	< LOR	< LOR	< LOR	90	250	250				
Nitrite + Nitrate	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	160	170	< LOR	< LOR	20	< LOR	90	250	250				
Total organic nitrogen	µg/L	980	1,140	1,880	2,040	2,540	780	480	480	1,960	1,740	2,120	1,260	1,230	860	770				
Total nitrogen	µg/L	1,000	1,200	1,950	2,200	2,600	800	700	700	2,000	1,800	2,200	1,300	1,400	1,200	1,000				
Reactive phosphorus	µg/L	< LOR	20	125	70	260	30	70	50	140	180	100	420	170	200	200				
Total phosphorus	µg/L	50	130	390	200	620	180	150	150	570	530	270	510	450	350	370				
Total metals																				
Aluminium	µg/L	250	620	3,060	660	7,500	2,350	3,510	3,560	8,120	2,080	140	1,160	4,340	4,410	5,130				
Arsenic	µg/L	3	2	2	5	4	2	2	1g	10	8	6	4	4	2	3				
Boron	µg/L	60	< LOR	60	80	60	< LOR	< LOR	60	< LOR	< LOR	80	70	< LOR	< LOR	< LOR				
Cadmium	µg/L	0.1	< LOR	0.1	0.1	0.1	0.1	< LOR	0.1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Chromium	µg/L	< LOR	< LOR	2	< LOR	5	6	4	< LOR	7	2	< LOR	< LOR	3	3	3				

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1	BC1	BC2	LW1	PW2	SG1	DA1	DR1	BC1	LW1	DA1	DR1
Cobalt	µg/L	< LOR	< LOR	1	2	8	<LOR	1	< LOR	4	3	1	< LOR	2	1	2				
Copper	µg/L	2	2	4	1	11	3	4	2	8	4	<LOR	3	6	6	8				
Iron	µg/L	270	1,320	3,080	820	6,520	2,810	3,970	2,350	9,100	3,580	3,30	1,030	5,060	4,240	5,140				
Lead	µg/L	< LOR	< LOR	2	< LOR	5	< LOR	1	< LOR	3	1	< LOR	< LOR	3	2	2				
Manganese	µg/L	92	47	44.5	222	665	52	70	17g	562	521	177	72	220	68	88				
Mercury	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Molybdenum	µg/L	4	< LOR	< LOR	1	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	2	< LOR	< LOR	1				
Nickel	µg/L	3	3	4	2	8	4	4	2	8	5	2	4	5	4	4				
Selenium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Silver	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	0.02	0.01	< LOR	< LOR	0.02	0.01	0.01				
Uranium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Vanadium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	20	< LOR	< LOR	< LOR	10	10	20				
Zinc	µg/L	< LOR	< LOR	9	< LOR	18	< LOR	6	< LOR	14	7	< LOR	< LOR	11	11	15				
Dissolved metals																				
Aluminium	µg/L	< LOR	< LOR	80	< LOR	< LOR	80	60	80	560	510	< LOR	80	420	280	290				
Arsenic	µg/L	2	1	2	4	2	1	1	2	6	5	5	4	2	2	2				
Boron	µg/L	70	80	80	90	80	60	80	< LOR	< LOR	< LOR	70	70	< LOR	< LOR	< LOR				
Cadmium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Chromium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	3	<LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Cobalt	µg/L	< LOR	< LOR	< LOR	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Copper	µg/L	< LOR	< LOR	1	< LOR	2	< LOR	< LOR	2	2	2	< LOR	2	2	2	3				
Iron	µg/L	< LOR	110	115	< LOR	< LOR	150	180	150	570	660	< LOR	70	350	240	240				
Lead	µg/L	< LOR	<LOR	<LOR	< LOR	< LOR	< LOR	< LOR	1g	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Manganese	µg/L	9	38	23	62	28	13	16	72g	6	5	< LOR	7	2	1	1				
Mercury	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Molybdenum	µg/L	3	< LOR	< LOR	1	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Nickel	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	<LOR	3	3	2	3	3	2	2				
Selenium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Silver	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Uranium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	**BC2**	**UW1T**	**LW1**	**PW2**	**SG1**	**DA1**	**DR1**	**BC1**	**BC2**	**LW1**	**PW2**	**SG1**	**DA1**	**DR1**	**BC1**	**LW1**	**DA1**	**DR1**
Vanadium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	10	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Zinc	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Total petroleum hydrocarbons																				
C6–C9 Fraction	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C10–C14 Fraction	µg/L	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C15–C28 Fraction	µg/L	< 100	160	155	< 100	120	< 100	< 100	< 100	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C29–C36 Fraction	µg/L	< 50	60	70	< 50	60	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C10–C36 Fraction (sum)	µg/L	< 50	220	225	< 50	180	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				

Table 4.10: Project surface water quality data June 2019—July 2023 DR1

Parameter	Units	DR1																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH value (lab)	pH Unit	7.78	7.74	8.22	8.10	8.09	7.68	7.64	7.73	7.84	7.83	7.82	7.8	7.65	7.78	7.93	7.67	7.72
Electrical conductivity (lab)	µS/cm	254	178	187	184	200	220	147	146	158	144	150	280	183	188	307	211	275
Total suspended solids	mg/L	12	44	62	34	24	93	155	32	123	56	46	41	64	76	19	16	18
Turbidity	NTU	11.8	215.0	185.0	77.1	40.1	268	304	216	319	249	253	104	218	292	11.8	54.2	34.3
Sulfate as SO4	mg/L	3	4	3	3	3	7	2	3	3	4	4	8	5	5	8	4	6
Dissolved major cations																		
Calcium	mg/L	14	14	14	13	14	13	10	11	11	10	11	18	10	11	20	11	17
Magnesium	mg/L	6	4	5	4	5	4	3	4	4	3	3	7	4	3	8	6	7
Sodium	mg/L	26	15	16	18	18	28	13	14	17	11	14	27	22	26	32	25	28
Potassium	mg/L	7	6	7	8	7	6	6	6	6	6	7	6	6	7	7	6	6
Dissolved metals																		
Aluminium	mg/L	0.02	0.07	0.07	0.04	0.07	0.06	0.12	0.21	0.12	0.02	<0.01	0.02	0.06	<0.01	0.07	0.19	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.002	0.002	0.001	<0.001	0.001	0.002	<0.001	0.001	0.003	0.003	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.001	0.003	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.004	0.003	0.002	0.002
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.027	0.002	0.004	0.010	0.004	0.03	0.006	0.008	0.004	0.012	0.005	0.007	0.004	<0.001	0.002	0.067	0.002
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.003	0.002	0.002	0.004	0.002	0.003	0.002	0.002	0.001	0.002	0.002	0.001	0.004	0.027	0.003	0.004
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.07	<0.05	<0.05	0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.05	0.06
Iron	mg/L	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.16	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.18	<0.05

Total metals																		
Aluminium	mg/L	0.41	7.06	7.91	3.79	1.84	10.2	10.2	7.89	11.4	6.11	6.54	9.18	13	15.7	0.85	1.39	1.08
Arsenic	mg/L	0.002	0.002	0.001	0.002	0.001	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.004	0.003	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	0.005	0.006	0.003	0.002	0.007	0.009	0.007	0.006	0.004	0.005	0.007	0.008	0.008	0.003	0.002	0.002
Copper	mg/L	0.001	0.007	0.009	0.005	0.005	0.011	0.01	0.008	0.012	0.007	0.011	0.007	0.012	0.014	0.005	0.003	0.008
Lead	mg/L	<0.001	0.003	<0.001	0.002	<0.001	0.003	0.003	0.002	0.004	0.003	0.004	0.002	0.003	0.005	<0.001	<0.001	<0.001
Manganese	mg/L	0.100	0.103	0.123	0.111	0.055	0.161	0.127	0.104	0.115	0.104	0.1	0.082	0.084	0.118	0.079	0.137	0.070
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.003	<0.001	<0.001
Nickel	mg/L	0.002	0.008	0.008	0.006	0.006	0.008	0.008	0.008	0.006	0.005	0.006	0.007	0.007	0.011	0.039	0.004	0.011
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	0.02	<0.01	0.01	<0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	0.016	0.02	0.010	<0.005	0.019	0.02	0.006	0.022	0.016	0.022	0.011	0.027	0.039	0.017	<0.005	0.009
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.05	<0.05	<0.05
Iron	mg/L	0.45	6.76	7.02	3.52	1.66	8.27	11	7.67	11.1	5.34	7.75	5.06	9.09	10.4	0.87	1.75	2.03
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	<0.1	0.2	0.1	0.2
Ammonia as N	mg/L	0.07	<0.01	0.05	0.12	0.03	0.23	0.2	0.15	0.31	0.1	0.16	0.44	0.32	0.43	<0.01	0.13	0.01
Nitrite as N	mg/L	<0.01	<0.01	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.02	0.32	0.15	<0.01	<0.01	0.12	0.14	<0.01	0.43	0.31	0.46	0.03	0.2	0.24	<0.01	0.01	0.02
Nitrite + Nitrate	mg/L	0.02	0.32	0.01	<0.01	<0.01	0.12	0.14	<0.01	0.43	0.31	0.46	0.03	0.2	0.24	<0.01	0.01	0.02
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	70	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	70	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Table 4.11: Project surface water quality data June 2019—July 2023 D/S DR1

Parameter	Units	D/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH value (lab)	pH Unit	7.71	7.86	8.60	8.06	8.22	7.74	7.57	7.63	7.82	7.82	8	7.67	7.64	7.91	7.83	8.01	7.61
Electrical conductivity (lab)	µS/cm	253	174	184	187	200	221	146	148	157	144	222	281	183	168	341	470	255
Total suspended solids	mg/L	< 5	162	78	27	26	102	150	36	108	52	80	42	84	79	20	17	10
Turbidity	NTU	10.6	312.0	112.0	74.8	35.6	270	313	210	335	260	248	100	218	301	10.6	12.1	31.7
Sulfate as SO4	mg/L	3	3	8	3	3	8	2	3	4	4	4	8	5	5	10	9	6
Dissolved major cations																		
Calcium	mg/L	14	14	15	12	14	13	10	12	11	10	20	18	9	10	21	23	15
Magnesium	mg/L	6	4	5	4	5	4	3	4	3	3	8	7	3	3	8	12	7
Sodium	mg/L	25	14	16	18	19	28	13	14	17	12	16	28	21	24	37	61	28
Potassium	mg/L	7	6	7	8	7	5	6	6	6	6	6	6	6	7	7	8	7
Dissolved metals																		
Aluminium	mg/L	0.02	0.09	0.1	0.03	0.06	0.05	0.12	0.15	0.1	<0.01	0.07	0.02	0.03	<0.01	0.05	<0.01	0.04
Arsenic	mg/L	0.001	<0.001	0.001	<0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.001	0.001	0.003	0.002	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.002	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.009	0.002	0.004	0.003	0.003	0.002	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.008	0.057	0.003	0.003	0.003	0.007	0.017	0.029	0.007	0.005	0.088	0.019	<0.001	<0.001	0.002	0.018	0.005
Molybdenum	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001
Nickel	mg/L	0.001	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.003	0.011	0.01	0.002
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	0.006	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06
Iron	mg/L	<0.05	0.07	0.06	<0.05	<0.05	<0.05	0.09	0.13	0.11	<0.05	0.08	<0.05	0.11	<0.05	0.05	<0.05	<0.05

Total metals																		
Aluminium	mg/L	0.41	10.20	5.00	2.93	1.51	10.6	10.8	8.59	11.5	5.82	6.17	10.9	12.2	15	0.49	0.61	1.77
Arsenic	mg/L	0.002	0.003	0.002	0.002	0.001	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.002	0.003	0.004	0.003	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	0.008	0.004	0.003	0.001	0.008	0.01	0.007	0.006	0.003	0.009	0.008	0.007	0.007	0.002	0.002	0.002
Copper	mg/L	0.001	0.011	0.007	0.005	0.004	0.011	0.011	0.009	0.011	0.007	0.026	0.008	0.011	0.01	0.008	0.004	0.002
Lead	mg/L	<0.001	0.005	0.002	0.001	<0.001	0.004	0.003	0.002	0.004	0.003	0.005	0.002	0.004	0.004	<0.001	<0.001	<0.001
Manganese	mg/L	0.060	0.223	0.069	0.060	0.050	0.132	0.144	0.132	0.118	0.089	0.173	0.092	0.088	0.115	0.039	0.095	0.064
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001
Nickel	mg/L	0.002	0.010	0.007	0.005	0.004	0.01	0.009	0.008	0.007	0.005	0.01	0.007	0.006	0.008	0.02	0.012	0.006
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	0.02	0.01	<0.01	<0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	0.026	0.01	0.016	<0.005	0.022	0.036	0.011	0.022	0.016	0.021	0.013	0.025	0.029	0.018	0.007	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.07	0.05
Iron	mg/L	0.41	10.20	4.37	2.77	1.40	8.50	11.8	8.12	10.9	5.16	8.73	5.45	8.75	9.18	0.54	0.66	1.82
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	8.03	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.004	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.2	<0.0001	0.2	0.2	0.1	0.1	0.2	0.2	0.1	<0.1	0.2	0.2	0.1
Ammonia as N	mg/L	0.06	0.05	<0.01	<0.01	0.01	0.005	0.03	0.06	0.19	0.02	0.06	0.06	<0.01	0.08	0.02	0.16	0.02
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.009	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.04	0.28	<0.01	0.01	<0.01	0.003	0.15	0.02	0.43	0.27	0.03	0.04	0.14	0.26	<0.01	<0.01	0.05
Nitrite + Nitrate	mg/L	0.04	0.28	<0.01	0.01	<0.01	0.141	0.15	0.02	0.43	0.27	0.03	0.04	0.14	0.26	<0.01	<0.01	0.05
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Table 4.12: Project surface water quality data June 2019—July 2023 U/S DR1

Parameter	Units	U/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH value (lab)	pH Unit	7.79	8.05	8.22	7.92	8.03	7.83	7.58	7.63	7.86	7.82	7.94	7.54	—	7.79	7.78	7.8	7.81
Electrical conductivity (lab)	µS/cm	306	282	383	379	445	267	148	148	147	146	156	194	—	238	189	254	495
Total suspended solids	mg/L	32	19	31	22	14	79	131	36	108	44	41	84	—	81	25	14	9
Turbidity	NTU	205	100.0	44.3	33.2	12.9	195	347	210	329	253	245	248	—	298	88	57.5	6.6
Sulfate as SO_4	mg/L	5	4	5	5	6	6	2	3	4	3	3	3	—	7	4	5	8
Dissolved major cations																		
Calcium	mg/L	14	18	23	20	21	17	9	12	10	10	10	14	—	14	12	13	24
Magnesium	mg/L	6	6	8	8	10	5	4	4	3	3	3	5	—	5	5	7	11
Sodium	mg/L	36	29	47	44	53	30	13	14	17	13	15	20	—	30	24	30	62
Potassium	mg/L	5	6	7	9	8	6	6	6	6	6	6	6	—	7	6	6	8
Dissolved total metals																		
Aluminium	mg/L	0.04	0.05	0.02	0.01	0.02	0.04	0.13	0.15	0.12	<0.01	<0.01	0.01	—	<0.01	0.44	0.1	<0.01
Arsenic	mg/L	<0.001	< 0.001	<0.001	0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001	—	0.001	0.002	0.002	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.001	0.001	0.002	0.002	0.002	0.005	0.003	0.003	0.004	0.003	0.003	—	0.005	0.003	0.002	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.002	0.002	0.008	0.006	0.003	0.007	0.024	0.029	0.003	0.016	0.013	0.012	—	0.001	0.009	0.083	0.001
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	0.001
Nickel	mg/L	0.002	0.002	0.002	0.003	0.004	0.003	0.004	0.002	0.002	0.003	0.002	0.002	—	0.025	0.006	0.004	0.004
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	—	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	—	<0.05	<0.05	0.05	0.06
Iron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	0.13	0.11	<0.05	<0.05	<0.05	—	<0.05	0.33	0.1	<0.05

Total metals																		
Aluminium	mg/L	7.15	3.56	1.60	0.84	0.54	8.03	10.1	8.59	9.74	5.54	6.47	5.82	—	17.2	4.06	2.77	0.29
Arsenic	mg/L	0.002	0.002	0.002	0.001	0.002	0.004	0.003	0.003	0.002	0.002	0.002	0.002	—	0.002	0.003	0.004	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.006	0.002	0.001	<0.001	<0.001	0.005	0.012	0.007	0.004	0.003	0.006	0.007	—	0.008	0.005	0.004	<0.001
Copper	mg/L	0.006	0.004	0.005	0.005	0.006	0.009	0.015	0.009	0.009	0.008	0.009	0.008	—	0.017	0.007	0.004	<0.001
Lead	mg/L	0.002	0.001	0.003	<0.001	<0.001	0.003	0.003	0.002	0.004	0.003	0.004	0.002	—	0.004	0.001	0.001	<0.001
Manganese	mg/L	0.083	0.040	0.077	0.103	0.090	0.141	0.152	0.132	0.104	0.088	0.091	0.12	—	0.127	0.062	0.159	0.037
Molybdenum	mg/L	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	0.001	0.001
Nickel	mg/L	0.006	0.005	0.004	0.005	0.004	0.007	0.015	0.008	0.005	0.006	0.007	0.009	—	0.04	0.009	0.006	0.003
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.02	<0.01	0.02	<0.01	<0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	—	0.02	0.02	<0.01	<0.01
Zinc	mg/L	0.012	0.015	0.006	<0.005	<0.005	0.016	0.026	0.011	0.02	0.015	0.022	0.014	—	0.032	0.019	0.009	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.06	0.06	0.05	<0.05	<0.05	<0.05	<0.05	0.06	—	<0.05	<0.05	<0.05	0.05
Iron	mg/L	6.50	3.33	1.47	1.12	0.54	6.30	12.9	8.12	8.74	4.97	7.76	5.84	—	10.4	4.08	2.9	0.30
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0014	<0.0001	0.0007	<0.0001	0.0016	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	—	<0.1	0.1	0.1	0.2
Ammonia as N	mg/L	0.11	<0.01	0.03	0.06	0.08	0.15	0.13	0.06	0.15	0.05	0.3	0.02	—	<0.01	<0.01	0.04	0.01
Nitrite as N	mg/L	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.46	0.29	0.01	0.01	<0.01	0.24	0.19	0.02	0.41	0.28	0.36	0.12	—	0.24	<0.01	0.01	<0.1
Nitrite + Nitrate	mg/L	0.46	0.29	0.15	<0.01	<0.01	<0.01	0.19	0.02	0.41	0.28	0.36	0.12	—	0.24	<0.01	0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	—	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	—	<100	120	<100	120
C29 - C36 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	120	<50	120

(-) site dry; not sampled

Table 4.13: Project surface water quality data June 2019—July 2023 MP1 BC

Parameter	**Units**	**MP1 BC**																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH value (lab)	pH Unit	7.69	—	—	7.27	7.61	I	7.53	7.63	7.86	7.77	8	7.17	7.76	7.8	7.84	8.01	7.85
Electrical conductivity (lab)	µS/cm	245	—	—	168	257	I	188	182	193	210	222	200	197	229	263	448	390
Total suspended solids	mg/L	40	—	—	6	12	I	6	13	47	18	80	41	54	82	22	14	11
Turbidity	NTU	49.3	—	—	132.0	13.7	I	8.8	17.1	280	203	248	348	179	187	58.1	10.2	10.9
Sulfate as SO4	mg/L	2	—	—	5	<1	I	<1	<1	3	5	4	5	6	5	8	8	7
Dissolved major cations																		
Calcium	mg/L	18	—	—	13	22	I	18	18	16	18	20	17	13	18	19	22	21
Magnesium	mg/L	7	—	—	5	10	I	6	6	6	6	8	6	5	7	6	10	10
Sodium	mg/L	21	—	—	12	15	I	11	12	15	14	16	15	25	20	29	54	46
Potassium	mg/L	7	—	—	8	8	I	8	6	6	6	6	7	7	7	7	8	8
Dissolved metals																		
Aluminium	mg/L	0.06	—	—	0.54	0.03	I	0.14	0.15	0.21	<0.01	0.07	<0.01	0.92	<0.01	0.09	<0.01	<0.01
Arsenic	mg/L	0.001	—	—	0.003	0.005	I	0.008	0.007	0.003	0.001	0.001	0.003	0.001	0.004	0.003	0.002	0.001
Cadmium	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.002	—	—	0.004	<0.001	I	0.005	0.003	0.011	0.01	0.009	0.005	0.005	0.003	0.002	0.001	0.002
Lead	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.045	—	—	0.134	0.270	I	0.058	0.112	0.124	0.14	0.088	0.152	0.043	<0.001	0.077	0.046	0.005
Molybdenum	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
Nickel	mg/L	0.002	—	—	0.005	0.004	I	0.005	0.004	0.004	0.003	0.003	0.003	0.002	0.005	0.004	0.023	0.005
Selenium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	—	—	0.005	<0.005	I	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.008	<0.005	<0.005
Boron	mg/L	<0.05	—	—	0.05	0.09	I	<0.05	<0.05	0.07	<0.05	<0.05	0.06	<0.05	0.06	0.06	0.06	<0.05
Iron	mg/L	0.06	—	—	0.43	1.29	I	0.49	0.39	0.18	<0.05	0.08	<0.05	0.76	<0.05	0.13	<0.05	<0.05

Total metals																		
Aluminium	mg/L	1.74	—	—	4.94	0.28	I	0.35	0.76	9.96	6.54	6.17	38.9	11.3	11.2	3.62	0.5	0.35
Arsenic	mg/L	0.002	—	—	0.005	0.007	I	0.008	0.008	0.004	0.004	0.004	0.01	0.002	0.006	0.005	0.003	<0.001
Cadmium	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.002	—	—	0.004	<0.001	I	<0.001	<0.001	0.008	0.007	0.009	0.03	0.008	0.01	0.003	<0.001	<0.001
Copper	mg/L	0.004	—	—	0.009	0.002	I	0.006	0.004	0.025	0.021	0.026	0.022	0.009	0.009	0.005	0.003	0.003
Lead	mg/L	<0.001	—	—	0.002	<0.001	I	<0.001	<0.001	0.002	0.002	0.005	0.005	0.003	0.003	0.001	<0.001	<0.001
Manganese	mg/L	0.086	—	—	0.194	0.332	I	0.149	0.17	0.299	0.273	0.173	0.389	0.072	0.297	0.191	0.132	0.062
Molybdenum	mg/L	0.001	—	—	<0.001	<0.001	I	0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.004	—	—	0.009	0.004	I	0.005	0.004	0.01	0.01	0.01	0.02	0.007	0.012	0.008	0.03	0.005
Selenium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	—	—	0.01	<0.01	I	<0.01	<0.01	0.02	0.02	0.02	0.07	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	—	—	0.019	<0.005	I	0.007	<0.005	0.02	0.016	0.021	0.036	0.022	0.019	0.015	0.008	<0.005
Boron	mg/L	<0.05	—	—	0.05	0.10	I	0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	0.07	0.07	0.06
Iron	mg/L	1.91	—	—	5.02	2.89	I	1.08	1.36	9.58	6.47	8.73	19.4	7.83	8	3.44	0.59	0.34
Other																		
Mercury (dissolved)	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	—	—	0.2	0.2	I	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
Ammonia as N	mg/L	0.15	—	—	0.14	0.05	I	0.05	0.02	0.09	0.15	0.06	0.11	0.05	<0.01	0.06	0.03	<0.1
Nitrite as N	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	0.15	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.1
Nitrate as N	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	0.03	0.05	0.08	<0.01	0.08	<0.01	<0.1
Nitrite + Nitrate	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	0.03	0.05	0.08	<0.01	0.09	<0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	—	—	<20	<20	I	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	110	<50
C15 - C28 Fraction	µg/L	<100	—	—	<100	<100	I	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	110	<50

(-) site dry; not sampled
(I) site inaccessible due to weather; not sampled

Table 4.14: Project surface water quality data June 2019—July 2023

Parameter	Units	U/S BC																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH value (lab)	pH Unit	—	—	—	7.17	—	7.80	7.58	7.56	7.86	8.01	8.23	7.26	7.45	7.94	D	7.99	7.81
Electrical conductivity (lab)	µS/cm	—	—	—	193	—	248	237	237	214	232	252	222	194	225	D	278	495
Total suspended solids	mg/L	—	—	—	37	—	19	8	15	142	14	14	76	35	31	D	9	9
Turbidity	NTU	—	—	—	146	—	13.1	10.6	11.3	313	67.8	33.8	305	247	121	D	6.4	6.6
Sulfate as SO_4	mg/L	—	—	—	2	—	2	1	1	4	6	6	5	4	4	D	4	8
Dissolved major cations																		
Calcium	mg/L	—	—	—	17	—	25	26	28	22	23	25	19	14	18	D	23	24
Magnesium	mg/L	—	—	—	6	—	10	8	8	8	7	8	7	5	7	D	9	11
Sodium	mg/L	—	—	—	13	—	14	13	15	15	16	18	18	15	24	D	30	62
Potassium	mg/L	—	—	—	7	—	6	6	5	6	5	6	7	6	7	D	8	8
Dissolved metals																		
Aluminium	mg/L	—	—	—	0.18	—	0.08	0.02	0.01	0.13	0.01	0.02	<0.01	0.22	0.33	D	0.01	<0.01
Arsenic	mg/L	—	—	—	0.007	—	0.006	0.004	0.005	0.004	0.001	0.001	0.004	0.003	0.003	D	0.004	0.001
Cadmium	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Chromium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Copper	mg/L	—	—	—	0.002	—	0.002	0.003	0.002	0.003	0.004	0.003	0.003	0.005	0.003	D	0.002	<0.001
Lead	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Manganese	mg/L	—	—	—	1.46	—	0.343	0.036	0.177	0.437	0.017	0.012	0.011	0.002	0.111	D	0.05	0.001
Molybdenum	mg/L	—	—	—	0.001	—	0.002	0.002	0.001	0.001	0.001	<0.001	<0.001	0.001	<0.001	D	0.001	0.001
Nickel	mg/L	—	—	—	0.006	—	0.006	0.004	0.003	0.004	0.003	0.003	0.003	0.003	0.009	D	0.006	0.004
Selenium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Silver	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Uranium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Vanadium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Zinc	mg/L	—	—	—	0.012	—	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	D	<0.005	<0.005
Boron	mg/L	—	—	—	<0.05	—	0.07	<0.05	<0.05	0.06	<0.05	<0.05	0.07	<0.05	0.09	D	0.07	0.06
Iron	mg/L	—	—	—	0.38	—	0.26	0.07	0.08	0.16	<0.05	<0.05	<0.05	0.21	0.28	D	<0.05	<0.05

Total metals																		
Aluminium	mg/L	—	—	—	4.36	—	0.84	0.31	0.37	11	3.39	1.32	8.78	14.4	7.22	D	0.35	0.29
Arsenic	mg/L	—	—	—	0.010	—	0.007	0.005	0.005	0.006	0.003	0.001	0.006	0.004	0.005	D	0.004	0.001
Cadmium	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Chromium	mg/L	—	—	—	0.004	—	<0.001	<0.001	<0.001	0.008	0.003	0.001	0.008	0.015	0.006	D	<0.001	<0.001
Copper	mg/L	—	—	—	0.006	—	0.004	0.004	0.002	0.013	0.007	0.005	0.013	0.013	0.007	D	0.003	<0.001
Lead	mg/L	—	—	—	0.002	—	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.003	0.004	0.002	D	<0.001	<0.001
Manganese	mg/L	—	—	—	1.72	—	0.528	0.167	0.307	0.601	0.104	0.066	0.537	0.13	0.192	D	0.122	0.037
Molybdenum	mg/L	—	—	—	0.001	—	0.002	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	0.001	0.001
Nickel	mg/L	—	—	—	0.010	—	0.006	0.004	0.004	0.01	0.006	0.004	0.012	0.012	0.014	D	0.007	0.003
Selenium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Silver	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Uranium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Vanadium	mg/L	—	—	—	0.01	—	<0.01	<0.01	<0.01	0.02	0.01	<0.01	0.02	0.03	0.02	D	<0.01	<0.01
Zinc	mg/L	—	—	—	0.016	—	0.008	<0.005	<0.005	0.018	0.017	<0.005	0.022	0.026	0.014	D	0.005	<0.005
Boron	mg/L	—	—	—	<0.05	—	0.06	<0.05	0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	D	0.07	0.05
Iron	mg/L	—	—	—	5.97	—	1.6	0.47	0.52	11.2	2.92	1.18	8.51	10.9	5.86	D	0.41	0.30
Other																		
Mercury (dissolved)	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Mercury (total)	mg/L	—	—	—	<0.0001	—	<0.0001	0.0002	<0.0001	0.0003	<0.0001	0.001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Fluoride	mg/L	—	—	—	0.2	—	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	D	0.2	0.2
Ammonia as N	mg/L	—	—	—	0.32	—	0.16	0.15	<0.01	0.22	0.07	0.06	0.12	0.04	0.02	D	<0.01	0.01
Nitrite as N	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.1
Nitrate as N	mg/L	—	—	—	<0.01	—	<0.01	0.02	<0.01	0.08	<0.01	0.03	0.03	0.28	<0.01	D	<0.01	<0.1
Nitrite + Nitrate	mg/L	—	—	—	<0.01	—	<0.01	0.02	<0.01	0.08	<0.01	0.03	0.03	0.28	<0.01	D	<0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	—	—	—	<20	—	<20	<20	<20	<20	<20	<20	<20	<20	<20	D	<20	<20
C10 - C14 Fraction	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	<50	D	<50	<50
C15 - C28 Fraction	µg/L	—	—	—	<100	—	<100	<100	<100	<100	<100	<100	<100	<100	120	D	<100	120
C29 - C36 Fraction	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	<50	D	<50	<50
C10 - C36 Fraction (sum)	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	120	D	<50	120

(-) site dry; not sampled

4.2.7 Water dependent assets

4.2.7.1 Municipal

The Banana Shire Council provides water supply services to the townships local to the Project. Banana Shire Council supplies potable water from several sources including Callide Dam and the Dawson River. Banana Shire Council provides potable water to Baralaba township from the Dawson River at Neville Hewitt Weir, approximately 8 km downstream of the Project (Banana Shire Council, 2018). The Woorabinda Aboriginal Shire Council also sources water from the Neville Hewitt Weir.

4.2.7.2 Agricultural

Agricultural users dominate the land nearby the Project. Agricultural users hold water allocations for the Dawson River under the Water Plan (Fitzroy Basin) 2011. A summary of un-supplemented entitlements, excluding entitlement holder names, is provided in Table 2.6 of Appendix A, Surface Water Impact Assessment.

The Project is located within Zone D of the Dawson Valley Water Management Area, as well as the Dawson Valley Water Supply Scheme which supports irrigation, urban and industrial customers. Supplemented entitlements are administered under the Dawson Valley Water Supply Scheme and are summarised in in Table 2.7 of Appendix A, Surface Water Impact Assessment.

4.2.7.3 Industrial

The Baralaba North Mine is located on the Dawson River and has an annual water entitlement of 500 ML/year under the Water Act as administered by the Water Plan (Fitzroy Basin) 2011. Dawson Mine is located within the Dawson River Catchment upstream of the Project and the remaining nearby sites are located in different catchment areas.

Both the Baralaba North Mine and Dawson Mine undertake controlled releases to the Dawson River. Mine affected water release limits are defined in the EA for each mine. Monitoring of releases from the Baralaba North Mine includes monitoring at Neville Hewitt Weir and elsewhere in the Dawson River. Monitoring of releases from the Dawson Mine occurs upstream of the Project.

4.2.7.4 Recreational

The lower Dawson River's main channel and its tributaries are used for both primary and secondary recreational purposes. These uses have been identified as environmental values for the Dawson River.

Baralaba Golf Course is located on the western bank of the Dawson River, approximately 1 km upstream of Baralaba township. On the eastern bank upstream of Baralaba township is the Neville Hewitt Weir campground and picnic area. Neville Hewitt Weir is recognised as a popular local fishing and waterskiing destination.

4.2.7.5 Aquatic ecosystems

The Dawson River and Banana Creek provide value as important aquatic ecosystem habitat in the region. Smaller drainage features within the MLA provide limited aquatic ecosystem value due to their highly ephemeral nature and disturbed condition.

A High Ecological Significance (HES) wetland (approximately 35 ha in area) is located within the MLA, between operational activities and the Dawson River (refer Figure 4.9). The wetland is considered to exist due to the presence of clays in the shallow subsurface, which allows surface waters to persist after rain or flood events (Appendix B, Groundwater Modelling and Assessment). The aquatic ecosystem value of this wetland is considered moderate, and similar to other wetlands in the region (Ecological Service Professionals, 2023).

Two small wetlands of general ecological significance were also identified within the MLA boundary, shown on Figure 4.9. The wetlands are associated with drainage features within the MLA. These wetlands lie outside of the active mine disturbance footprint.

The cumulative impacts of the proposed releases from the Project have been assessed in section 4.4.15, in consideration of other authorised releases.

4.2.7.6 Groundwater dependent ecosystems

Potential impacts of the Project on groundwater dependent ecosystems have been addressed in Chapter 7, Flora and Fauna.

The Project is located approximately 11 km south of Baralaba North Mine and approximately 27 km north of Dawson Mine.

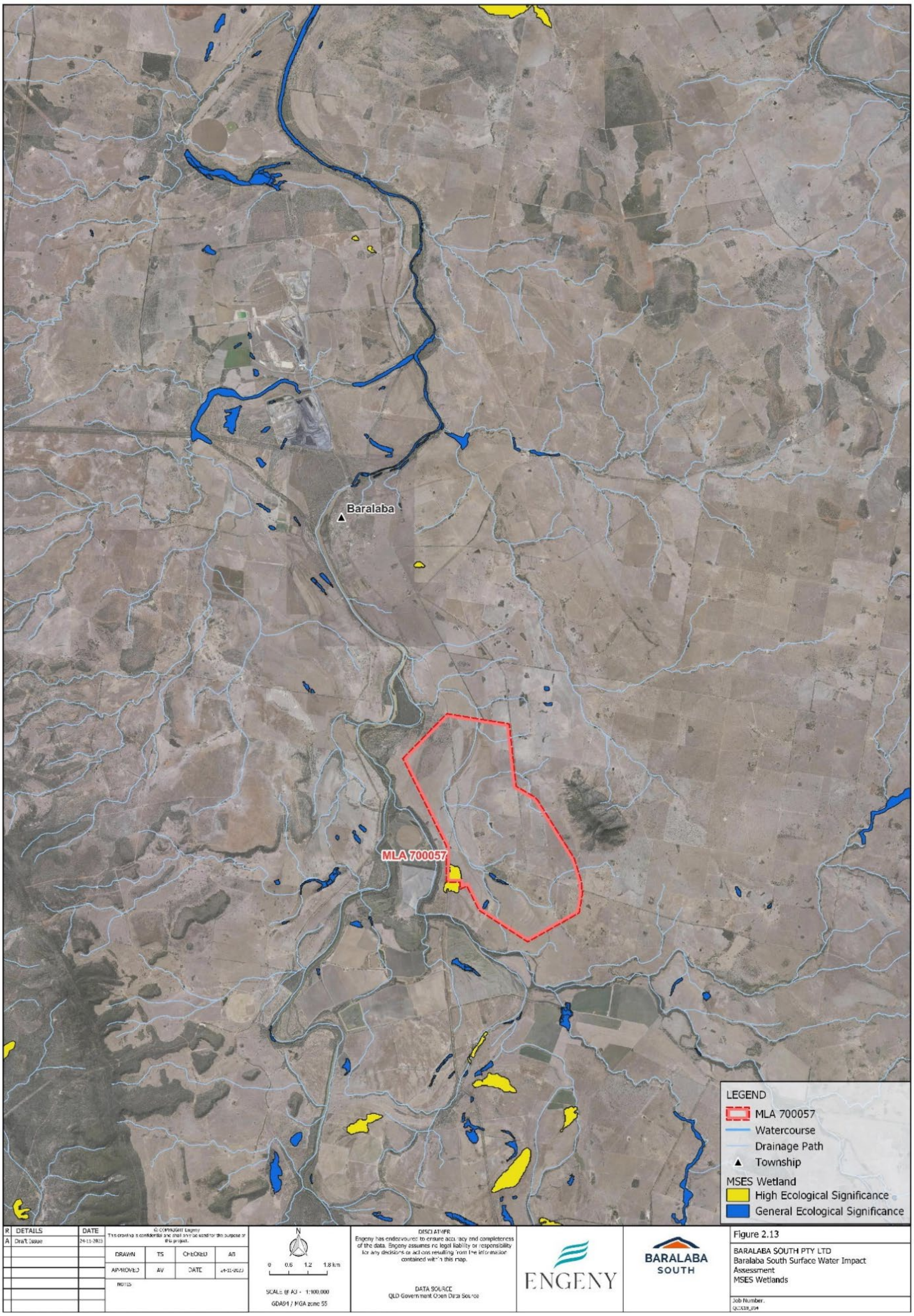

Figure 4.9: HES and GES wetland locations

4.3 Water management system

4.3.1 Objectives

The proposed water management system for the Project has separation of water types by:

- **Mine affected water**—defined as water which has interacted with mining activities consistent with the Mine Affected Water definition from the 'Queensland Model Mining Conditions' (DES, 2017). This includes water runoff and groundwater collected within the mining pit, recycled water from the coal wash plant, runoff from the mine infrastructure area (MIA) and excess water in the tailings drying cells.
- **Sediment water—**rainfall and runoff generated by disturbed landforms including overburden or WRE areas, pre-cleared areas and rehabilitation that is not yet established. This water does not contain elevated water quality parameters other than suspended solids and must be treated through the erosion and sediment control system.
- **Clean water**—runoff from undisturbed or established rehabilitation areas that has not come into contact with disturbed land or active mining areas.
- **Raw water**—untreated water supplied from an external water supply.
- **Potable water**—treated water suitable for human consumption.

The Water Management System for the Project has been designed to minimise environmental impacts on the receiving environment, as well as provide runoff containment and supply to water demands of the Project.

The objectives of the Water Management System are to:

- minimise capture of clean surface water from external catchments via catchment diversion;
- prioritise recycling and reuse of mine affected water first, ahead of other water sources for site demands including processing and dust suppression;
- preferential supply from site water storages over external supply and surface water harvesting;
- minimise and manage releases of water to receiving waterways; and
- prevent uncontrolled release of mine affected water to receiving waterways in > 95% of years.

4.3.2 Strategy

The proposed water management strategy is to:

- divert clean catchment around mine infrastructure and disturbed land through the use of diversion drains and pumping from upstream clean storages;
- contain mine affected runoff in dedicated storages for reuse in the Project;
- capture and treat disturbed runoff in sediment basins and other sediment control infrastructure before it leaves the site;
- minimise external catchment runoff reporting to the mining pit;
- preferentially re-use mine affected water and sediment runoff captured within the ML to supply operational water demands (dust suppression and CHPP demands); and
- progressively rehabilitate / stabilise WREs and mine infrastructure areas to reduce the generation of sediment runoff.

4.3.3 Water management infrastructure

The Water Management System includes the use of water management infrastructure to achieve the separation of water types using mine affected water dams, sediment dams, clean water dams and diversion drains.

4.3.3.1 Mine water dams

Mine water dams will be used to manage 'mine affected water'. Mine water storages will contain surface water runoff and groundwater collected within the mining pit, recycled water from the CHPP, runoff from the MIA area and excess water in the tailings drying cells.

Site storages for the management of mine-affected water are summarised in Table 4.15. Mine affected water storages have been designed to provide 95th percentile wet season containment as per the outcome of the preliminary consequence category assessment, 'Significant' (Appendix A, Surface Water Impact Assessment). Mine water storages are not located within the 0.1% AEP flood extent.

Water collected within the pits from rainfall events and groundwater ingress will be dewatered to the Mine Water Dam (MWD). The MWD will be preferentially utilised to supply the CHPP and dust suppression demands. The water management strategy includes controlled releases of excess water. Controlled releases will occur from the MWD only when streamflow conditions within the receiving waterways meet nominated thresholds and site water inventories require reduction to maintain safe levels.

The Environmental Water Dam (Enviro Dam) has been designed to provide wet weather containment for runoff from the MIA. Water will be transferred between the Enviro Dam and the MWD to maintain containment capacity and to provide additional supply storage for the CHPP.

Overflow pathways for dams are shown on Figure 4.10.

Table 4.15: Water management infrastructure—Mine water dams

ID	Description	Catchment area (ha)	Estimated embankment height (m)	Full supply volume (ML)
MWD	Embankment dam sized to maximum capacity allowing storage of dewatered inventory from pit and sediment dams. Dam to be used as intermediary storage for CHPP process water. Capture recycled water from coal wash plant and mechanical dewatering.	29	~ 14	1,220
Enviro Dam	Storage to capture runoff from MIA area, ROM and rejects stockpile.	79	~ 8	410

4.3.3.2 Sediment dams

Sediment dams will be used to collect 'sediment water', that is rainfall and runoff generated by disturbed landforms including waste rock, pre-cleared areas and rehabilitated areas that are not yet established. Sediment dams are required to ensure runoff from waste rock and disturbed areas is intercepted prior to overflows entering the receiving environment during rainfall events. Sediment dams form a key part of the erosion and sediment control management practices for the Project and will be managed to ensure settling volumes are reinstated prior to the next rainfall event.

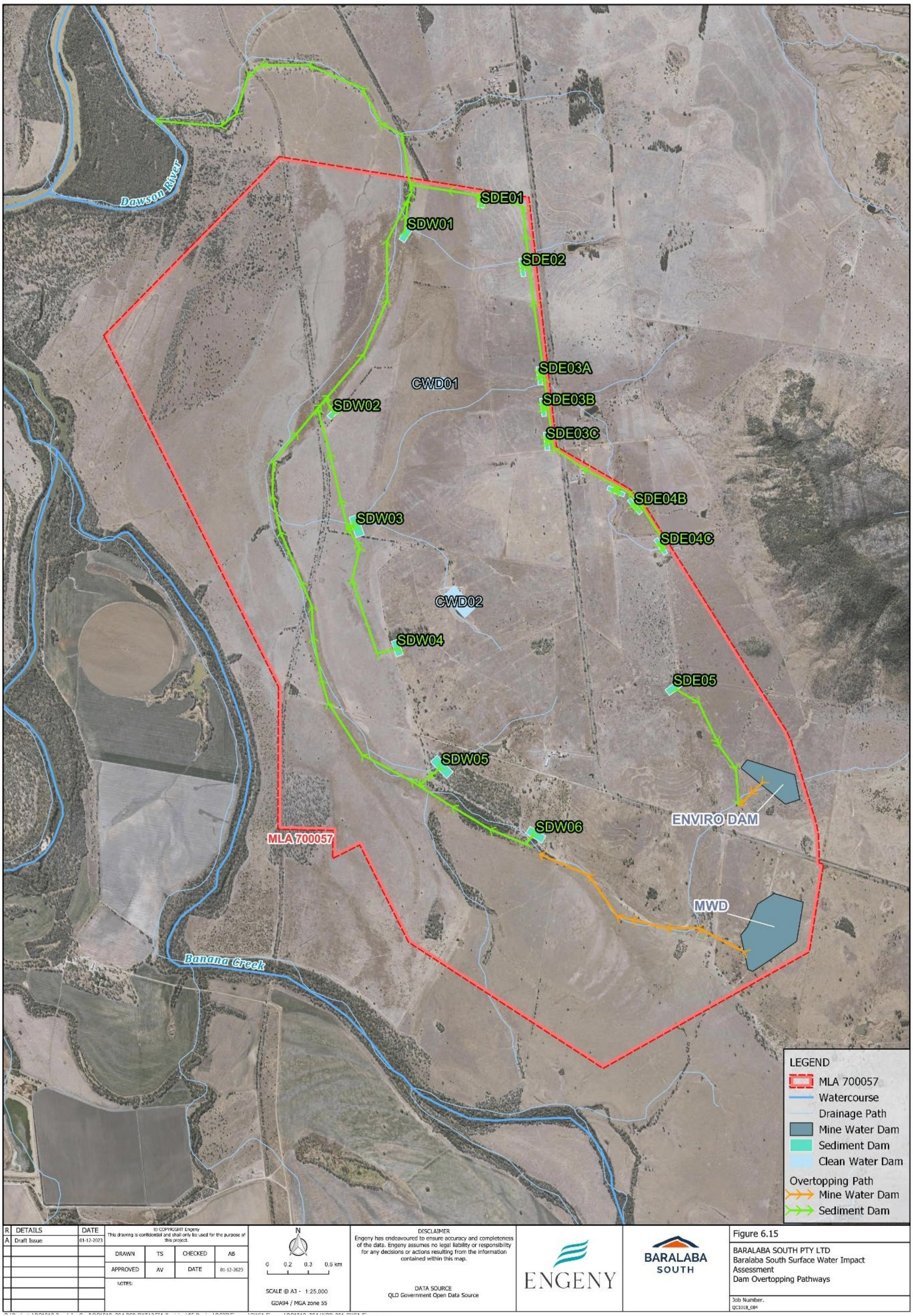

Figure 4.10: Overflow pathways for water management infrastructure

Sediment dams are proposed to capture runoff from disturbed areas including access roads, unrehabilitated waste rock and cleared land. Sediment dams for the Project are sized in accordance with the International Erosion Control Association Guidelines methodology for “Type D” sediment basins (IECA ,2018). “Type D” sediment basins were selected as the high maintenance requirements of “Type A” and “Type B” (flow through chemical flocculation basins) are not practical in a mining operation and “Type C” basins are not suitable for dispersive or clayey soil types. The “Type D” sediment basins are designed to operate on a 5-day cycle, that being filling from a storm event and then dewatering prior to the next storm event within a 5-day period. The basins are designed to contain a nominated 5-day storm rainfall depth based on the catchment conditions (soil types) and the receiving environment. High flows are directed through the basins which allows the basins to treat small to medium flow events at a very high efficiency while still allowing coarse sediments to settle out in high flow events.

The sediment basin’s total volume was sized to allow for a settling zone volume to contain a five-day, 85th percentile rainfall event and a sediment storage zone volume equal to 50% of the settling volume. The 85th percentile standard was adopted which is required for sediment basin with a design life greater than six months and discharging to sensitive receiving waters. Volumetric runoff coefficients adopted for the basin sizing were selected based on expected soil types encountered at the site (clay materials). The inputs used in the sizing of the sediment dams for the Project are summarised in Appendix A, Surface Water Impact Assessment.

The sediment dams have also been placed at regular frequencies which reduces the dam sizes and allows simpler access for desilting and maintenance activities (compared to a single consolidated storage). Placement of sediment dams was determined based on topographical low points. Sediment dams are generally required around the out of pit waste rock emplacement to treat sediment laden runoff before discharging off site.

Sediment dams will include pumping infrastructure for dewatering of the settling zone storage volume in a maximum 5-day period to allow their continued effectiveness and availability to treat sediment-affected runoff in successive storm events. The sediment dams will dewater to the mine water system to maximise re-use of runoff within the Project area for water demands and minimise the use of raw water. This is a conservative approach for assessing impacts to streamflow and provides additional water supply for processing and dust-suppression demands, hence reducing reliance on the water allocations.

The design of sediment dams is based on the expected geochemistry of waste material, however, ongoing monitoring of water quality during operations will be required to confirm contained runoff does not include other contaminants and as such require alternative management strategies.

A summary of sediment dam design is provided in Table 4.16. Embankment heights are preliminary and will be reviewed as part of the future detailed design for each dam. Overflow pathways for sediment dams are shown on Figure 4.10.

Table 4.16: Water management infrastructure—sediment dams

ID	Description	Catchment area (ha)	Full supply volume (ML)	Estimated embankment height (m)	Associated mine stages (Year)
Western Sedimentation Dam 1 (SDW01)	Manages sediment runoff generated from northwestern section of the northern waste rock emplacement.	92.4	26.3	~1	1 – 23
Western Sedimentation Dam 2 (SDW02)	Manages sediment runoff generated from western section of the northern waste rock emplacement.	32.8	9.3	~1	3 – 23
Western Sedimentation Dam 3 (SDW03)	Manages sediment runoff generated from western section of the waste rock emplacement.	100.4	28.6	~1	3 – 23
Western Sedimentation Dam 4 (SDW04)	Manages sediment runoff generated from south-western section of the waste rock emplacement.	51.6	14.7	~1	6 – 23
Western Sedimentation Dam 5 (SDW05)	Manages sediment runoff generated from south-western section of the waste rock emplacement.	98.2	27.9	~1	11 – 23
Western Sedimentation Dam 6 (SDW06)	Manages sediment runoff generated from southern section of the northern waste rock emplacement.	72.6	20.7	~1	23
Eastern Sedimentation Dam 1 (SDE01)	Manages sediment runoff generated from northern section of the northern waste rock emplacement.	10.0	2.8	~1	1 – 23
Eastern Sedimentation Dam 2 (SDE02)	Manages sediment runoff generated from north-eastern section of the northern waste rock emplacement.	33.7	9.6	~1	1 – 23
Eastern Sedimentation Dam 3A (SDE03A)	Manages sediment runoff generated from north-eastern section of the waste rock emplacement.	29.8	8.5	~1	3 – 23
Eastern Sedimentation Dam 3B (SDE03B)	Manages sediment runoff generated from north-eastern section of the waste rock emplacement.	34.0	9.7	~1	6 – 23
Eastern Sedimentation Dam 3C (SDE03C)	Manages sediment runoff generated from eastern section of the waste rock emplacement.	34.4	9.8	~1	6 – 23

ID	Description	Catchment area (ha)	Full supply volume (ML)	Estimated embankment height (m)	Associated mine stages (Year)
Eastern Sedimentation Dam 4A (SDE04A)	Manages sediment runoff generated from eastern section of the waste rock emplacement.	33.1	9.4	~1	6 – 23
Eastern Sedimentation Dam 4B (SDE04B)	Manages sediment runoff generated from eastern section of the waste rock emplacement.	32.9	9.4	~1	6 – 23
Eastern Sedimentation Dam 4C (SDE04C)	Manages sediment runoff generated from eastern section of the waste rock emplacement.	34.3	9.8	~1	11 – 23
Eastern Sedimentation Dam 5 (SDE05)	Manages sediment runoff generated from southern section of the waste rock emplacement.	55.8	15.9	~1	11 – 23
Year 1 Sedimentation Dam 1 (SDY01_01)	Manages sediment runoff generated from eastern section of the initial northern waste rock emplacement.	17.1	4.9	~1	1 – 3

4.3.3.3 Clean water management

Clean water dams will be utilised for the management of 'clean water', that is natural rainfall and runoff from undisturbed or established rehabilitation. Clean water is water that has not come into contact with disturbed land or active mining areas. Clean water dams have been designed to contain a nominal 2-year, 24-hour runoff volume. Pump rates have been proposed to enable 20-day dewatering.

Diversion of clean catchment has been maximised to reduce the harvesting of clean catchment into the mine water system. Where topography allows, clean catchment is diverted via drainage features which connect upstream clean catchment with the receiving waterways. Where a diversion drain is not feasible, clean catchment will be diverted using clean water dams equipped with pumped release to the Dawson River. Water quality of clean water dams is expected to meet water quality objectives allowing for release into the Dawson River.

There are two clean catchment diversions on the eastern side of the MLA which redirect runoff from Mount Ramsay around the Project. A third clean water drain involves the drainage diversion of a stream order 3 waterway (Tributary 8) around the proposed out of pit WRE to ensure the drainage path is not impacted by the Project.

A summary of clean water infrastructure is provided in Table 4.17. Clean water storages are proposed to be mostly excavated storages and will not have permanent water retaining embankments.

Table 4.17: Water management infrastructure—clean water infrastructure

ID	Description	Catchment area (ha)	Size	Associated mine stages
Northern clean water drain	Diverts clean catchment runoff east of MLA from mining activities, diverting it south into the Dawson River	470	4.3 km drainage channel	Year 1-23
Southern clean water drain	Diverts clean catchment runoff east of MLA from mining activities, diverting it south into Banana Creek.	586	3.7 km drainage channel	Year 1-23
Tributary 8 diversion drain	Minor realignment of Tributary 8 around the proposed waste rock emplacement toe and sediment collection drain at the northern extent of the MLA	3,180	0.39 km drainage channel	Year 1-23
Clean Water Dam 1 (CWD1)	Captures clean catchment runoff from south-of the northern waste rock emplacement.	181	88 ML	Year 1-3
Clean Water Dam 2 (CWD2)	Existing structure capturing clean catchment runoff from south of mining pit.	66	32 ML	Year 1-3

4.3.3.4 Water release/extraction infrastructure

A high-capacity pump and pipeline will be used to release water from the MWD to the Dawson River. The outlet pipe will extend over and beyond the bank of the Dawson River to minimise the risk of erosion. The position of the pipeline and release point have been located to minimise potential impacts to environmental values and are shown on Figure 4.11. The pipeline will be located within a 10 m corridor that will also be used for maintenance and access.

The pipeline will predominantly above ground to the Dawson River. Ground supports will be used to raise the pipeline above the natural surface level on the floodplain so that overland flow is not obstructed.

Water extraction infrastructure will include a pump and above ground poly pipe to extract and transfer water from the Dawson River to the MWD. The water supply pipeline is proposed to be located adjacent to the water release pipeline shown on Figure 4.11.

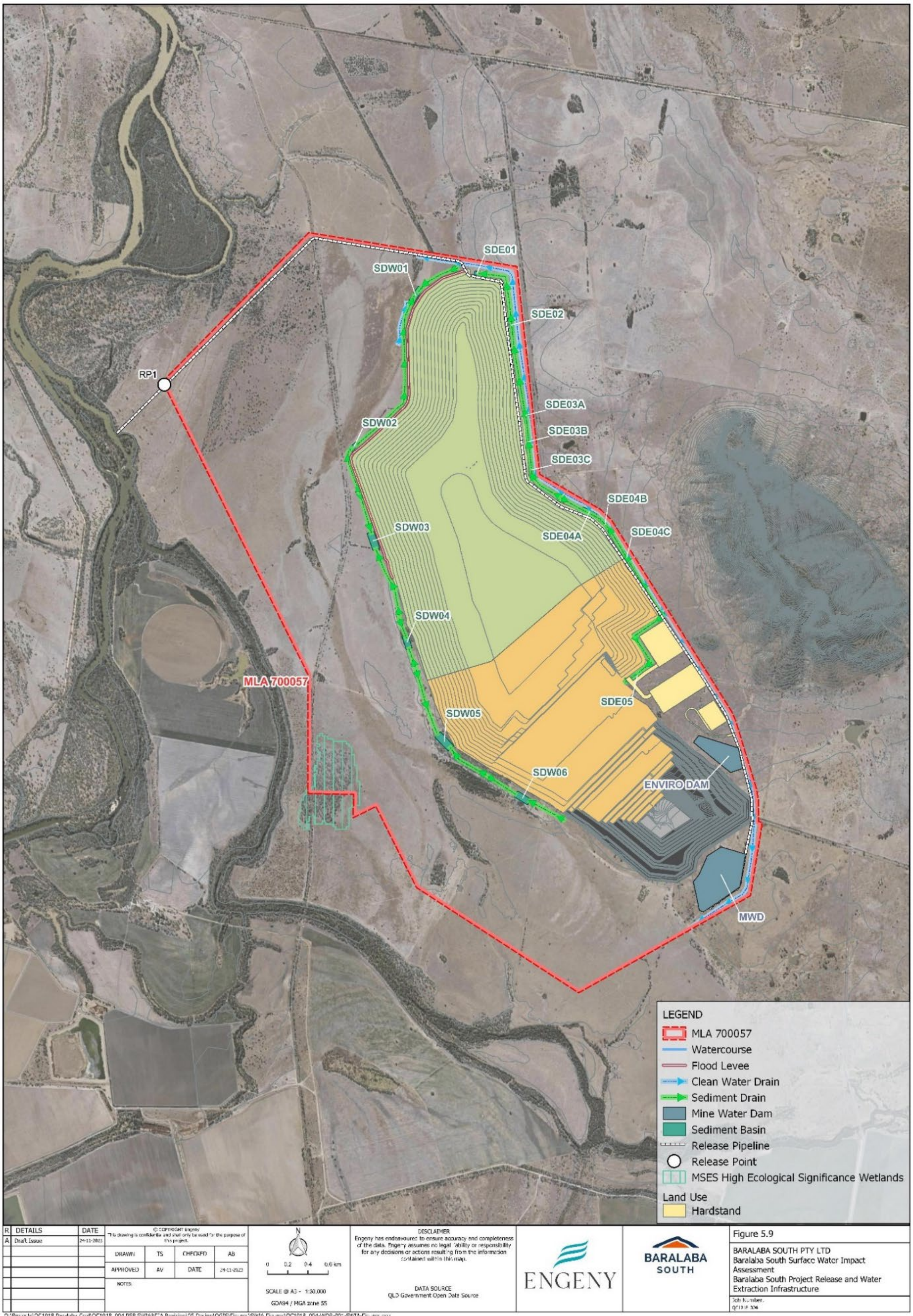

Figure 4.11: Proposed release and extraction pipeline

4.3.4 Surface water modelling

4.3.4.1 Operational water balance model

To assess surface water impacts, an operational water balance model was developed by Engeny Water Management (Appendix A, Surface Water Impact Assessment) using GoldSim modelling software. The model represents the proposed Project water management system and surrounding waterways and has been used to assess the performance of the following Water Management System elements:

- containment performance of key water storages;
- pit inundation frequency, volume and period;
- supply demands and shortfalls;
- external supply requirements;
- mine water releases; and
- changes to streamflow regime in surrounding waterways.

A schematic of the Water Management System is provided in Figure 4.12. The water balance model incorporates the transfer rates and destinations of the schematic. The Water Management System operation is outlined in Table 4.18.

The various model input parameters (e.g. climate inputs, catchment conditions, groundwater ingress and quality) are detailed below and in Appendix A (Surface Water Impact Assessment). The model was run with a daily timestep for a period of 23 years, representing the operational life of the mine. The model stepped through 111 realisations of 23-year sequences of the 111 years of available climate data for the mine site thereby providing a probabilistic simulation of Water Management System performance.

Table 4.18: Water management system operation of storages

Storage	Full Supply Volume (ML)	Maximum operating volume (ML)	Pump rate (L/S)	Pump destination	Years active
Pit	173,000 [1]		400	Mine Water Dam	1-23
MWD	1,220	1,000	500	Release	1-23
			150	Environmental Water Dam	
ENVIRO DAM	420	350	153	CHPP	1-23
SDW01	26.3	25	41	Mine Water Dam	1-23
SDW02	9.3	9	14	Mine Water Dam	3-23
SDW03	28.6	27	44	Mine Water Dam	3-23
SDW04	14.7	14	23	Mine Water Dam	6-23
SDW05	27.9	27	43	Mine Water Dam	11-23
SDW06	20.7	20	32	Mine Water Dam	23
SDE01	2.8	2.7	4	Mine Water Dam	1-23

Storage	Full Supply Volume (ML)	Maximum operating volume (ML)	Pump rate (L/S)	Pump destination	Years active
SDE02	9.6	9	15	Mine Water Dam	1-23
SDE03A	8.5	8	13	Mine Water Dam	3-23
SDE03B	9.7	9	15	Mine Water Dam	6-23
SDE03C	9.8	9	15	Mine Water Dam	6-23
SDE04A	9.4	9	15	Mine Water Dam	6-23
SDE04B	9.4	9	14	Mine Water Dam	6-23
SDE04C	9.8	9	15	Mine Water Dam	6-23
SDE05	15.9	15	25	Mine Water Dam	11-23
SDY01_01	4.9	4.6	8	Mine Water Dam	1-3
CWD1	88	84	193	Dawson River	1-3
CWD2	32	31	71	Dawson River	1-3

[1] Pit storage volume varies
[2] Sediment Dam volume includes sediment storage volume and settling zone volume.

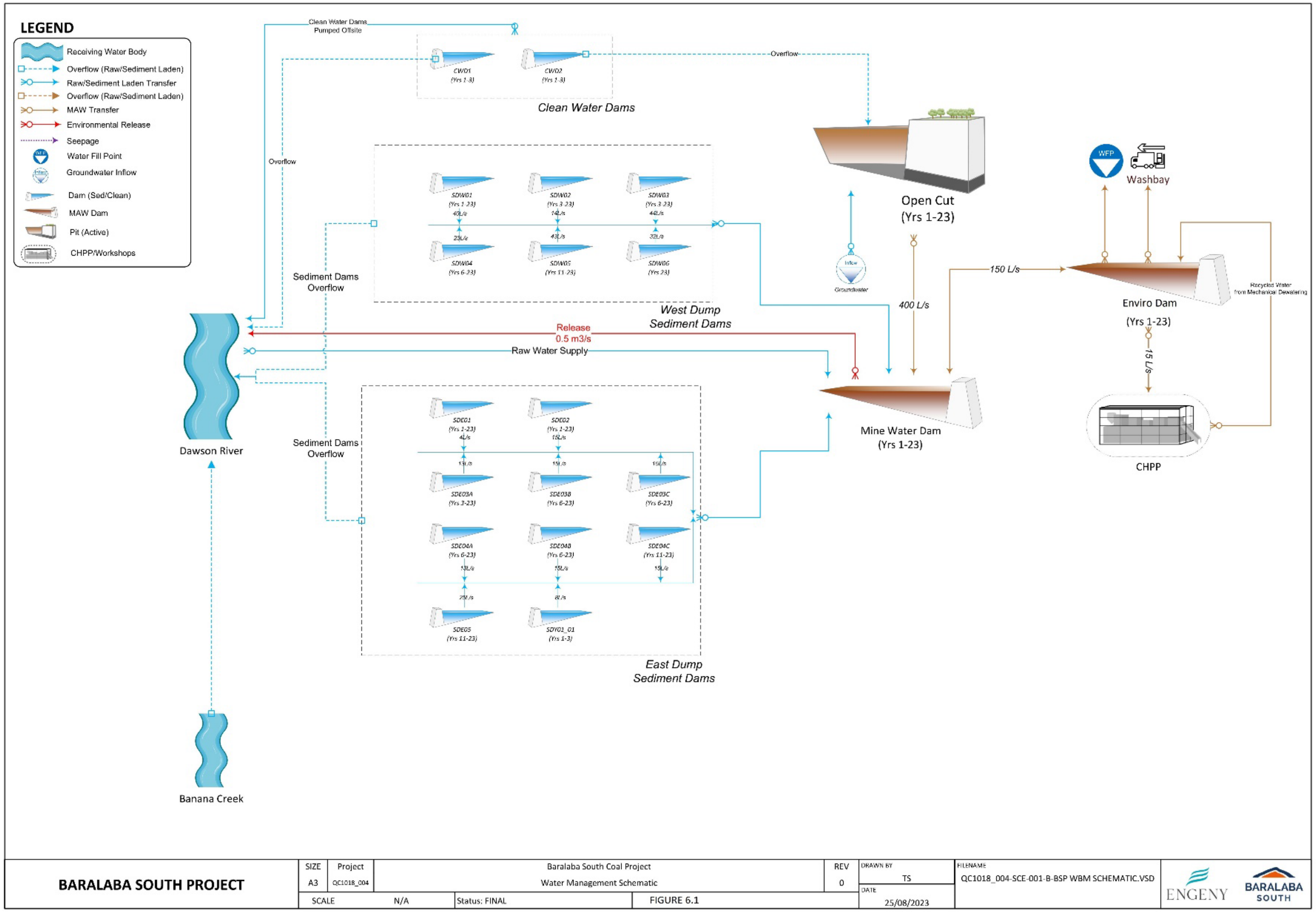

Figure 4.12: Water management schematic

Climate inputs

Climate data inputs to the water balance model of rainfall and evaporation were sourced from both BOM rainfall stations and Silo Data Drill. A 129-year data set was used to allow continuous simulation of scenarios. Monthly average rainfall, lake evaporation and evapotranspiration for the Project are summarised in Table 4.19.

Table 4.19: Monthly average climate data

Month	Rainfall (mm)	Lake evaporation (mm)	Evapotranspiration (mm)
January	103	204	200
February	108	171	168
March	75	168	166
April	41	131	130
May	36	98	98
June	37	76	76
July	29	85	85
August	22	113	112
September	27	146	144
October	52	184	180
November	71	197	192
December	99	212	207
Total	**700**	**1,785**	**1,758**

Catchment Runoff

The GoldSim model uses the Australian Water Balance Model to simulate catchment runoff for the Project. The Australian Water Balance Model uses three surface stores to simulate partial areas of runoff within the catchment. The water balance of each surface store is calculated independently of each other at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. The model has a base flow component where part of this runoff becomes recharge of the base flow store (if there is a base flow component to the stream flow).

The adopted Australian Water Balance Model parameters were sourced from the Baralaba Central Mine water balance model calibrated in 2013 and have been continually validated as part of the Baralaba North Mine water management plan annual updates.

The Project water balance model includes a contaminant transport model to simulate water quality (salinity) within site storages. Salinity generation rates for the assigned land use types were adopted from modelling of the Baralaba North Mine (WRM, 2013). These rates were validated based on recorded water quality in existing storages at the Baralaba North Mine. The adopted salinity for the WRE land use is higher than the expected salinity of 338 mg/L determined from geochemical analysis of potential waste rock materials, which provides a conservative approach to estimating mine water storage salinity and impacts from releases. A salinity of 3 mg/L has been adopted for direct rainfall to storages (DERM, 1997). A varying streamflow and electrical conductivity relationship have been developed for the Dawson River for the purpose of estimating release opportunity.

Catchments

Catchment boundaries were defined for all storages across the life of mine using mine and WRE planning GIS layers and the results from the LiDAR survey of existing topography undertaken on the 25 March 2011. Assumptions to the modelling of catchment areas include:

- Waste rock emplacements are rehabilitated within three years of being completed.
- Rehabilitation has a five-year establishment period.
- Rehabilitated catchments will require erosion and sediment control until rehabilitation is established.

A summary of adopted catchment areas and land use for each modelled stage is provided in Appendix A, Surface Water Impact Assessment.

Groundwater

Groundwater ingress to the open cut pit was modelled and provided as an input to the water balance model (Appendix B, Groundwater Modelling and Assessment). Groundwater ingress is variable based on the location and geometry of the pit and was input into the water balance model as a time series (to align with the mine plan). The groundwater ingress rates provided by Watershed HydroGeo and were reduced by 10% to account for evaporation losses of the pit walls. The average pumpable groundwater ingress for the operational period of the mine plan is 0.37 ML/day (0.41ML/day total ingress).

The total groundwater ingress is attributed to several sources including:

- waste rock seepage (20%);
- weathered and interburden (45%);
- coal measures (28%); and
- alluvium (colluvium) (8%).

Groundwater inflow EC was informed from the true groundwater inflows from alluvium, coal measures, weathered and interburden reported in Appendix B, Groundwater Modelling and Assessment and the results from the geochemical assessment of waste rock (Appendix E, Geochemical Assessment). The following water quality parameters were adopted for the water balance model:

- average of 16,750 mg/L TDS for groundwater inflow from the alluvium, coal measures and weathered and interburden inflows; and
- average of 338 mg/L TDS for inflow from waste rock seepage.

Dawson River Flow

The Dawson River streamflow used to assess mine water release opportunity and impact has been adopted from the Dawson Callide Sub-catchment Integrated Quantity and Quality Model (IQQM) developed for the Water Plan (Fitzroy Basin) 2011. The streamflow series from the Dawson River IQQM was available at the Dawson River at Beckers (130322A) gauging station location for the period 1889 to 2007. The streamflow series was extended to 2019 using data from the streamflow gauging station to match the adopted climate data period.

Dawson River water quality

A varying flow and Electrical Conductivity (EC) relationship for the Dawson River was used to model mine water release opportunity and impacts in accordance with the proposed mine water release conditions. The flow EC relationship was developed by fitting an average relationship to the continuous monitoring data from the Dawson River at Beckers gauging station (130322A).

Mine water releases

To prevent the accumulation of mine water on site and minimise the risk of uncontrolled mine water releases to the receiving environment, mine water is proposed to be released at appropriate conditions and rates. The model uses IQQM streamflow data for the Dawson River and water quality streamflow relationships developed from the Becker's Streamflow gauge to determine the release opportunity and potential release volume. The predicted model water quality for the release dam is used to assess the release potential.

Streamflow assessment

The approved IQQM developed hydrology model for the Water Plan (Fitzroy Basin) 2011 was updated to include:

- The Project's catchment reduction of 966 ha (0.024% of catchment reporting to Beckers gauging station).
- Groundwater drawdown reduction to Dawson River baseflow of 0.1 ML/day (<0.01% of flow).

The IQQM model was then used to assess reduction in Dawson River streamflow volumes and flow duration at the Project location and at the Beckers gauging station as well as compliance against the EFOs and Water Allocation Security Objectives in the Water Plan (Fitzroy Basin) 2011. The IQQM includes the proposed Nathan Dam project, and all assessments therefore represent cumulative impacts including this project.

Final void assessment

The mine planning progression for the Project will result in the southeastern mining pit remaining as a residual void. The final void model hydrology was modified from the water balance model to address final void inflows (catchment runoff, direct rainfall and groundwater inflows) and final void outflows (evaporation) described as follows:

- Catchment runoff inflows to the final void waterbody are estimated from 103 ha of rehabilitation land use and 118 ha of final void land use areas, based on the associated Australian Water Balance Model parameters. Adopted TDS generation rate for rehabilitation and final void catchment runoff is 230 mg/L and 1,000 mg/L, respectively.
- Direct rainfall on the final void surface area is calculated from daily rainfall applied to the surface area of the final void which is dynamically calculated each daily timestep using the stage storage relationship described in section 4.3.4.1.
- Groundwater inflows calculated based on the final void level groundwater inflow relationship described in section 4.3.4.1.
- Evaporation from the final void waterbody surface area is calculated from daily Moreton's Lake Evaporation time series extracted from the SILO Data Drill at the Project location. An evaporation reduction factor of 20% was applied to account for shading and reduced windspeed of the lake surface area from the pit walls.

The Project final void arrangement is shown on Figure 4.13.

Improved catchment inflow measures

The diversion of clean catchment into the final void will dilute groundwater inflows and slow the evapo-concentration process of the final void and is proposed as an option to improve the water quality of the final void. The proposed measures include:

- Redirect an additional 200 ha of rehabilitation to the pit lake to increase clean runoff volumes; and
- Modification of surface drainage on the final landform in-pit WRE to increase rainfall infiltration and seepage through the backfilled waste rock to the pit lake.

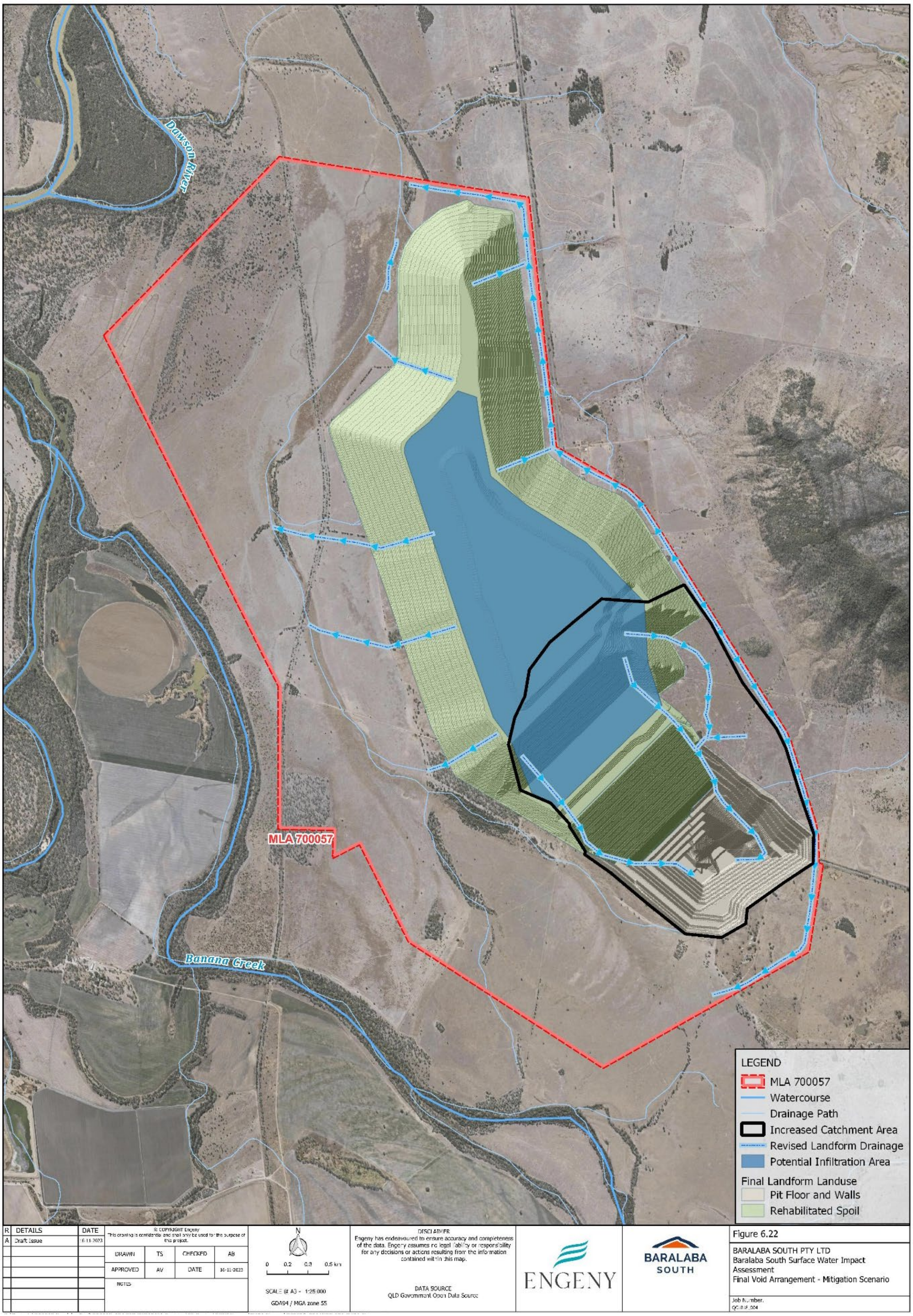

Figure 4.13: Final void arrangement

Groundwater inflow

A groundwater recovery curve for the final void waterbody was developed by Watershed Hydrogeo using the regional groundwater model (Appendix B, Groundwater Modelling and Assessment). Groundwater inflow to the final void consists of flows from the remaining coal measures, weathered and interburden material, alluvium, and waste rock seepage from the backfilled pit.

Figure 4.15 shows the relationship between final void water level and groundwater inflow for the final void as well as the contribution breakdown of the multiple inflow sources. The groundwater recovery to the final void steadily decreases as the pit lake rises in level. The groundwater inflow relationship breakdown shows that at lower lake elevations (below -150 mAHD), waste rock seepage makes up less than 20% of the groundwater inflow, however at higher lake elevations (above -25 mAHD) waste rock seepage makes up over 70%, and the remainder is sourced from true groundwater

An average TDS concentration of 16,750 mg/L has been adopted for the alluvium, coal measures and weathered and interburden inflows and a TDS concentration of 338 mg/L for the waste rock seepage inflows.

A summary of the groundwater recovery inflows for varying final void water levels, percentage inflow contribution and TDS adopted for the final void hydrology model is presented in Table 6.11 of Appendix A, Surface Water Impact Assessment.

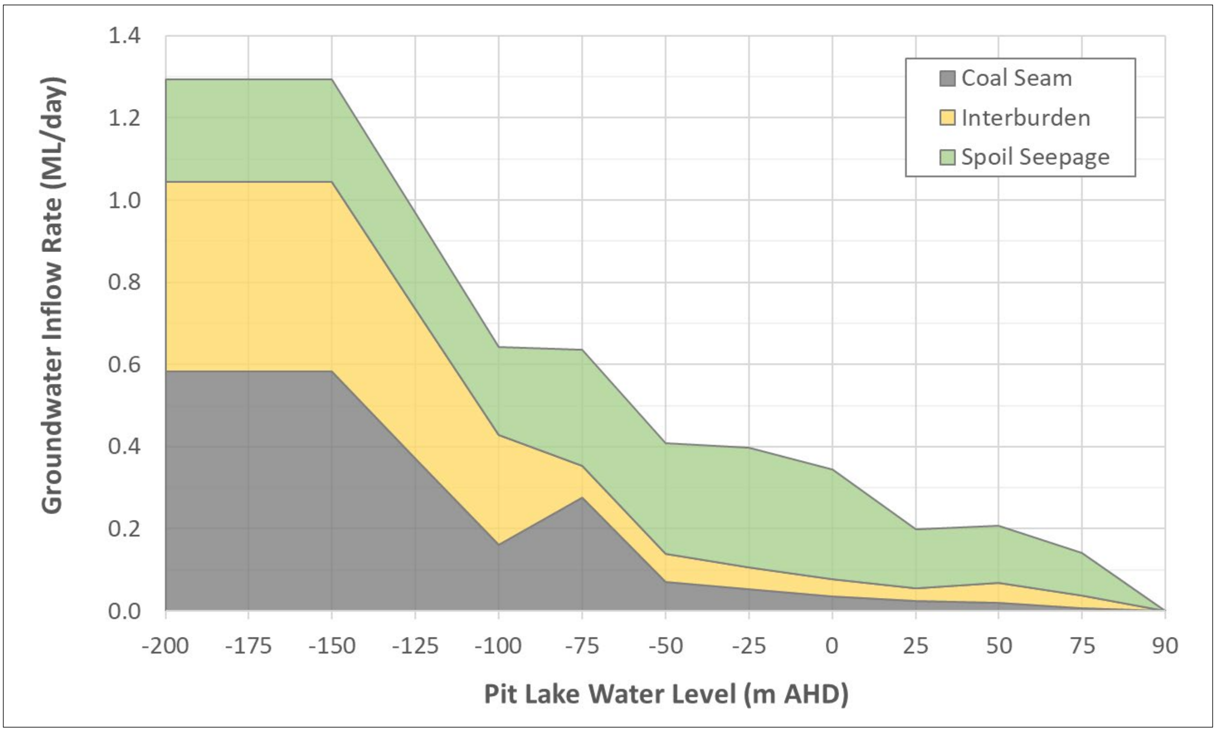

Figure 4.14: Final void groundwater recovery relationship

Climate change sensitivity assessment

A climate change sensitivity assessment was undertaken to determine the impact of climate change on the predicted impacts. The model climate data inputs were adjusted using the methodologies outlined in 'Climate Change in Australia Technical Report' (CSIRO, 2015) to undertake the sensitivity assessment. Climate projections for 'Best' and 'Worst' case scenarios and 'Maximum Consensus' were used to assess climate change scenarios on the water balance model and final void outcomes, where:

- **Best Case scenario** has lower rainfall and higher evaporation, reducing rainfall runoff resulting in reduced spills from storages and reduced mine water release.
- **Worst Case scenario** has higher rainfall and lower evaporation, increasing rainfall runoff resulting in increased spills from storages and increased mine water releases.
- **Maximum Consensus** is the climate future projected by at least 33% of climate models and comprises at least 10% more models than any other scenario and is considered the most representative forecast of all the climate models.

4.3.4.2 Water management system performance

The average annual water balance provides an indication of the interaction between the mine plan and the water demands and supply. The key outcomes from the average annual water balance include the following:

- Rainfall and runoff are highest during years 11-19 when the total site catchment is at its largest.
- Runoff and groundwater account for on average 60% and 13%, respectively, of total water inflows to the system.
- Mine water releases slightly increase during the later years of the mine life due to lower water demands and increased groundwater inflows.
- Raw water extraction between mine years 1 to 19 account for on average 31% of the total water inflows to the system.

- The external raw water supply requirement to meet water demands in 95% of years is typically 600 to 700 ML/year with a peak requirement of 881 ML in Year 3.
- The maximum annual make-up water volume predicted during the mine life under median rainfall conditions is 600 ML in Year 3.
- Median annual raw water supply volumes are significantly smaller than the maximum requirement (typically less than 300 ML/year after Year 7)
- Dust suppression demand is the largest outflow from the system, accounting for on average 41% of total outflows.
- Dust suppression remains constant until year 14, reaching its peak in year 6.
- Lower CHPP demands are observed in year 1 and year 23. The mine years in between remain constant over the Project duration.
- Mine water releases account for on average 14% of the total water outflows from the system.

The Project average annual water balance (inflows and outflows) for the modelled mine plan stages have been summarised in Table 4.20.

Table 4.20: Average annual water balance (ML/year)

Inflow / Outflow	Year 1	Year 3	Year 6	Year 11	Year 14	Year 19	Year 23
Rainfall	66	59	82	95	112	104	131
Rainfall runoff to mine water and sediment dams	306	359	598	706	750	689	575
Groundwater inflow to mining pit	105	53	174	112	161	102	246
Clean Water Dam Overflow to Mine Water System	8	1	0	0	0	0	0
Raw Water Intake	312	559	388	282	203	247	4
Total Inflows	**797**	**1,031**	**1,243**	**1,195**	**1,226**	**1,143**	**955**
Evaporation	153	138	181	203	229	210	282
Dust Suppression	572	567	607	496	434	378	100
CHPP Water Use	186	315	347	338	336	324	118
Mine affected water release (via release structure)	20	15	60	98	135	90	122
Sediment Dam Overflow	2	2	30	77	96	118	129
Total Outflows	**933**	**1,037**	**1,225**	**1,213**	**1,231**	**1,119**	**751**
Change	**-136**	**-6**	**17**	**-18**	**-4**	**24**	**205**

4.3.4.3 Water demand

Site water demands have been calculated for the processing of coal, dust suppression, potable water and sewage treatment and have been incorporated into the operational water balance model. Annual water demands are provided in detail in section 5.4 of Appendix A, Surface Water Impact Assessment and are summarised as follows:

- The CHPP will require a reliable supply of water ranging between 107 ML/yr (year 23) to 381 ML/yr (year 8).
- Dust suppression is required on all trafficked, unsealed roads in the absence of adequate rainfall. Dust suppression demands for trafficked, unsealed roads for the Project are estimated between 111 ML/yr (years 23) to 669 ML/yr (year 6).
- Other water demands anticipated for the Project include: potable water (70 kL/week), water for wash downs 30 kL/day.

Annual CHPP and dust suppression water demands have been summarised in Table 4.21.

Table 4.21: CHPP and dust suppression water demands by year

Year	CHPP water demands (ML/year)	Dust suppression - haul road (ML/year)
1	175	629
2	313	503
3	304	625
4	306	667
5	325	667
6	336	669
7	350	415
8	381	397
9	376	494
10	351	518
11	327	547
12	340	367
13	340	375
14	325	479
15	362	560
16	368	578
17	363	429
18	317	523
19	313	417
20	294	478
21	313	544
22	198	224
23	107	111

4.3.4.4 Water supply

Water demands for the Project will be supplied according to the following priority (excluding potable water supplies):

1) Mine water supplied from pit dewatering (including groundwater inflows).
2) Recycled process water recovered from the CHPP tailings thickener and belt press filters.
3) Surface runoff water captured and stored within the Project water dams.
4) Water supply 'make-up' sourced from water allocations from the Dawson Valley Water Supply Scheme. Related entities of the proponent currently hold over 1,418 ML of water allocation from the Fitzroy Basin, Dawson River Zones C/D and 315ML of water licences from the Broadmeadow properties.

Mine affected water will be captured within the Water Management System and pumped to key water supply dams on site which will then be preferentially utilised for dust suppression and process demands. Captured water will be used in preference to any external allocation.

External supply of water to the mine is expected where demand of the net site water balance exceeds inputs from rainfall runoff and groundwater. Medium reliability water allocations within the Dawson Valley Water Supply Scheme have a monthly supplemented water sharing index of at least 82%. Water allocations can be assumed to be fully supplied in 82% of months (Water Plan (Fitzroy Basin) 2011). The Project accessing this allocation will not impact other existing licence holders as water allocations are existing entitlements (i.e. no new water entitlements are being sought for the Project).

4.3.4.5 Controlled release

Controlled releases of mine affected water will be used in the Water Management System to manage stored site inventories. Mine affected water releases from the Project are pumped releases from storages used to contain water which has come into contact with mining or processing activities (MWD or Enviro Dam).

Mine affected water release opportunities have been assessed in accordance with the 'Model Mining Conditions' (DES, 2017a) and the 'Model Water Conditions for Coal Mines in the Fitzroy Basin' (DES, 2013) (Appendix A, Surface Water Impact Assessment). The proposed mine water release conditions dictate natural flow conditions when releases can occur and the allowable maximum release rates and water quality. The release conditions have been designed to ensure release flows are significantly diluted with natural flows in the Dawson River to ensure downstream water quality will not exceed the receiving waterway water quality limits. The proposed release conditions are governed by Electrical Conductivity as salinity (measured as electrical conductivity) is the key of-concern surface water quality parameter associated with the Project.

The proposed release opportunities are governed by the following conditions:

- High flow conditions in the Dawson River—high flow conditions River (measured at the confluence of Dawson River and Banana Creek) occurs when discharge is greater than 100 m^3/s.
- Maximum allowable release rate—maximum release rate of 0.5 m^3/s to provide a minimum 1:200 dilution with natural flows (for a natural flow condition in the Dawson River of 100 m^3/s).
- End of pipe water quality is lower than the defined end of pipe limit—the end of pipe limit is defined as 10,000 µS/cm.
- Electrical conductivity at the downstream monitoring locations is maintained at lower than 500 µS/cm and between pH 6.5 and pH 9.0.

Mine water release can occur at a maximum rate of 0.5 m^3/s when flow in the Dawson River is above the minimum flow threshold of 100 m^3/s and the release storage water quality characteristics are less than the end of pipe limits of 10,000 µS/cm. The proposed end of pipe release limit of 10,000 µS/cm has been selected based on the upper end of the end of pipe EC range recommended in the Model Mining Conditions (3,500 µS/cm to 10,000 µS/cm) for high flow stream conditions (DES, 2017). The upper EC limit of 10,000 µS/cm has been selected to provide a conservative estimate of the Project's potential impacts on Dawson River water quality for this surface water impact assessment. A range of EC and release rate values for the low, medium, and high flow conditions will be determined for the Project's site Environment Authority at a future date in accordance with the Model Mining Conditions (DES, 2017).

The receiving waterway release limits have been developed with consideration of the Baralaba North Mine Environmental Authority, the water quality objectives for the receiving waters and historical Dawson River water quality. The mine water release strategy is summarised Table 4.22, Table 4.23 and Table 4.24. The release point will be the release pipeline, where it intersects the MLA boundary, presented in Figure 4.11. Details of the expected volume, duration and impact of controlled water releases is discussed in section 4.4.1.

Table 4.22: End-of-pipe mine affected water release limits

Quality characteristic	End-of-pipe release limits	Monitoring frequency
Electrical Conductivity (µS/cm)	10,000 µS/cm	Daily during release (the first sample must be taken within two hours of commencement of release)
pH (pH units)	6.5 (min)–9.0 (max)	

Table 4.23: Release point conditions

Receiving water description	Release point	Gauging station	Easting (GDA94)	Northing (GDA94)	Minimum flow in receiving water way for release event	Maximum release rate	Flow recording frequency
Dawson River	RP1	Dawson River at Banana Creek Confluence	149.822	–24.0873	100	0.5	Daily

Table 4.24: Receiving waterway release limits

Quality characteristic	Release limits	Monitoring frequency
Electrical Conductivity (µS/cm)	500 µS/cm	Daily during release (the first sample must be taken within two hours of commencement of release)
pH (pH units)	6.5 (min)–9.0 (max)	

4.4 Potential impacts

The potential impacts of the Project on surface water have been assessed by:

- Engeny Water Management (2021a), as outlined in the Surface Water Impact Assessment (Appendix A);
- Engeny Water Management (2021b), as outlined in the Flood Impact Assessment (Appendix C); and
- Terrenus Earth Sciences (2019), as outlined in the Geochemical Assessment (Appendix E).

The Surface Water Impact Assessment has been peer reviewed by the suitably qualified and experienced expert, Greg Roads (WRM Water and Environment). The peer review letter is provided as Attachment 6.

Potential impacts of the Project on surface water include:

- impacts on stream flow in the Dawson River and Banana Creek due to loss of catchment areas consequent to capture of runoff within on-site storages and the open cut pit;
- impacts to stream flows in minor watercourses within the Project MLA boundary;
- impacts on stream flows in the Dawson River and Banana Creek as a result of groundwater drawdown to the pit void;
- impacts on environmental values in the Dawson River and Banana Creek due to controlled and uncontrolled releases of mine-affected water and from sediment dam release;
- impacts on the flooding regime of the Dawson River, Banana Creek, and associated tributaries;
- impacts on regional water availability, given the potential requirement to obtain water from external sources to meet Project construction and operational water requirements;
- impacts on the water quality of the receiving environment;
- impacts on the adjacent HES wetland due to reduction in catchment or land disturbance; and
- impact to regional environmental values due to the cumulative impact of regional projects.

4.4.1 Controlled mine water release impacts

Controlled releases from site will only occur where the storage capacity of the site Water Management System is exceeded—and then only in accordance with Fitzroy model release conditions of the EA. Mine affected water releases from the Project are defined as pumped releases through a release point from storages used to contain water which has come into contact with mining or processing activities. These storages may contain water with elevated contaminant levels. Release from mine affected water storages are proposed to coincide with medium to high flow events in the Dawson River.

Controlled mine water releases were modelled in accordance with the mine water release strategy. Mine water releases occur from Mine Water Dam at a maximum rate of 43.2 ML/day (500 L/s pumping system) with a release efficiency factor of 90%.

Releases only occur when the modelled flow in the Dawson River is greater than 100 m^3/s in accordance with the release conditions. Therefore, all release events coincide with medium-high streamflow conditions in the Dawson River. The Dawson River flows above 100 m^3/s for approximately 5% of the time or 18 days per year on average.

End of pipe water quality is defined as the quality of the water being released at the point of discharge into the Dawson River. The maximum release rate and end of pipe limits provide a minimum 1:200 dilution ratio which ensures the water quality characteristics at the downstream monitoring point do not exceed the receiving waterway release limits.

Estimated annual release volumes over the project duration for a range of probabilities are summarised in Figure 4.15. The results illustrate that releases typically occur in less than 25% of years. In a prolonged wet climate conditions (95th percentile), the annual release volume varies from 100 ML to 850 ML.

Figure 4.15: Annual controlled release volumes

Figure 4.16 shows an exceedance plot of annualised release event frequency and Figure 4.17 shows an exceedance plot of release event duration for all release events simulated in the model. These plots show that:

- There are no controlled releases events in 75% of years.
- The project is expected to have at least 1 controlled release event in less than 25% of years and at least 2 release events in 5% of years.
- The duration of controlled release events is expected to range from 1 to 20 days (5th percentile and 95th percentile) with the median controlled release event duration being 5 days.

Controlled releases would occur over a time period consistent with the existing duration of medium-high flows in the Dawson River and would not impact the duration of flow events.

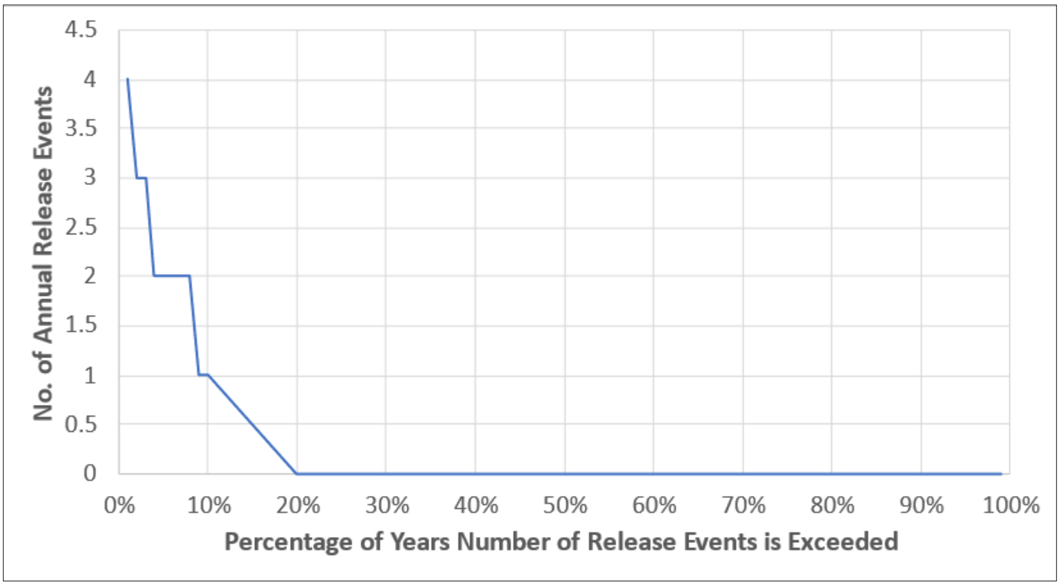

Figure 4.16: Number of release events per year

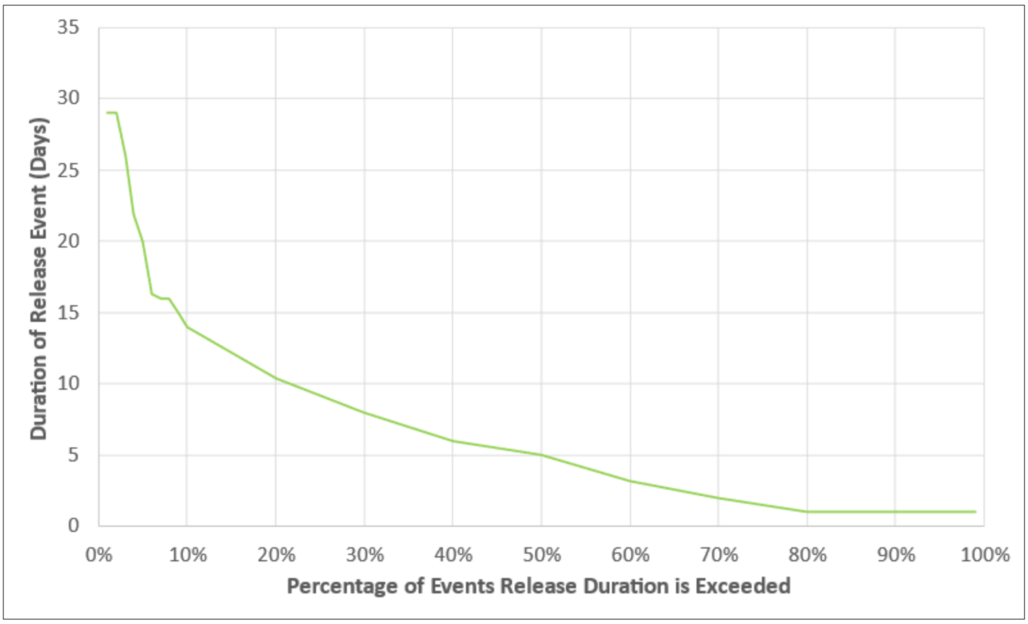

Figure 4.17: Duration of release events per year

4.4.1.1 Release Mixing Zone

The mixing zone is defined as the area downstream of the release location where release waters mix rapidly with the receiving waters due to momentum, buoyancy and turbulence of the surface water (DES, 2016). Within the initial mixing zone, dilution of release waters takes place and water quality objectives may not be met. Controlled releases from the Project will be discharged directly to the Dawson River main channel from MWD1 via a pipeline. Controlled releases will mix directly with Dawson River flows which provide the required dilution to achieve the receiving water quality release limits. As described previously, the controlled release strategy has been developed so the release rate does not exceed 0.5% of the Dawson River streamflow, providing a minimum 1:200 dilution.

Small areas of elevated EC concentrations are expected in the localised vicinity of the controlled release discharge location, however the average salinity in the river immediately downstream of the discharge location will remain below the receiving waterway water quality limit of 500 µS/cm. This is due to the high dilution rate from the proposed release conditions and mixing of the release waters from high velocity and turbulence at the discharge point location as well as mixing with the natural turbulence of flow in the river.

4.4.2 Mine water dam overflow

The site water balance model was also used to determine the overflow frequency of the proposed mine water dams. Mine Water Dam and Enviro Dam both had no overflows during any of the model simulations, demonstrating a greater than 99th percentile annual containment performance standard.

In an overflow event Environment Dam and Mine Water Dam would overtop to clean water tributaries of the Dawson River. These dams have been designed to contain greater than the 95th percentile wet season inflow (overflow in less than 5% of years). The water balance assessment identifies no uncontrolled overflows from the mine water system in any simulated scenarios, which demonstrates the mine water system exceeds the design containment standard.

The design containment standard for the mine water dams, and the water balance modelling results, ensure that there would be minimal actual or potential uncontrolled discharge of contaminants to waters that may or have the potential to cause an adverse effect on identified environmental values.

4.4.3 Sediment dam overflows

Sediment dams have been designed in accordance with the International Erosion Control Association Guidelines methodology for “Type D” sediment basins. Design selection was based on the soil types and for protection of sensitive receiving waters. It is proposed to continually dewater the sediment dams to the mine water system to improve containment above what is required. The catchments reporting to the sediment dams are progressively rehabilitated over the Project life which reduces sediment runoff generation which further improves the performance of the sediment dams.

The operational water balance model indicates that sediment dams overtop in approximately 30% of years, which is higher than the containment standard adopted for the 85^{th} percentile, five-day rainfall event. The annual overflow frequency of each sediment dams and the year which this occurs is provided in Appendix A, Surface Water Impacts.

The sediment dams have been designed to provide sufficient storage for settlement of suspended solids so that water quality during overtopping events has negligible impact on the water quality in the receiving waterway. During overtopping events, coarse sediments will continue to settle out as flow attenuates through the dam reservoirs. Sediment dams will be designed such that overtopping velocities are managed so they do not cause scour on the overtopping flow paths (as shown in Figure 4.10). Spillway control structures may include a combination of rock chutes, rock aprons and level spreaders.

Monitoring of overtopping events will be undertaken to assess the performance of the sediment dams and ensure downstream environmental values are maintained and validate the design assumptions. Overtopping flows from sediment dams are not expected to have impacts on water quality affecting vegetation within the overflow pathways between the Project MLA and the Dawson River. Settlement dams will also include overflow control structures with scour protection (rock chutes, rock aprons and/or level spreaders) to ensure non-erosive discharges.

4.4.4 Clean water releases

Clean water releases from the Project are defined as release from storages capturing only clean catchment runoff. These storages contain water which exhibits the same water quality characteristics as the receiving environment and does not come into contact with areas disturbed by mining activities. The release of clean water from site will not impact water quality or environmental values in the receiving waterways. Clean water release is required where a gravity diversion drain is not possible, to maximise separation of clean and mine affected waters.

4.4.5 Flooding

The Project has the potential to impact the behaviour of the adjacent Dawson River floodplain due to the construction of mine infrastructure. The potential flood impacts of the Project are addressed in detail in Chapter 6, Flooding and Regulated Dams.

4.4.6 Stream flow impacts

4.4.6.1 Groundwater baseflow/leakage

The drawdown effects on the baseflow/leakage at the watercourses and drainage features defined near the Project have been assessed in Appendix B, Groundwater Modelling and Assessment, and the analysis presented in Chapter 5, Groundwater which includes a comparative analysis of the predicted groundwater–surface water interactions both with and without the Project.

While the predicted groundwater drawdown in the Permian strata as a result of the Project would be limited in the shallow groundwater systems, it would incidentally transfer directly to some, albeit immeasurable, leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology by up to approximately 0.2 ML/day, although more likely 0.16 ML/d, which when compared to the average surface water flows in the Dawson River for the past 5 years) is a 0.01% reduction in flow. Similarly, the modelled leakage predicted from Banana Creek is considered negligible, as it only flows on occasions following rainfall events.

4.4.6.2 Catchment reduction

Potential sources of impact on streamflow in the Dawson River from the Project include:

- Decreased flow due to capture of rainfall runoff within the project disturbance area; and
- Reduction in flow as a result of predicted groundwater drawdown from the Dawson River (Watershed HydroGeo, 2023).

Impacts to the Dawson River streamflow are assessed using the Dawson River Integrated Quality and Quantity Model (IQQM) that was developed by the State Government to inform water resource planning aspects of the Water Plan (Fitzroy Basin) 2011.

The model results show the Project is expected to have only minor reductions to the Dawson River streamflow volume and duration. The Project is expected to have a reduction in streamflow less than 0.045% (mean annual flow) at the Project location which is not expected to impact the existing Dawson River riparian vegetation or channel morphology. Modelled changes to Dawson River stream flows at the Dawson River at Beckers gauging station are summarised in Table 4.25.

Table 4.25: Dawson River streamflow impact summary (Beckers Gauging Station)

Flow condition	Event basis	Stream flow characteristics before Project	Stream flow characteristics after Project	Change (%)
Base flows	Percentage of time Base flow is exceeded (86ML/day)	30.5%	30.3%	-0.66
Medium Flows	Annual mean	693,050 ML/year	692,769 ML/year	-0.04
	Median ratio of annual flows	52.4%	52.0%	-0.76
High Flows	2-year ARI peak	26,002 ML/day	25,968 ML/day	-0.13
	5-year ARI peak	100,026 ML/day	99,956 ML/day	-0.07
	20-year ARI peak	209,777 ML/day	209,628 ML/day	-0.07
	4 percentile flow	7,669 ML/day	7,664 ML/day	-0.07
	10 percentile flow	1,524 ML/day	1,520 ML/day	-0.26

In summary:

- The Project will result in only minor reductions in the Dawson River mean annual streamflow volume (0.08% at the Project location and 0.04% at the Dawson River at Beckers gauging station.
- The Project will have only minor impacts to flow duration with negligible impacts to the Dawson River low, medium and high flow regimes.
- The Project achieves all Environmental Flow Objectives specified in the Water Plan (Fitzroy Basin) 2011.
- The Project has negligible impact on existing water licences and allocations from the Dawson River and achieves the Water Allocation Security Objectives in the Water Plan (Fitzroy Basin).

The minor reduction in streamflow as a result of the Project is not predicted to impact the existing Dawson River riparian vegetation or channel morphology.

There are also number of small, unnamed tributaries which flow through the MLA. The catchments of waterways flowing through the MLA are expected to be reduced by the open cut pit and water containment storages. The total catchment of the main waterway draining through the MLA to the Dawson River is expected to have a maximum reduction of ~33% in year 23 of the Project. This is expected to have a moderate impact to streamflows in the waterway during operations, however at closure with the rehabilitated mine landforms draining from site, the catchment reduction is reduced to 13% (up to 420 ha draining to the final void).

Where possible, undisturbed catchments have been diverted with clean water drains and dams to reduce accumulation of mine affected water and potential impacts to water resources. The reduction in streamflow in small ephemeral waterways within the MLA is not expected to result in significant impacts to water values.

4.4.7 Sodicity of soils

Soils of the Project are dominated by non-sodic topsoils and non-sodic and sodic subsoils. The sodic nature of subsoils indicates that they may become dispersive if exposed to surface water run-off for prolonged periods post topsoil stripping, resulting in increased sediment loads in run-off.

Stripping depths for topsoil resources have considered the sodicity of soils and are not considered to be sodic and dispersive. A significant majority of topsoil reclaimed will originate from the Langley SMU, which is characterised by non-sodic soil with negligible dispersibility (see Appendix K). Rehabilitated landforms are at low risk of the dispersive impacts associated with sodic soils.

4.4.8 Waste rock emplacement seepage

A geochemical assessment of potential waste rock and coal reject materials has been conducted by Terrenus Earth Sciences (Appendix E, Geochemical Assessment) to inform the potential water contaminants generated by water infiltration through the waste rock emplacements. The assessment concluded that the waste rock is expected to be overwhelmingly NAF, with excess acid neutralising capacity, and have a negligible risk of developing acid conditions. Furthermore, waste rock is expected to generate relatively low-salinity surface runoff and seepage, with relatively low soluble metal/metalloid concentrations (Appendix E, Geochemical Assessment).

The soluble multi-element results indicate that leachate from bulk waste rock has the potential to contain slightly elevated soluble aluminium, arsenic, molybdenum and/or selenium concentrations compared to applied ANZECC (2000[2018]) aquatic ecosystem protection and/or livestock drinking water quality guideline concentrations. Slightly elevated concentrations for some metals/metalloids for waste rock and coal reject materials are common at coal mines in the Bowen Basin and, generally, do not result in any significant water quality issues (Appendix E, Geochemical Assessment).

Waste rock materials are expected to have mixed sodicity and dispersion potential (non-sodic through to strongly sodic). Waste rock landforms will be constructed with short and low (shallow) slopes and will be progressively rehabilitated to minimise erosion.

Coal processing reject materials are expected to generate pH-neutral to alkaline, low-salinity runoff and seepage. Approximately 64% of potential coal reject samples have been classified as NAF, 10% as 'low' to 'moderate' PAF, and 26% of samples as uncertain. Based on the sulphur concentrations, the results suggest the capacity for most PAF and uncertain materials to generate significant acidity is low (Appendix E, Geochemical Assessment). It should be noted that CHPP rejects are expected to comprise less than 5% of the volume of all mining waste rock handled during the Project (Appendix E, Geochemical Assessment).

Total metal/metalloid concentrations in coal reject are also expected to be low. Some coal reject materials could produce leachate containing slightly elevated concentrations of soluble arsenic and/or selenium and, to a lesser extent, aluminium, as is common from Permian coal measures in the Bowen Basin.

The geochemical characteristics of waste rock and potential coal rejects at the Project are consistent with the geochemical characteristics of these materials at Baralaba North Mine. This confirms the geological and geochemical consistency of the Baralaba Coal Measures in this district, from Baralaba North through to the Project (Appendix E, Geochemical Assessment).

Seepage generated by in pit WRE will report to nearby pits and be managed in the mine water system. Seepage generated in out of pit WRE is expected to follow the natural topography under the WRE. This would lead to out of pit WRE seepage draining to backfilled voids or the open cut pit. Uncontrolled release of seepage is not expected to occur from site and recovered seepage flows will be managed in accordance with the mine water management system. It is not expected that seepage from WREs will cause any additional impacts to water quality in the receiving waterway.

4.4.9 Accidental release of hazardous materials or dangerous goods

There is the potential for accidental release of hydrocarbons or chemicals during activities resulting in localised contamination. Facility design and management of all required fuels and hydrocarbons will ensure there are effective means of secondary containment to prevent or minimise releases to the environment from any on-site fuel and oil storage. The associated risk of release and impacts to water values is low.

4.4.10 Water dependent assets

4.4.10.1 Regional water availability

The Project will source most of its water demands from both surface water runoff within the Project boundaries and groundwater ingress. The water management strategy for the Project will divert clean catchment water away from disturbed mining areas for release from the site, while rainfall runoff from disturbed areas, pit water and recycled water from the CHPP, will be captured and diverted to mine water dams as mine-affected water.

Water supply 'make-up' will be sourced from water allocations from the Dawson Valley Water Supply Scheme. Related entities of the proponent currently hold over 1,418 ML of water allocation from the Fitzroy Basin, Dawson River Zones C/D and 315ML of water licences from the Broadmeadow properties. Utilisation of water allocations by the Project will not result in any additional impact to other existing allocation holders, as the resource will be accessed in accordance with the existing allocation conditions.

The Project is not anticipated to impact supply of water from the Benleith Water Scheme. Additionally, there is not anticipated to be any impact on the objectives of the Water Plan (Fitzroy Basin) 2011.

4.4.10.2 Aquatic ecosystems

The Dawson River and Banana Creek provide value as important aquatic ecosystem habitat in the region. Potential impacts associated with flooding, streamflow and contaminant release have been assessed in previous sections. The potential impacts to aquatic ecosystems as a result of the Project is considered to be low.

The Water Management System has been designed to minimise potential impacts on the HES wetland. The Project will not reduce the catchment area reporting to the wetland and will not have a significant impact on flooding interactions between the Wetland and the Dawson River and Banana Creek. Impacts to the wetland have also been assessed as part of the aquatic ecology report (Ecological Service Professionals, 2023). The aquatic ecology report concluded that the aquatic ecosystem value of this wetland was moderate rather than high, and that this wetland would provide similar value habitat as other wetlands in the region (Ecological Service Professionals, 2023).

Two small wetlands of general ecological significance were also identified within the MLA boundary. The wetlands are associated with small ephemeral drainage features. These wetlands lie outside of the Project footprint and are not expected to be significantly impacted by the Project.

4.4.10.3 Groundwater dependent ecosystems

Potential impacts of the Project on groundwater dependent ecosystems have been addressed in Chapter 7, Flora and Fauna.

4.4.11 Moura Baralaba Road Realignment

The Project includes the realignment of an approximate 4.5 km of the Moura Baralaba Road to the east of the MLA (700057) which is subject to separate approvals. The road realignment is located outside of the 0.1% AEP regional flood level and will be designed so that there are negligible flow impacts. The new road will have a sealed surface preventing sediment runoff. A construction erosion and sediment control plan will be developed to prevent impacts during the construction of the road.

4.4.12 Electricity Transmission Line

The Project includes development of an electricity transmission line (ETL) of approximately 8 km in length within a 20 m easement, and associated infrastructure. The ETL will link the Project with the Baralaba

Substation, located approximately 6 km east-south-east of the Baralaba township. Two ETL alignment options are being considered where the final ETL alignment will be determined at a later date in consideration of the outcomes of the assessments conducted for the EIS and the preference of a third party responsible for the infrastructure. The ETL will have minimal ground disturbance and the transmission line poles will be located outside of waterways to avoid impact overland flows or flooding. The ETL is expected to have negligible surface water impacts.

4.4.13 Great Barrier Reef Catchment Waters

The Project is located in the Fitzroy Region of the Great Barrier Reef (GBR) river basins and therefore is required to address the Reef discharge standards for industrial activities (ESR/2021/5627). The standards outline the requirement to quantify fine sediment or dissolved inorganic nitrogen (DIN) loads, released via a point source to GBR waters and demonstrate there will be no residual impact associated with the Project. The Project is expected to have discharges to water from sediment dam overflows (occurs in less than 30% of years) and controlled releases of mine affected water (occurs in less than 25% of years).

Estimated sediment loads from the existing land area that comprises the Project disturbance area have been compared with expected sediment loads in water discharges during the operational phase of the mine to assess the residual impact associated with the Project. Sediment loads have been quantified as per the following:

- Existing Case (pre-mining) sediment loads were estimated from an average annual sediment generation rate in surface runoff of 0.125 tonnes/hectare/year, applied to the catchment area intercepted by the Project. The sediment generation rate was adopted from the calibrated sediment generation rate for the Fitzroy Natural Resource Management region in the technical report: "Modelling reductions of pollutant loads due to improved management practices in the Great Barrier Reef catchments - Whole of GBR" (Waters, et al., 2014).
- Project Case sediment loads were calculated by applying a potential discharge TSS concentration of 350 mg/L to the average annual discharge volumes determined from the operational water balance model for sediment dam overflows and controlled mine water release. The potential TSS concentration of 350 mg/L was conservatively adopted from the mine affected water release limits presented in Table C2 of the existing Baralaba North Mine Environmental Authority (EPML00223213) (DES, 2023).

The estimated Existing and Project Case sediment loads and the change in loads for the key mine plan years are presented in Table 8.1. The results show that the Project is expected to reduce sediment loads on GBR catchment waters mostly due to the expected discharge volumes being less than the natural catchment runoff volumes. The assessment was considered conservative due to the adopted potential TSS concentration of Project Case discharges being higher than expected for the following reasons:

- Sediment dam overflows are expected to have a much lower TSS concentration than the adopted mine affected water release limits.
- The waste rock emplacement catchment will be progressively rehabilitated which will reduce sediment loads reporting to the sediment basins.
- Recorded TSS concentrations in existing storages at Baralaba North Mine are significantly lower than the adopted concentration of 350 mg/L used to assess potential impacts to sediment loads.
- Post-closure the Project landforms will be completely rehabilitated to maintain existing case sediment generation loads. The final void pit lake is not predicted to overflow and therefore there is no expected residual increase to sediment loads post-closure. The assessment of impacts to GBR waters has been based on sediment as there was insufficient information to determine DIN concentrations of releases. However, a similar reduction in loads is expected for DIN due to the smaller discharge volumes compared to the existing catchment surface runoff volumes.

Table 4.26: Impacts to sediment loads and DIN loads on Great Barrier Reef catchment waters

Project Year	Year 1	Year 3	Year 6	Year 11	Year 14	Year 19	Year 23
Existing Case (pre-mining)							
Area (ha)	650	598	810	921	936	937	966
Runoff Volume (ML)	382	352	476	542	550	551	568
Sediment Loads (tonnes/year)	81	75	101	115	117	117	121
Project case							
Average annual sediment dam overflow volume (ML)	2	2	30	77	96	118	129
Average annual mine water controlled release volume (ML)	20	15	60	98	135	90	122
Total average annual release volume (ML)	22	17	90	175	231	208	251
Sediment Load (tonnes/year) (generation rate of 350 mg/L of discharge volume)	8	6	32	61	81	73	88
Change in annual sediment load (tonnes/year)	-73	-69	-69	-54	-36	-44	-33

4.4.14 Final void

Diverting clean catchment into the final void would dilute groundwater inflows and slow the evapo-concentration process in the final void waterbody and, thereby, reduce salinity. A final void hydrology assessment has been conducted for two scenarios:

- **Scenario 1**—final void catchment area (i.e. base case, no diversion of any additional catchment into the final void).
- **Scenario 2**—final void catchment area, plus the diversion of additional rehabilitation landform runoff and enhanced waste rock infiltration.

Scenario 2 (improved catchment inflows) is proposed to support an improved rehabilitation outcome and as such has been proposed in this application. The modelling results show:

- The final void water level is expected to approach an equilibrium level of 32 mAHD (92.5 GL of storage) after approximately 325 years which is approximately 61 m below natural surface.
- The equilibrium lake level remains approximately 40 m to 50 m below the pre-mining standing groundwater levels near the final void location (based on observed data this is typically 68-80 mAHD) (Watershed HydroGeo, 2023).

- At equilibrium, the model predicts multi-annual fluctuations in water level between 24.6 mAHD and 37.4 mAHD.
- EC in the final void was not shown to reach an equilibrium over a 500-year forecast with EC predicted to reach 5,650 µS/cm at 100 years post closure and 5,840 µS/cm when the void lake level reaches equilibrium conditions.
- The water quality mitigation indicates a minimum freeboard allowance of 55 m for a pit crest level of 93 mAHD indicating there is no risk of overtopping to the receiving environment.

The results also show the void is not at risk of overtopping to the receiving environment.

Continued accumulation of salt is expected to occur as a result of runoff and groundwater ingress combined with evaporative concentration. In the proposed final void arrangement, there are no salt outflows, and therefore it is expected that TDS will continue to increase until saturation at a very slow rate. The final void hydrology model assumes a constant salt load from waste rock and groundwater inflows. It is more likely that the runoff water quality would improve over time as salts are leached from the landform, which indicates the model results are conservatively high.

Under all climate change scenarios, the pit lake level is more than 50 m below ground and will remain as a groundwater sink. The associated risk of contaminant release and environmental harm is insignificant.

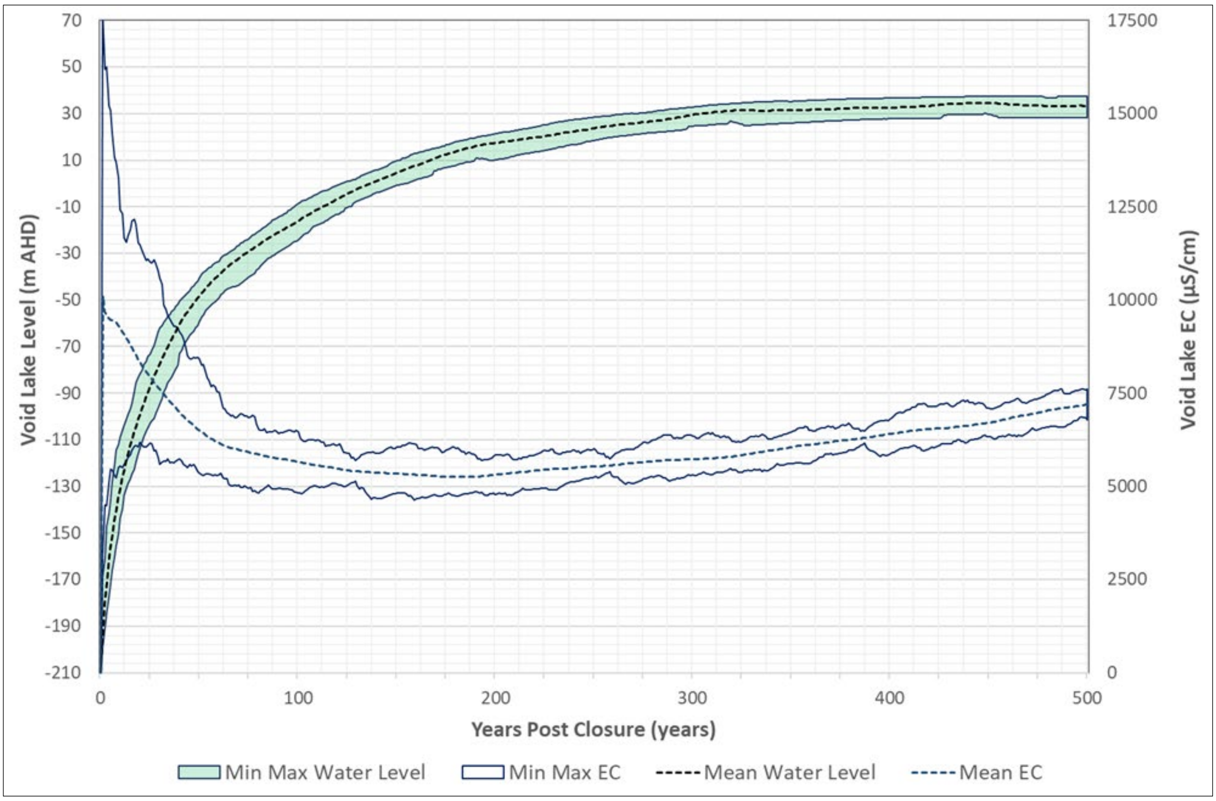

Figure 4.18: Final void water level (improved catchment inflow scenario)

4.4.15 Cumulative impacts

The Project is located approximately 11 km south of the Baralaba North Mine and approximately 27 km north of the Dawson Mine. The concurrent operation of these sites has the potential to result in cumulative impacts on the surface water environmental values. Cumulative impacts on surface from the Project and existing industry in the Dawson River catchment could include:

- Impacts to water resources including existing surface water entitlements due external raw water supply demand for each operation.

- Impacts to the Dawson River streamflow regime from a cumulative reduction in the Dawson River catchment area.
- Impacts to Dawson River water quality due to concurrent controlled mine water releases occurring from each operation.

4.4.15.1 Streamflow and catchment

The Project catchment accounts for approximately 0.024% of catchment at the Dawson River at Beckers gauging station. The Baralaba North Mine has a similar catchment area as the Project. The cumulative streamflow impacts resulting from the catchment harvesting of both the Project and Baralaba North Mine is expected to be approximately 0.04% mean annual flow.

There is no expected cumulative impact to the Neville Hewitt Weir as Baralaba North Mine is located downstream of the weir.

4.4.15.2 Water allocations

The Baralaba North Mine and Dawson Mine are both located on the Dawson River and likely to have access to water entitlements from the Dawson River which are administered under the Water Plan (Fitzroy Basin) 2011. Entitlements under this plan are modelled using the regional Dawson Callide Sub-catchment Integrated Quantity-Quality Model, and cumulative impacts are considered before entitlements are granted. There are not expected to be any further cumulative impacts as a result of the Project accessing existing water allocations.

4.4.15.3 Controlled mine water releases

The mine water management system will operate in accordance with EA release conditions and in-stream trigger levels aligned with the WQOs in the 'Environmental Protection (Water and Wetland Biodiversity) Policy, 2019'.

The Project will conduct controlled releases of mine affected water to the Dawson River in accordance with the EA conditions. The Dawson River also receives controlled releases of mine affected water from the Baralaba North Mine, located approximately 11 km north of the Project and the Dawson Mine, located approximately 27 km south of the Project.

An assessment of a simultaneous release from the Baralaba North Mine, Dawson Mine, and the Project has been undertaken to assess the potential for water quality exceedances at the Beckers gauging station on the Dawson River.

A worst-case assessment was undertaken where all mines are releasing the maximum quantity of water with the maximum end-of-pipe EC during minimum Dawson River flows. The 90th percentile background Dawson River streamflow EC has conservatively been adopted for the assessment. Based on the worst-case assessment, the maximum expected EC at the Dawson River Beckers gauging station is 389 µS/cm, which is well below the receiving waters EC limit in the Baralaba North Mine EA (500 µS/cm). For the same scenario with a background streamflow equal to the high flow WQO objective of 210 µS/cm, Dawson River EC could potentially reach 300 µS/cm.

This is a highly conservative assessment as this scenario is based on the unlikely event that all mines are releasing the maximum quantity of water at the maximum allowable EC during minimum Dawson River flows. Also, in practice the timing of releases from the three mines are not likely to align due to the significant spatial distances between the mines.

Table 4.27: Cumulative release water quality (Dawson River EC High Flow WQO)

Dawson River flow rate (m^3/s)	Dawson River EC (µS/cm)	Baralaba North release		Dawson Mine release		Baralaba South release		Dawson River at Beckers EC (µS/cm)
		Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	
30	210	0.5	1,500	0.288	1,500			243
53	210	0.5	3,000	0.288	1,500			243
92	210	0.5	5,000	0.38	5,000			255
100	210		5,000	0.38	5,000	0.5	10,000	300
140	210	0.5	7,000	0.55	5,000	0.5	10,000	287
190	210	0.5	10,000	0.82	5,000	0.5	10,000	282

Table 4.28: Cumulative release water quality (90th percentile background Dawson River EC)

Dawson River flow rate (m^3/s)	Dawson River EC (µS/cm)	Baralaba North release		Dawson Mine release		Baralaba South release		Dawson River at Beckers EC (µS/cm)
		Rate (m3/s)	EC (µS/cm)	Rate (m3/s)	EC (µS/cm)	Rate (m3/s)	EC (µS/cm)	
30	300	0.5	1,500	0.288	1,500	-	-	331
53	300	0.5	3,000	0.288	1,500	-	-	332
92	300	0.5	5,000	0.38	5,000	-	-	345
100	300	0.5	5,000	0.38	5,000	0.5	10,000	389
140	300	0.5	7,000	0.55	5,000	0.5	10,000	376
190	300	0.5	10,000	0.82	5,000	0.5	10,000	371

4.4.16 Climate change impacts

4.4.16.1 Operational water balance

The Project operational water balance model daily climate inputs were adjusted using the year 2050 climate projections to assess the impact of the “best” case, “worst” case and “maximum consensus” climate change scenarios on the water balance assessment results.

The year 2050 projected climate change variables reduce the total runoff reporting to storages and increases evaporation from storages in the operational water balance model. This results in a reduction in controlled and uncontrolled releases from the Project and overall reduction in the identified impacts to the receiving environment.

4.4.16.2 Final void water balance

The modelled climate change scenarios do not improve or worsen the impacts from the Project’s final void. Under all climate change scenarios assessed, the pit lake level is more than 50 m below ground and the pit is not at risk of overtopping. Water quality (TDS) in the pit lake is expected to be higher for the climate change scenarios with increased evaporation and reduced rainfall, although is not expected to have any adverse impacts to the receiving waterway as the final void is not expected to overtop.

4.5 Mitigation measures, management, and monitoring

The water management system infrastructure has been developed to achieve the water resources and water quality objectives of:

- equitable, sustainable and efficient use of water resources;
- maintenance of environmental flows, water quality, in-stream habitat diversity and naturally occurring inputs from riparian zones (including groundwater dependent ecosystems) to support the long-term maintenance of the ecology of aquatic biotic communities;
- the condition and natural function of water bodies are maintained including the stability of beds and banks of watercourses;
- protecting the environmental values of waters; and
- protecting the environmental values of wetlands.

A range of management strategies have been proposed to mitigate any adverse environmental impacts on water resources and water quality, and to assist in meeting the water quality objectives and protection of identified environmental values.

4.5.1 Diversion of clean catchments

The water management system minimises the clean catchment captured by site, reducing the Project’s impact on streamflow in the receiving waterway. This is achieved by reducing the quantity of catchment diverted away from the Dawson River and into the mine water system. The design of clean catchment diversions throughout the Project has reduced to negligible the impact on streamflow, meeting all flow objectives for the Dawson River.

4.5.2 Mine affected water containment

Mine affected water storages have been designed such that the standard of containment for all water infrastructure containing mine water meets the environmental objectives for regulated structures containing contaminants from the DEHP Guideline for Structures which are Dams or Levees Constructed as part of Environmentally Relevant Activities (EHP, 2017).

The design containment standard for the mine water dams and the water balance modelling results ensure that overtopping events occur in less than 5% of years. Water balance modelling shows no overflows from mine affected water storages.

Water management infrastructure has been designed to progress as mining operations advance as shown on Figure 4.19 to Figure 4.25.

4.5.3 Preferential process use of mine affected water

Any water dewatered from the pit will be used preferentially for supply to the CHPP and dust suppression. The water management system is designed to prioritise use of stored inventories of mine water, reducing the external raw water supply requirements.

4.5.4 Mechanical dewatering

Mechanical dewatering of tailings allows for increased recycling of processing water, reducing the reliance on external water supply (Dawson River water allocations) to meet site water demands. The gross water demand of the plant is anticipated to be up to 50% less than that of other plants utilising conventional tailings management techniques.

4.5.5 Final landform design

The final landform has been designed to incorporate clean catchment diversions and drainage from the mine landforms to prevent harvesting of overland flow and risk of scour to the void walls. In addition, the final landform has been designed to provide suitable flood protection to prevent any flood inflow from the Dawson River system into the final void pit lake.

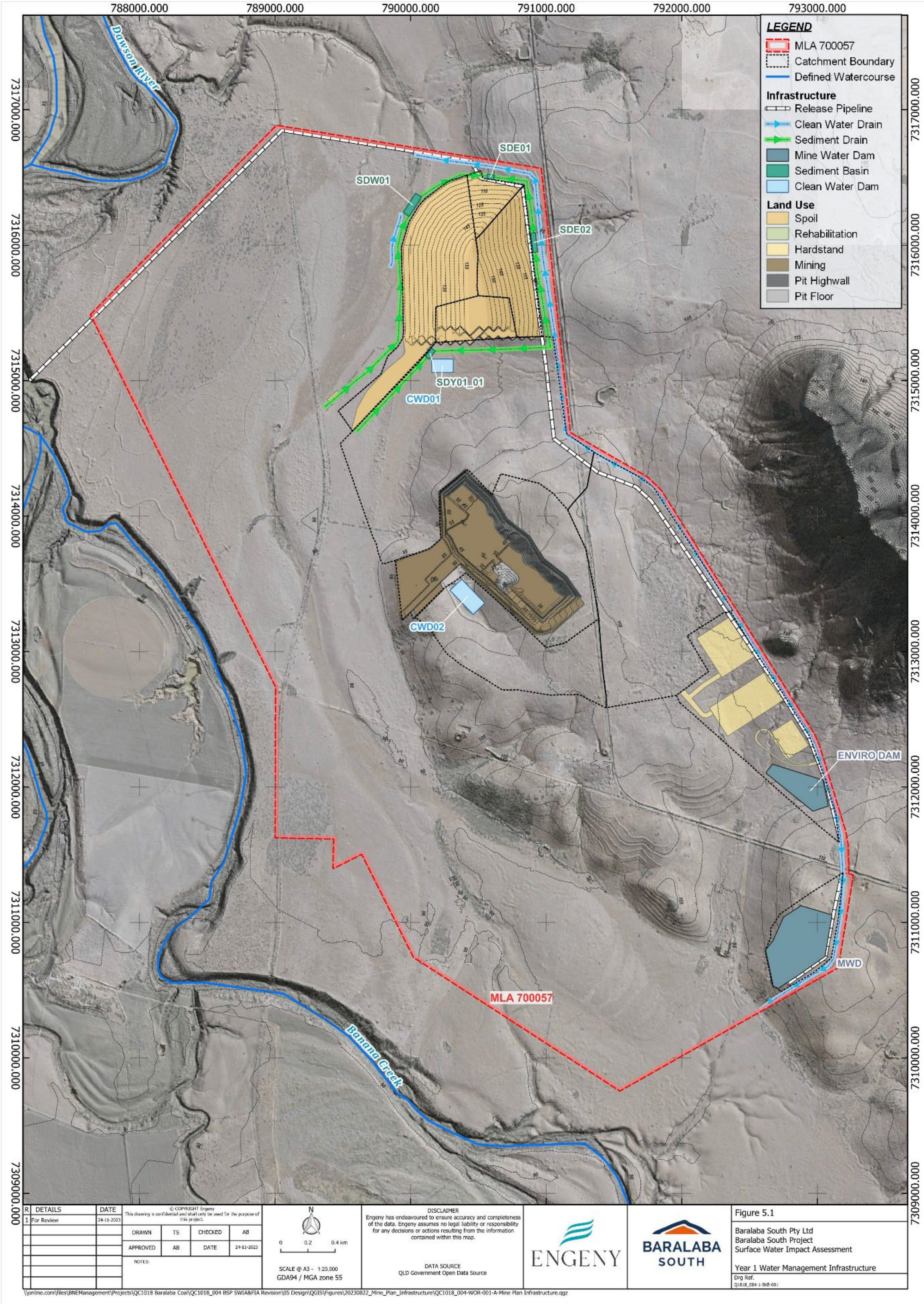

Figure 4.19: Year 1 Water management infrastructure

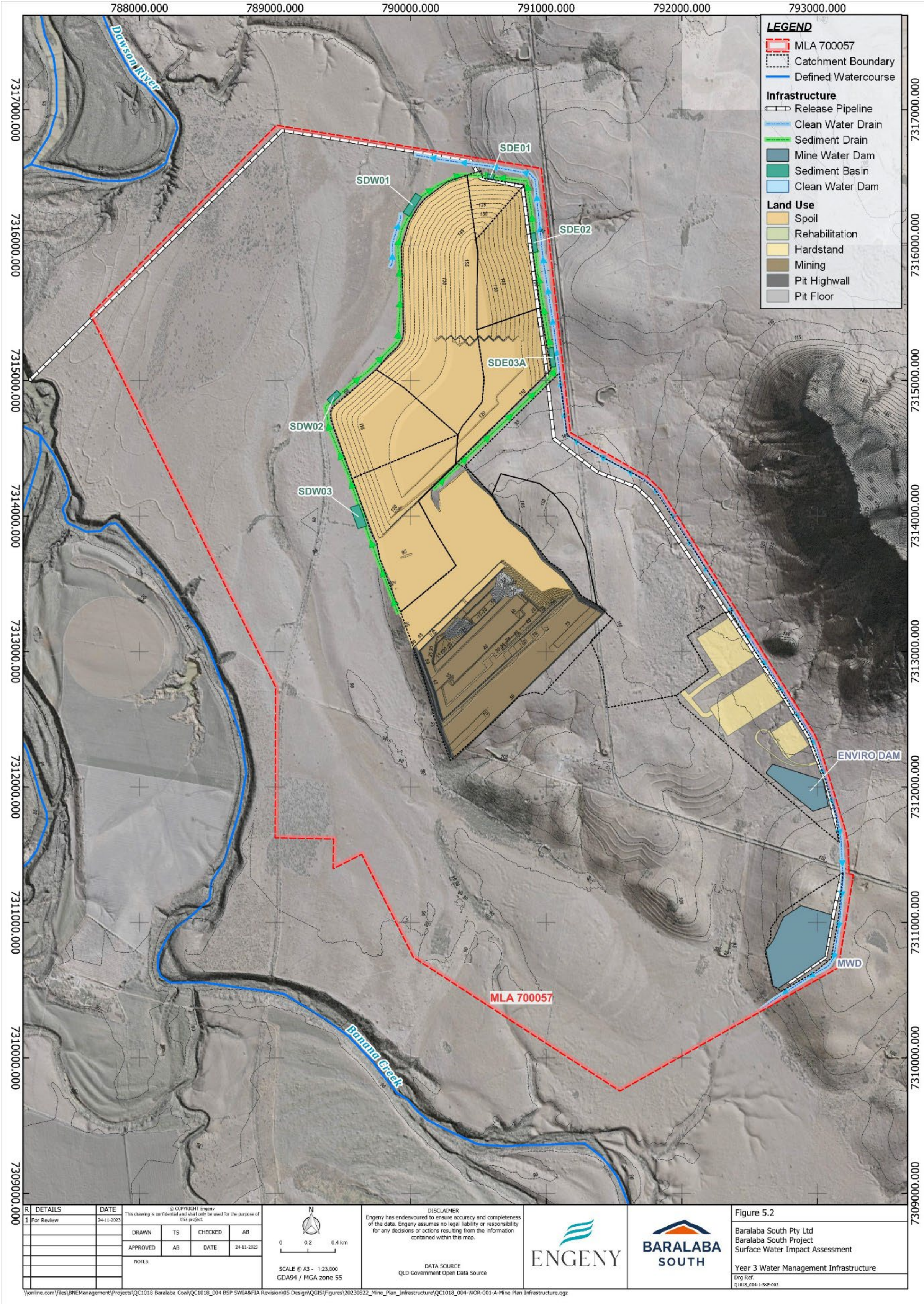

Figure 4.20: *Year 3 Water management infrastructure*

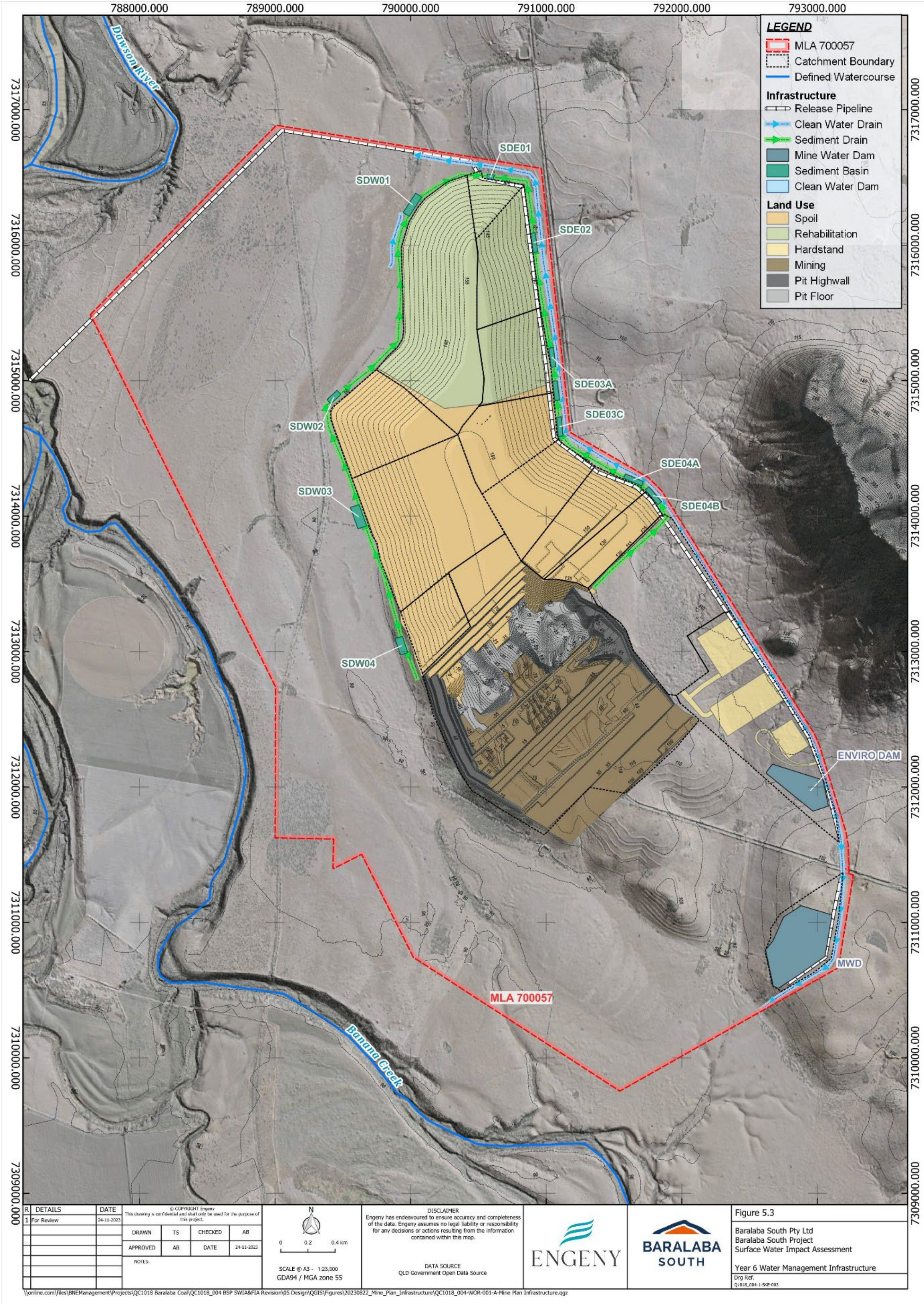

Figure 4.21: Year 6 Water management infrastructure

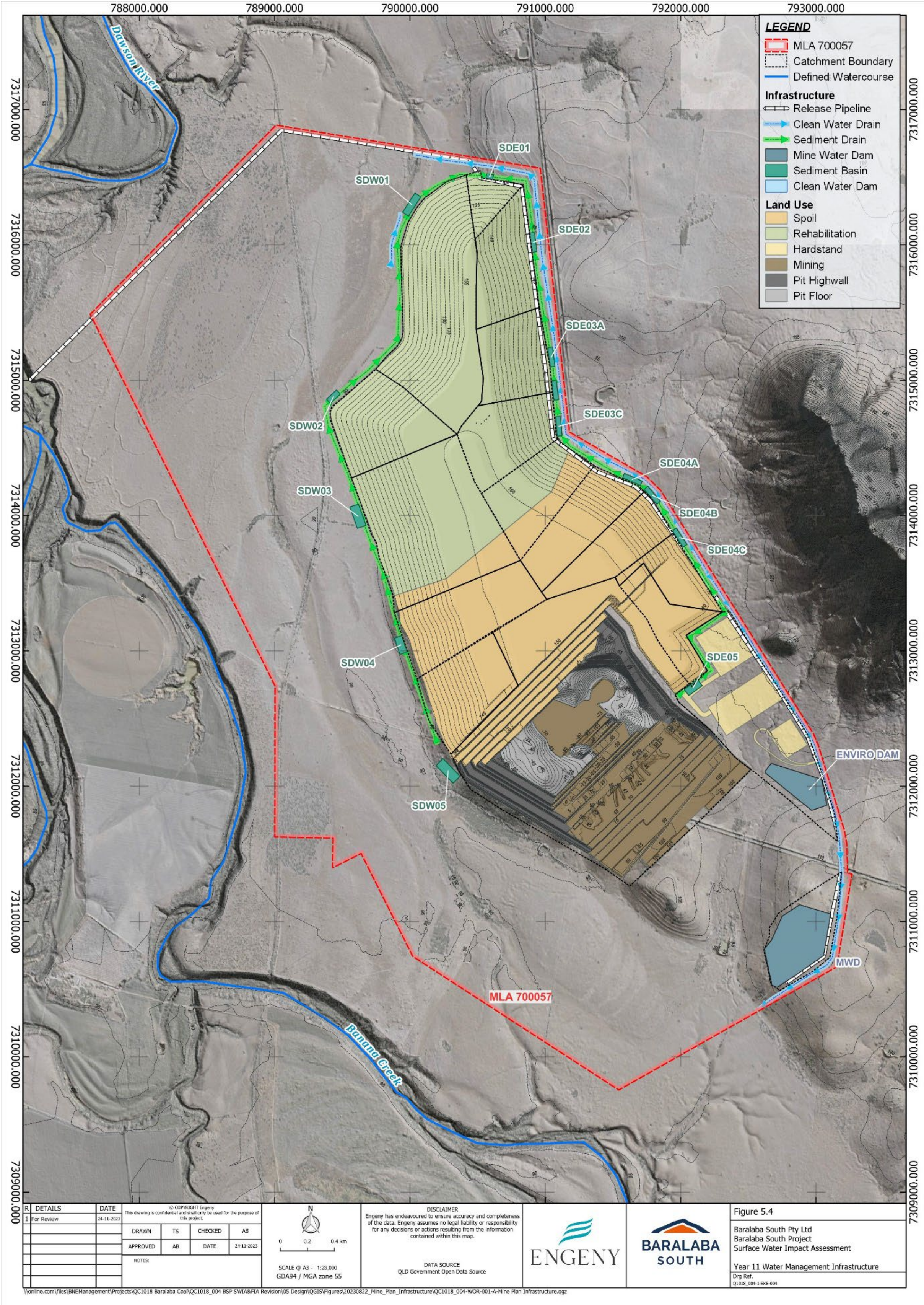

Figure 4.22: Year 11 Water management infrastructure

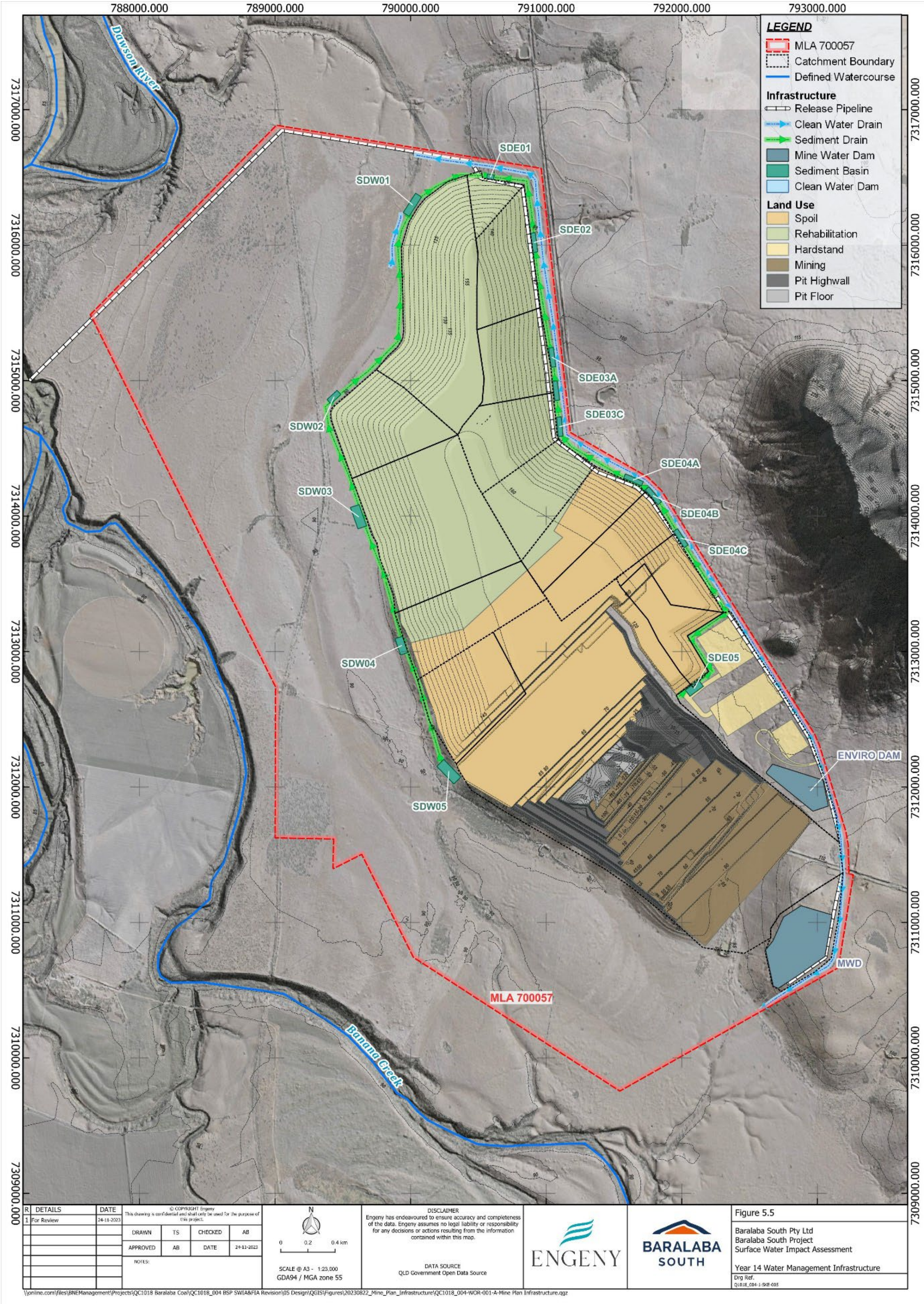

Figure 4.23: Year 14 Water management infrastructure

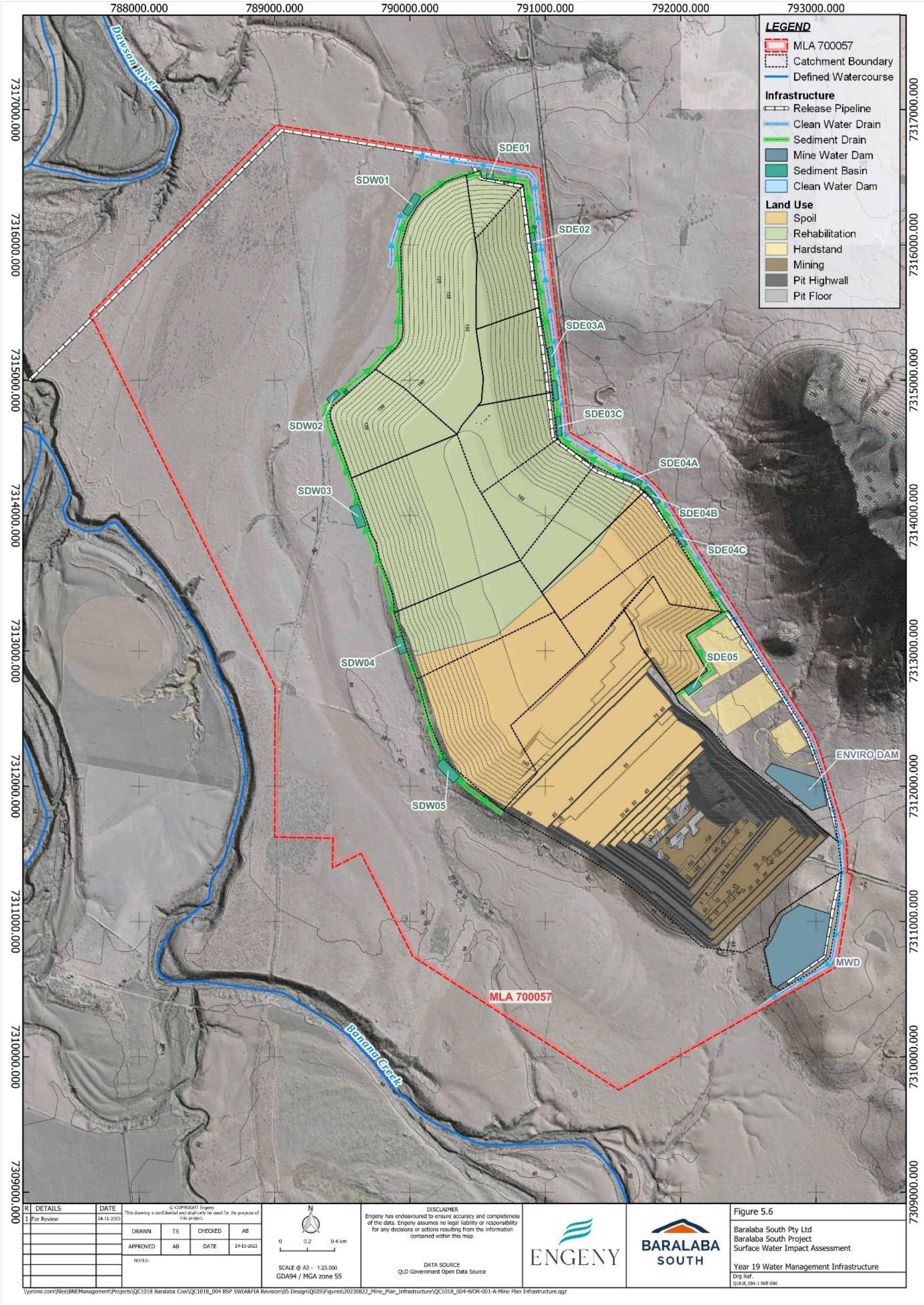

Figure 4.24: Year 19 Water management infrastructure

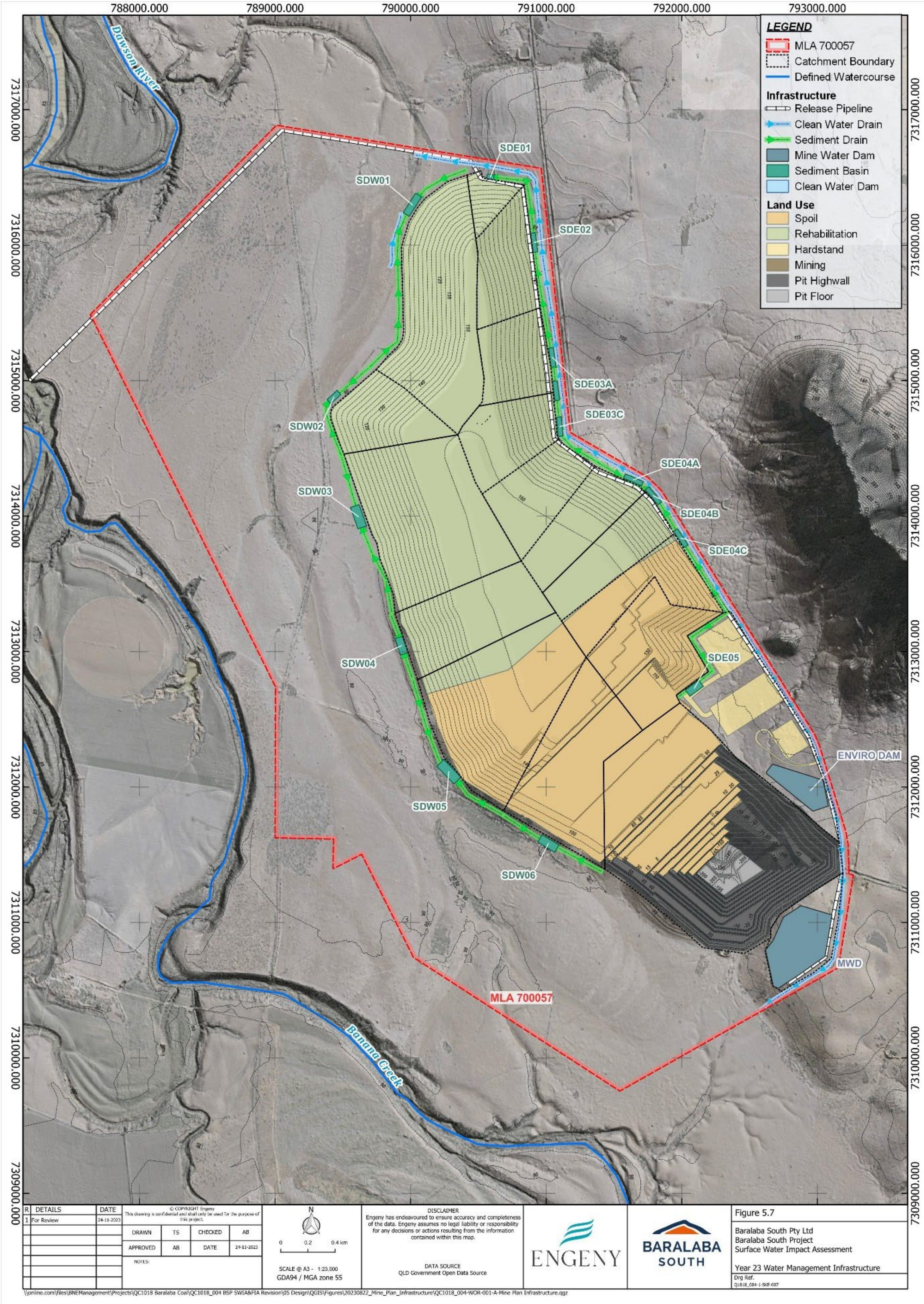

Figure 4.25: Year 23 Water management infrastructure

4.5.6 Water quality management and monitoring

4.5.6.1 Surface water quality monitoring program

A Surface Water Quality Monitoring Program will be implemented for the Project. Monitoring of upstream, downstream and storage water quality will be used to assess potential impacts of the Project. Monitoring will be undertaken at background (i.e. control) sites located upstream of the release point on the Dawson River and along Banana Creek.

Proposed water quality monitoring locations are summarised in Table 4.29 and shown on Figure 4.11 and Figure 4.5. Dawson River at Beckers and Dawson River at Baralaba are existing points monitored by DoR and Baralaba North Mine respectively. The remaining locations are proposed to be monitored by the proponent. Coordinates for the release location RP1 will be refined once detailed design of the structure has been completed.

Additional or alternative monitoring locations (e.g. other water storages on-site and/or surrounding environmental features) will be developed as part of site-specific plans as required.

Table 4.29: Proposed water quality monitoring locations

Monitoring location (ID)	Easting (GDA94)	Northing (GDA94)
U/S Banana Creek	149.897	-24.3091
U/S Dawson River	149.794	-24.3254
Dawon River Confluence	149.830	-24.254
MP1 Banana Creek	149.844	-24.2763
MP2 Release Location (RP1)	TBC	TBC
Northern Tributary	149.856	-24.236
D/S Dawson River	149.819	-24.2081
Dawson River at Baralaba DR1 (Baralaba North Mine SWMP)	149.805	-24.1825
Dawson River at Beckers (130322A)	149.822	-24.0873

Sample methodology

Water quality monitoring will be undertaken using a combination of laboratory and in situ sampling by trained personnel and in accordance with the Queensland 'Monitoring and Sampling Manual' (DES, 2018c). Sampling methodology will involve the following:

- sample collection to be undertaken using a grab sampler which has been decontaminated and rinsed with distilled water between sample locations;
- the use of appropriate sample containers which have been provided by the laboratory;
- samples will be labelled clearly with the sample number, site and date sampled;
- all samples will be forwarded to the laboratory in a secure and appropriately cooled container;
- samples are to be collected and handled within appropriate holding times for the analysis of concern, and this information can be obtained and confirmed from the laboratory responsible for the analysis of samples;
- water samples will be analysed by a NATA accredited laboratory for the proposed physico-chemical, biological and toxicant indicators for the Project are outlined in Table 4.30;

- all sample batches to be sent to a NATA accredited laboratory are to be accompanied by a chain of custody form;
- in-situ measurements of water quality parameters including pH, electrical conductivity, turbidity, dissolved oxygen, and temperature will be undertaken at each monitoring point; and
- additional samples will be taken for quality assurance and quality control (QA/QC), including duplicate samples and sample blanks. Specific identification codes will be used for these samples to ensure the laboratory conducting the sample analysis is not alerted to these samples being controls/blanks. Laboratory QA/QC data as obtained per laboratory analysis procedures will be requested and included in result review and analyses.

The water quality indicators specified in Table 4.30 have been developed based on identified WQOs for the receiving waterways, expected contaminants to be produced from the operation (based on the Baralaba North Mine water quality data and EA), and the 'Model Mining Conditions' (DES, 2017a). Analysis of metals will include both total and dissolved metal concentrations.

Water quality parameters will be measured against the WQOs defined in the EA, and where they are not met, investigations will be undertaken to determine the cause and any required corrective actions.

Streamflow/level monitoring data will be collected from the DoR stations and two of the proposed Project water monitoring sites (U/S Dawson River and D/S Dawson River).

Regular (quarterly/monthly) surface water quality monitoring will be undertaken until a statistically robust data set of baseline local water quality data has been obtained in accordance with the 'Queensland Water Quality Guidelines' (DEHP, 2009) and the 'National Water Quality Management Strategy' (ANZG, 2018).

Table 4.30: Proposed water quality indicators

Monitoring category	**Indicator**
Physico-chemical	• pH • Salinity (EC, Total Dissolved Solids) • Turbidity • Sulphate • Dissolved Oxygen • Total Suspended Solids • Colour
Biological	• Chlorophyll • Cryptosporidium • Blue-green Algae • Algal toxin
Toxicant	• Metals and Metalloids (As, Al, Ag, B, Ba, Be, Cd, Co, Cr, Cu, F, Fe, Hg, Li, Mo, Mg, P, Pb, Pd, Ni, Se, U, V, Zn) • Fluoride • Sodium • Carbonate, Hardness • Nitrogen (Ammonia, Nitrate/Nitrite, Total Organic Nitrogen) • Total Recoverable Hydrocarbons and Total Petroleum Hydrocarbons

Mine water dams and sediment dams will also be monitored over the life of the Project. Surface runoff and seepage from waste rock emplacements, including any rehabilitated areas, will be monitored for standard water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride, and alkalinity), major cations (sodium, calcium, magnesium, and potassium), TDS and a broad suite of soluble metals/metalloids.

4.5.6.2 Receiving Environment Monitoring Program

A Receiving Environment Monitoring Program (REMP) will be developed for the Project in accordance with the 'Model Mining Conditions' (DES, 2017a) and in consideration of the 'Receiving Environment Monitoring Program Guideline' (DES, 2014a).

The aim of a REMP is to monitor and assess the potential impacts of controlled or uncontrolled releases of water and associated contaminants to the environment from a regulated activity. A REMP provides a basis for evaluating whether the discharge limits or other conditions imposed upon an activity have been successful in maintaining or protecting receiving environment values over time (DES, 2014a).

The REMP design document will include:

- the environmental values to be enhanced or protected for receiving waters potentially affected by mine water releases;
- measurable indicators associated with the environmental values (e.g. physical, chemical, or biological indicators) and the WQOs for these indicators;
- suitable test sites within the receiving waters that are potentially impacted by releases;
- suitable control sites where a background or reference condition can be established;
- a description of the frequency and timing of sampling; and
- how the condition of, and impacts to, environmental values will be assessed.

REMP monitoring will be undertaken biannually at a minimum and will be undertaken to account for seasonal variability.

Water quality monitoring

The proposed water quality monitoring including the WQOs for water quality is described in section 4.5.6.1.

Biological monitoring

Macroinvertebrate sampling will be undertaken biannually to account for larval growth and recruitment associated with seasonal wet / dry cycles. The selection of macroinvertebrate monitoring sites will be conducted by a suitably qualified person engaged to undertake the survey and will consider sites previously sampled, REMP water quality monitoring sites and prevailing conditions.

Macroinvertebrate sampling will be undertaken in accordance with the AusRivas method by a suitably qualified person.

Results from macroinvertebrate surveys will be assessed against historical data and compared against trends in water quality results.

Macroinvertebrate survey results will be included in the Annual REMP Report.

Flow monitoring

Streamflow gauging will be undertaken during the operational phase of the Project to inform release opportunities and assess impacts. In addition to the flow gauging already undertaken at the DoR stations, streamflow/level monitoring will be undertaken at the Dawson River confluence with Banana Creek monitoring point to inform natural streamflow conditions for mine water release.

The results from flow monitoring will also be used to interpret the results from water quality monitoring against flow conditions.

Review and reporting

Results from monitoring and sample analysis will be collated, reviewed, and compared to the WQOs defined for the Project. The comparison will include consideration of background data, seasonality, occurrence of mine water discharge events and event specifics (e.g., mine water quality and contaminant levels, volume of discharge, streamflow, etc.).

Where results exceed an identified WQO, further investigations will be undertaken to determine possible causes of the exceedance. Further sampling may be warranted to verify the results. If required, an action plan will be developed and implemented to correct any causal issues.

An annual REMP report outlining the findings of the REMP, including all monitoring results and interpretations will be prepared and made available to DES on request. This report will include an assessment of background reference water quality, a comparative analysis of the condition of downstream water quality and WQO, and the suitability of any discharge limits to protect downstream environmental values.

4.5.7 Adaptive management

Consistent with best practice in mine water management, the proponent will further investigate the potential options and proposed approaches for separation of different water quality source waters on-site as part of the detailed design of the Water Management System and refine as required during the life of the Project.

An annual review of the performance of the Water Management System will be undertaken over the mine life to continually inform updates to the Water Management System.

The performance of the Water Management System will be assessed against:

- compliance with the Project's EA conditions:
- results of water monitoring and the REMP;
- water demand and supply requirements; and
- the implementation of mitigation measures.

To ensure adequacy of the Water Management System, the review of the Water Management System will include a review of the Project's water balance. Updates to the water balance model will be conducted, if required. The following data and information will be collected for the duration of the Project to inform regular updates and validation of the operational water balance model:

- water inventory of the mine water dams and sediment dams (dam water level);
- water quality sampling of the mine water storages and sediment dams;
- pumped flow meter data for major transfer and water demand offtakes (pit dewatering, CHPP water transfers, fill points);
- aerial surveys of the mine topography to review catchment area and land use development; and
- daily rainfall.

The model will be validated (or calibrated) to historical dam inventories using the recorded data listed above. The update and review of the model will be used to assess validity of the following model parameters, inputs, and assumptions:

- surface water runoff parameters for the various site land uses;
- salinity generation rates for the various site land uses;
- pumpable groundwater volumes reporting to the mining pit (using pit dewatering information);
- truck fill demands and water loss through the CHPP; and
- the classification of storages using water quality information (sediment storage or mine affected storages).

4.5.8 Erosion and sediment control plan

During operations, the potential to transport contaminants via surface water flow will be managed through erosion and sediment control structures which comply with the EA Conditions. An Erosion and Sediment Control Plan will be prepared for the Project consistent with the IECA recommendations outlined in the 'Best Practice Erosion and Sediment Control Guideline' (IECA, 2018) to minimise erosion and sediment generation from disturbed areas and maintain water quality in downstream water systems. The Erosion and Sediment Control Plan will be prepared by a suitably qualified person and implemented during construction, operations, and rehabilitation.

The erosion and sediment control plan will define the following aspects of the erosion sediment control requirements for the site:

- Limiting disturbance to prevent sediment runoff generation.
- Erosion control measures aimed to prevent soil erosion from disturbed areas including revegetation and rehabilitation.
- Documenting soil types and disturbed catchment areas on the site and their potential for sediment generation.
- Design and management of drainage control measures to prevent erosion from concentrated flows and manage the flow of clean and sediment runoff.
- Erosion and sediment control requirements associated with temporary disturbance and construction activities.
- Design and management of sediment dams including dewatering and desilting requirements and suitable construction materials.
- Water quality testing of sediment dam to assess their performance and inform continual improvements of the erosion and sediment control system.

Sediment dams will form a key component of the Erosion and Sediment Control Plan. Sediment dams for the Mine Water System have been designed in accordance with the 'International Erosion Control Association Guidelines' methodology for Type D sediment basins (IECA, 2018). Sediment basins have been designed to contain sediment affected runoff from disturbed areas including rehabilitated areas until they are suitably established. Eight sediment basins have been designed to capture runoff from the overburden emplacement areas and the MIA.

Sediment dams will be equipped with pumping infrastructure providing for transfer of water to the MWD. Mine water transfers will be utilised to assist with sediment basin settling volumes.

Sediment dams will be designed such that overtopping velocities are managed so they do not cause scour on the overtopping flow paths. Sediment dams will also include overflow control structures with scour protection (rock chutes, rock aprons and/or level spreaders) to ensure non-erosive discharges. Sediment dam spillway structures will be designed such that during overtopping events, velocity impacts in the receiving waterway are negligible.

Clean water drains have been designed to ensure clean water is diverted around disturbed areas, reducing the risk of contaminants and increased sediment loads being discharge to the receiving environment via surface water. Surface water runoff from disturbed areas will be managed via drains and bunds to direct runoff to erosion and sediment control structures.

Additional erosion and sediment controls to be included in the plan will include the following:

- topsoiled areas will be deep ripped to reduce compaction from heavy machinery, encourage infiltration of water and prevent erosion. Areas will be ripped along the contour to reduce the velocity of run-off water down the slope;
- where required, stockpiles will be constructed to less than 3 m high and contoured to encourage water drainage;
- the placement of topsoil stockpiles away from drainage areas, roads, machinery, transport corridors and stock grazing areas;
- preservation of vegetation around drainage lines and riparian zones to reduce the exposure of the B horizon if excavation is necessary;
- use of upslope diversion drains to reduce runoff from undisturbed areas onto disturbed areas;
- the use of downslope collection drains to divert surface water to sediment dams (e.g. mulch berms, sediment ponds and drop inlet protection) to contain sediment-laden run-off from disturbed areas;
- the use of sediment fences and filters to retain and filter suspended solids;
- where possible, traffic will be confined to maintained tracks and roads; and
- assessment of the integrity and effectiveness of erosion control measures will be undertaken at regular periods, especially following significant rainfall events.

Installed erosion and sediment control structures will not be removed until monitoring indicates that disturbed areas have been stabilised.

4.5.9 Progressive rehabilitation

The Project will implement progressive rehabilitation to disturbed areas to minimise potential runoff from exposed landforms containing increased sediment loads to an operational minimal, reducing the overall erosion and sediment risk. Rehabilitation activities will involve rehabilitation of overburden emplacements that will promote natural surface runoff properties through the construction of contour drains on the external slopes of rehabilitated landforms.

Progressive rehabilitation activities to minimise the risk of erosion and sedimentation will include:

- rehabilitating disturbed landforms as soon as practicable after disturbance;
- replacement of topsoil and subsoil consistent with existing soil profiles;
- reshaping disturbed landforms to a stable landform including the incorporation of contour drains; and
- establishing groundcover.

Progressive rehabilitation activities will result in the following outcomes:

- the potential generation of sediment from disturbed landforms' will be minimised;
- natural runoff properties which, after establishment, can be allowed to runoff into the receiving waterways, reducing the length of capture and treatment of disturbed catchments will be restored; and
- potential impact of contaminated water into the receiving environment will be minimised.

The rehabilitation strategy for the Project is provided in Chapter 3, Rehabilitation.

4.5.10 Contaminants management

The risk associated with the accidental mobilisation of contaminants on site will be proactively and reactively managed through the following measures:

- hazardous chemicals and dangerous goods will be stored in bunded storage areas within the MIA with spill clean-up kits located in close proximity, in accordance with relevant Australian Standards;
- transfers of fuels and chemicals within the MLA will be controlled and managed in accordance with Standard Operating Procedures developed for the Project to minimise the risk of spillage outside bunded areas; and
- wastewater from wash down areas will be directed through oil and grease separators before being transferred to mine water storages;
- any contaminated material/major spillage of stored material in bunded areas will be collected and transported offsite by a licensed waste collection agency; and
- any significant leakage/spillage events will be reported immediately and the appropriates clean-up operations will be implemented.

Appropriate procedures, containment and spill control measures will be implemented at suitable locations where the transportation and loading, as well as storage of hazardous and/or dangerous materials occurs onsite. The design and management of all required fuels and hydrocarbons will ensure there are effective means of secondary containment to prevent or minimise releases to the environment from any fuel and oil storage onsite.

4.5.11 Water management plan

A Water Management Plan will be prepared for the Project in consideration of the DES guideline for the 'Preparation of Water Management Plans for mining activities' (DEHP, 2012). It will include:

- A description of the baseline environment, including environmental values and water quality objectives of the receiving waterways, a description of receiving waterways, local and regional groundwater aquifers, current and historical mining and associated activities, site climate conditions and water quality monitoring of the receiving waterways and groundwater aquifers used to establish baseline conditions.
- A description of the potential sources of contaminants that could impact on water quality.
- A description of the Water Management System including objectives, site storages details and locations, transfer infrastructure, identification of bulk water storages and maintenance methodology for water infrastructure and freeboard in containment structures.
- The water release strategy including details of release infrastructure, trigger levels for commencing and ceasing releases and release monitoring requirements.
- A description of the water balance model including major water inflow and outflow mechanisms details, water balance model development (details of calibration of runoff parameters, key input assumptions) and water balance forecast results.
- A program for the monitoring and review of the Water Management Plan's effectiveness.
- Corrective actions and contingency procedures for emergencies.
- Assignment of responsibility for water management plan actions.

The Water Management Plan will be updated annually prior to the wet season for the life of the Project. This will enable identification of changes to the water management system and associated impacts to the operational water balance and receiving environmental values. The update process will identify risks associated with the water management system and feedback to infrastructure and operational management improvements.

Details of the groundwater components of the Water Management Plan are described in Chapter 5, Groundwater. Details regarding the flooding and regulated structure groundwater components of the Water Management Plan are described in Chapter 6, Flooding and Regulated Dams.

4.5.11.1 Controlled release strategy

Water captured within the site's Water Management System will be used preferentially on site for dust management which will reduce the requirement for controlled release events. Controlled releases will be utilised to manage site water storages where necessary. It is proposed that controlled water releases will occur from the MWD to a single release point at the Dawson River, immediately north of the confluence with Banana Creek shown on Figure 4.11.

Pre-release monitoring

Streamflow gauging will be undertaken during the operational phase to inform release opportunities and assess impacts. In addition to the flow gauging already undertaken at the DoR stations, streamflow/level monitoring be undertaken at two of the Project sites - U/S Dawson River and D/S Dawson River.

Prior to any controlled release event, water quality testing of key water quality parameters including pH, EC, suspended solids, turbidity and oil and grease will be undertaken to ensure water is of appropriate quality for release into the receiving environment. If water is identified as being outside the permitted release range, water will be treated prior to release. If required, treatments will include the following:

- neutralisation of water through the addition of an acid to lower pH or a base to raise the pH;
- treatment with flocculent to settle suspended sediments; and
- removal of oil with a hydrophobic oil boom.

Any treatment of water prior to the release will be undertaken in accordance with a site job safety analysis and risk assessment and records maintained in an electronic database.

Release conditions

Controlled releases will occur when flow in the Dawson River, at the confluence with Banana Creek, is above the minimum throw threshold of 100 m^3/s, the release storage water quality characteristics are less than the end-of-pipe limits (10,000 µS/cm) and EC in the Dawson River at Beckers is maintained lower than 500 µS/cm.

The proposed mine water release strategy is summarised in Table 4.22, Table 4.23 and Table 4.24.

Release monitoring

Water quality will be monitored during a release event in accordance with the Project's EA conditions. The proposed water quality monitoring for release is summarised in Table 4.31 and Table 4.32. Monitoring locations are presented on Figure 4.11 and Figure 4.5.

Notification

In accordance with proposed EA conditions the administering authority will be notified as soon as practicable and no later than 24 hours after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the release with the information outlined in EA condition F13.

In accordance with the proposed EA conditions the environmental authority holder will notify the administering authority as soon as practicable and nominally no later than 24 hours after cessation of a release event of the cessation of a release notified under Condition F13. Information on the cessation of a release event will be provided in writing with the information outlined in EA condition F14.

In accordance with the proposed EA conditions, if any release monitoring result indicates an exceedance of or non-compliance with any environmental authority limit the administering authority must be notified within twenty-eight (28) days of completion of analysis.

Reporting

Mine releases will be recorded and include the following details:

- water treatment method;
- water quality monitoring details (time, tests undertaken, time of dewatering if required/recording requirements;
- release volumes and dates; and
- release water quality.

Records will be maintained in the Project electronic database.

Table 4.31: Receiving waters contaminant trigger levels

Quality Characteristic	Trigger Level	Monitoring Frequency
pH (pH Units)	6.5–9.0	Daily during the release
Electrical Conductivity (µS/cm)	500	
Total Suspended Solids (mg/L)	350	
Sulphate (SO_4^{-2}) (mg/L)	250	

Table 4.32: Receiving water upstream background sites and downstream monitoring points

Description	Easting (GDA94)	Northing (GDA94)
Upstream (background) monitoring points		
U/S Banana Creek	149.897	-24.3091
U/S Dawson River	149.794	-24.3254
Dawson River / Banana Creek Confluence	149.830	-24.254
MP1 Banana Creek	149.844	-24.2763
Downstream monitoring points		
D/S Dawson River	149.819	-24.2081
Northern Tributary	149.856	-24.236
Dawson River at Baralaba DR1 (Baralaba North Mine) SWMP)	149.805	-24.1825
Dawson River at Beckers (130322A)	149.822	-24.0873

Note: Exact location coordinates to be confirmed.

4.5.11.2 Mine water management infrastructure management

During the operations phase, monitoring of water management infrastructure will be undertaken to include, sediment dams, clean water dams, mine water dams, pump and pipe networks and the drainage system. Monitoring of the water management infrastructure will include:

- visual inspections of water management infrastructure on a quarterly basis as well as pre/post significant rainfall events;
- monthly visual inspections of the pump and pipe network;
- quarterly water quality monitoring of mine water storages;
- records of all water usages and transfers will be maintained;
- metering of inflows and outflows will be monitored with accurate, fit for purpose flow meters to allow for the early detection of leaks, spills and blockages in pipe and pump infrastructure;
- quarterly monitoring of mandatory reporting levels and maintenance of dam volume as a requirement of the EA Conditions;
- daily monitoring of meteorological conditions for flood, significant rainfall events or drought conditions to proactively manage water management storage volumes;
- quarterly monitoring storage capacity to ensure compliance with design storage allowance (DSA) volumes;
- assessing the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year; and
- ensuring the storage capacity in each regulated dam meets the Design Storage Allowance volume for the dam and is available by November 1 each year.

Water quality monitoring of mine water storages (sediment dams, clean water dams and mine water dams) will be undertaken quarterly for pH, EC, total suspended solids, and turbidity. Dams with a reasonable risk of contamination from oil and grease will be sampled biannually. The parameters proposed in the mine water management monitoring program (Table 4.33) will be subject to review over time. Sampling methodology will be undertaken as described in section 4.5.6.1.

Table 4.33: Mine water storages monitoring program

Parameter	Monitoring frequency	Analysis type
pH (pH Units)	Quarterly	Field
EC (µS/cm)		Field and Laboratory
Total Suspended Solids (mg/L)		Laboratory
Turbidity (NTU)		Field and Laboratory
Oil and Grease (mg/L)	Biannual	Laboratory

4.5.11.3 Emergency and contingency planning

The Water Management Plan will include proactive management measures for flood, drought, and severe weather events, these will include:

- testing of pit flood pumps prior to each wet season;
- monitoring of BOM 3-month rainfall outlooks;
- daily updates to the water balance model in the lead up to an emergency situation (where possible, e.g., cyclone warning) and, in particular, survey of water levels as input to the model is considered critical;

- a reduction of water usage during extended periods of drought;
- monitoring of existing water usage and analysis of this data allowing early identification of inefficiencies in the system, and these inefficiencies will be targeted for reduction in forward planning; and
- annual review of the mine water balance and assessment of the system reliability for the upcoming season.

4.5.11.4 Adaptive management

Results from the monitoring and inspections undertaken through the Water Management Plan will be reviewed regularly, performance considered and used to inform updates to the Water Management Plan procedures. The review will allow for updates to occur in accordance with new/updated legislative and mandatory requirements.

4.5.11.5 Training

Information in the Water Management Plan will be included in the site induction and familiarisation training for relevant personnel.

The proponent will ensure employees and contractors involved with monitoring, maintenance and operation of the water management infrastructure are appropriately trained.

4.5.12 Potential corrective actions

Where water quality results exceed an identified WQO, an investigation will be undertaken to determine the possible causes of the exceedance. This may include further sampling to verify the results and the identification and implementation of corrective actions.

Potential corrective actions will include where relevant:

- modification of construction, operation and/or rehabilitation activities as required;
- maintenance and/or management of erosion and sediment controls where inspections indicate the controls are not operating effectively;
- implementation of additional erosion control measures;
- implementation of additional waste rock management measures;
- Water Management System audit;
- modification of the Water Management System;
- review and revision of protocols for controlled releases;
- review and revision of monitoring trigger levels;
- increasing the monitoring frequency or sampling locations to inform the nature of the impacts and the effectiveness of the corrective actions implemented; and/or
- follow-up inspections and/or monitoring.

4.5.13 Annual Review

An annual review of surface water quality trends and groundwater quality trends will be conducted by a suitably qualified person or persons. The review will assess the change in surface water quality and groundwater quality over time compared to historical trends and impact assessment predictions.