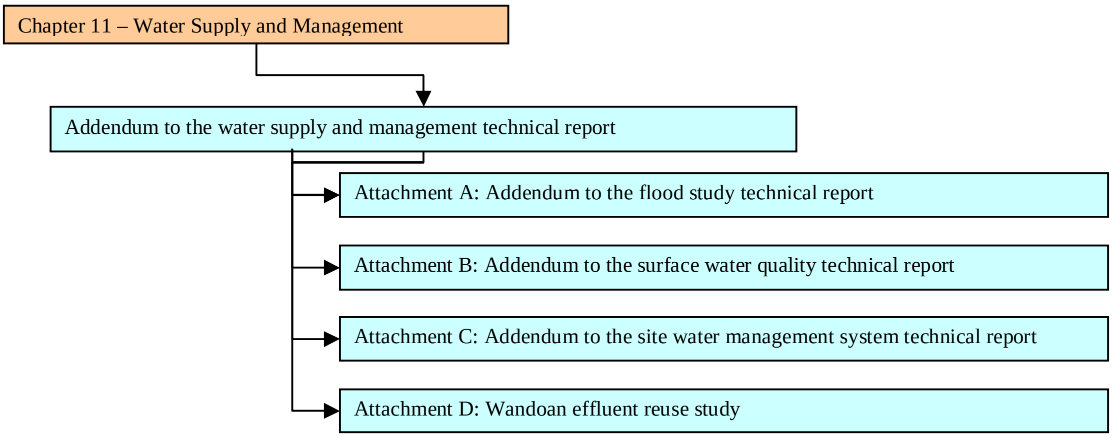
11 WATER SUPPLY AND MANAGEMENT

11.1 INTRODUCTION

This chapter provides further assessment and information on water supply and management for the Supplementary Environmental Impact Statement (EIS), in response to various submissions on the EIS and modifications/refinements to the Project. The information presented builds on the EIS Volume 1, Chapter 11 Water Supply and Management and should be read in conjunction with the EIS chapter.

Chapter 6 Project Operations of the Supplementary EIS provides further details on the overall modifications and refinements to the Project.

Further detailed information is located in the Addendum to the Water Supply and Management technical report relating to the Supplementary EIS, presented in STR11-1-SV1.5, and its associated attachments. These are summarised as:



11.2 METHODOLOGY OF ASSESSMENT

A number of refinements have been made to the assessment studies undertaken including:

- Water Management:
  - water quality assessment has been revised with additional background water quality monitoring data included in the assessment of existing water quality. The proposed network of operational monitoring points and discharge points, has also been revised to reflect changes to the proposed pit layouts
  - conceptual water management system design has incorporated a number of changes including the number, size and location of water management dams to cater for changes made to the mine layout
  - historical simulation water balance assessment has been updated for the revised water management system layout, and additional details have been provided on downstream impacts. An indicative assessment of site water quality has also been prepared for comparison with the proposed licensed receiving water quality limits
  - flood impact assessment has incorporated additional ground survey data into the hydraulic flood models, and the flood inundation assessment over the eastern portion of the site has been extended upstream and downstream. Historical flood observations have been collated from local landholders and compared to modelled flood levels in these events to validate the model. Mitigation measures to reduce the potential impact of the operation on off-site flood levels have also been investigated.
- Water Supply:
  - the Project water demand estimates have been refined in light of changes to the production schedule and unit water consumption
  - the potable water supply and wastewater disposal system conceptual designs have been further refined to improve their performance.

In undertaking these assessments, the key relevant Acts are the *Water Act 2000* (Water Act) and the *Environmental Protection Act 1994* (EP Act). Other applicable legislation includes:

- Water Regulation 2002
- Environmental Protection Policy (Water) 2009
- Water Resource (Great Artesian Basin) Plan 2006
- Great Artesian Basin Resource Operations Plan 2006
- Water Resource (Fitzroy Basin) Plan 1999
- Fitzroy Basin Resource Operations Plan 2006
- *Water Supply (Safety & Reliability) Act 2008.*

11.2.1 FLUVIAL GEOMORPHOLOGY ASSESSMENT

No further assessment was undertaken associated with fluvial geomorphology for the Supplementary EIS.

11.2.2 WATER QUALITY ASSESSMENT

The methodology for assessment of water quality parameters is the same as that described in the EIS, however the addendum to the water quality technical report included in Attachment B builds on the water quality assessment presented in the EIS. Additional water quality data obtained between September 2008 and March 2009 for daily monitoring and event monitoring has been incorporated into the original water quality datasets, and refinements/ modifications to the Project scope have also been considered.

The review of relevant legislation and guidelines pertaining to the surface water assessment was discussed in the EIS, with the Environmental Protection (Water) Policy 2009 (EPP (Water)) coming into force on 28 August 2009 since EIS publication.

To clarify some points raised in submissions on the EIS, the following provides a brief summary of environmental values and water quality objectives.

The EPP Water states legally binding standards for water quality in Queensland. Environmental Values (EVs) and Water Quality Objectives (WQOs) for surface water have been established under the EPP (Water).

Environmental Values (EVs) for the MLA areas have not been identified specifically in the EPP (Water), being within the Fitzroy River catchment. Western Downs Regional Council (WDRC) is in the process of developing EVs for the area. Discussion on the environmental values is further outlined in the EIS and water quality technical report.

None of the affected waters are scheduled in Schedule 1 of the EPP (Water) through the corresponding EVs and WQOs report(s). The EVs of the receiving waters are therefore deemed to be considered by addressing water quality guidelines.

The EPP (Water) indicates that the Queensland Water Quality Guidelines (QWQG 2009) and the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 Guidelines are appropriate to be used to decide water quality trigger values for EV indicators for a waterbody. At the time of preparing this chapter, the Queensland water quality guidelines (QWQG) 2009 referred to in the EPP (Water), Schedule 2, had not been published by the Department of Environment & Resources Management (DERM), and the QWQG 2006 are to be used (pers. comms 16/09/09).

11.2.3 CONCEPTUAL WATER MANAGEMENT SYSTEM DESIGN

Technical Guidelines for Mine Water Management

To clarify a point raised in submissions on the EIS with respect to dams containing hazardous waste, the Mandatory Reporting Level (MRL) is defined as the available storage volume below the spillway crest, equivalent to the lower of the design Annual Exceedance Probability (AEP) 72 hour storm or the design AEP wave allowance. If the MRL is exceeded, the administering authority (DERM) will be notified, and measures to prevent or minimise any actual potential environmental harm will be implemented if the water level encroaches to within the volume of the 0.1 AEP 24 hour storm from the spillway crest.

In estimating the MRL, DERM requires that (regardless of design storm duration) the design volumetric runoff co-efficient should be set at 1.0 (to reflect the possibility of wet antecedent rainfall conditions). As a result, the 72 hour duration design storm results in a larger volume of runoff than for shorter duration storms, as the total rainfall depth is larger. Further details are provided in the Addendum to the Site WMS technical report in Attachment C of STR 11-1-SV1.5.

Adopted design criteria

A risk assessment will be carried out for each dam to determine if it should be classified as a hazardous waste dam, and to assign a hazard category based on the quality of the stored material and the potential for harm. Each dam will be designed in accordance with the following criteria.

Non – hazardous dams

The spillway will be designed considering accepted engineering standards, such as the ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams (ANCOLD, 2000). As a minimum, the spillway will be designed to pass the peak discharge from the 0.01 AEP design flood event.

Non – hazardous (Sediment Dams)

The design storage volume for sediment dams will be sufficient to contain runoff the 10% AEP time of concentration rainfall event.

Hazardous dams

The storage volume will be sufficient to ensure no discharge when operated as part of the overall site water management system under historical climate conditions, as determined through water balance modelling.

The spillway will be designed to pass the peak discharge from a design flood event of the appropriate design AEP for the hazard category, as listed in the table below.

Table 11-1: Spillway design AEP

Hazard category	Design AEP
Low	0.01
Significant	0.001
High	0.0001

Guideline for watercourse diversions

The EIS identifies a number of proposed levees for flood protection. The authorisation of levee banks on mining tenements falls under the jurisdiction of the *Environmental Protection Act 1994*. However where levee banks form plugs for the existing watercourses, some levees may be incorporated into the licensing of the watercourse diversions, and would be assessed under the *Water Act 2000* and the *Integrated Planning Act 1997*.

Since publication of the EIS, DERM (formerly NRW) has confirmed that the '*Watercourse Diversions – Central Queensland Mining Industry*' regional guideline will be applied in the consideration of applications for water licences and development permits for the watercourse diversions within the Project area. More details are provided in section 11.6.3.

11.2.4 HISTORICAL SIMULATION AND WATER BALANCE ASSESSMENT

The historical simulation and water balance has been revised to reflect recent changes to the mine layout and schedule.

Further details of the surface water impact assessment have been presented to describe the potential impact on low flows in watercourses downstream of the MLA areas. Flows of this magnitude are of interest to stock and domestic users as they can be important for filling waterholes during dry periods. The seasonal variation of impacts on downstream flows has also been assessed. Details of the analysis are provided in the addendum to the site water management system technical report as given in Attachment C of STR 11-1-SV1.5 and a summary of the results of the revision to the downstream impact assessment is provided in sections 11.5.2.

At this stage, it is not necessary to prepare water balance studies for final voids. As described in Chapter 6 Project Operations, section 6.4.4, the tailings disposal and management plan involves the filling of most of the final voids in the vicinity of the CPP with fine rejects (tailings), except for Wubagul Pit, Woleebee Creek Pit and Woleebee North Pit. Measures for mitigating potential impacts associated with final mine voids are discussed in section 11.6.2. Hydrological modelling will form part of the mine closure planning process, and will be carried out once the number and locations of mine voids has been finalised.

Water Resource (Fitzroy Basin) Plan 1999 (amended August 2005)

The Water Resource (Fitzroy Basin) Plan 1999 is in the process of review and a replacement Water Resource Plan is anticipated to be finalised by September 2010.

The current exemption for the take of overland flow for activities authorised under a mining tenement applies for this Project. However, the review of Water Resource (Fitzroy Basin) Plan 1999 may result in possible amendments to the overland flow provisions during the life of the mine development. The WJV will consult with DERM prior to taking overland flow to ensure appropriate approvals/exemptions are in place for any extractions taken after the new provisions are in place.

Fitzroy Basin ROP amended April 2006

There is provision in the Fitzroy ROP for licences to be granted on mining tenures, to contain runoff or seepage which would otherwise flow from the site, to allow for suitable storage and treatment. The EIS does not reference any proposed take of water from a watercourse that would be required to remove mine site seepage or runoff that is unavoidably discharged or proposed to be discharged into a watercourse. It is unlikely that this provision (section 6.1.3 of the ROP) would be triggered for a new mine development and DERM (formerly NRW) recommends the removal of the reference to the grant of these licences from the EIS.

Referable dams

Since July 2008, referable dams have been legislated under the *Water Supply (Safety and Reliability) Act 2008*. section 11.4.5 discusses referable dams associated with the Project further.

11.2.5 FLOOD IMPACT ASSESSMENT

The hydraulic modelling that was performed for the EIS has been expanded upon for this Supplementary EIS. The MIKE 11 hydraulic model of the Woleebee/Juandah Creek system was refined and expanded, and a new HECRAS model was constructed for Two Mile Creek in the south-eastern corner of the MLA areas. No changes have been made to the assessment prepared for Mud Creek, Mount Organ Creek or Spring Creek that was presented in the EIS.

Additional flood level observations have also been obtained from local landholders regarding flooding in the 1983 and 1991 flood events. High water marks observed in these events have been compared to hydraulic modelling results for model verification. The results are described briefly in section 11.3.4. Full details of the updates to the flood studies are provided in the Addendum to flood study technical report in Attachment A of STR 11-1-SV1.5.

DERM (formerly NRW) has indicated that as part of the diversion design licensing process, it would expect to see increases in flood level outside the mine lease areas minimised. Options for mitigating the downstream impacts of the Woleebee Creek diversion have been investigated for this Supplementary EIS and are presented in section 11.6.4.

11.2.6 WATER SUPPLY AND WASTEWATER ASSESSMENT

The methodology for estimating water requirements for the Project is generally the same as discussed in the EIS. section 11.4 outlines the further refinements made to water supply and sewerage infrastructure since the publication of the EIS.

Additional assessment was undertaken for the disposal of effluent from the Wandoan Wastewater Treatment Plan (WWTP) The Model for Effluent Disposal using Land Irrigation (MEDLI) was used to determine the fate of nitrogen, phosphorus and soluble salts for proposed effluent irrigation system. The model was used to determine effluent storage requirements given local climatic conditions. Attachment D of STR 11-1-SV1.5 details the assessment.

11.2.7 GROUNDWATER IMPACT ASSESSMENT FOR SUPPLIES DRAWN FROM GREAT ARTESIAN BASIN

The WJV is considering a range of alternative construction water supply sources to be used in preference to the GAB, and as described in section 11.4.3 there are good prospects of obtaining most, if not all requirements from these sources. The GAB supply will only be used during construction as a last resort, if all other on-site sources are insufficient to prevent interruptions to the construction schedule.

A simple analysis of aquifer drawdown resulting from the construction demand extraction was made for the EIS. The simplifying assumption of infinite aquifer extent made in this assessment is consistent with DERM's (formerly NRW's) methodological requirements for assessment of relatively small short-term extractions. This simplified methodology gives a good indication of the relative impact of a new extraction on the GAB. However, it is acknowledged that estimates of absolute drawdown made using this method need to be used with caution.

Observations on drawdown in the vicinity of Cockatoo Creek are consistent with the results of the simplified drawdown analysis. A reduction in measured static water levels is apparent across most of the GAB due to the extraction of water for a range of purposes over many decades.

11.3 EXISTING ENVIRONMENT

11.3.2 CATCHMENTS AND DRAINAGE

With the addition of Wubagul Pit to the mine schedule, two additional creeks will be impacted by mining activities, these being:

- Two Mile Creek
- un-named creek, north of Two Mile Creek.

Both creeks are tributaries of Juandah Creek, and flow into Juandah Creek, just south of Wandoan township.

Since completion of the EIS, DERM (formerly NRW) has completed a site inspection of the MLA areas, and advised which drainage features have been determined as watercourses under the *Water Act 2000*. Table 11-2 (which replaces Table 11.3 in the EIS) below lists these watercourses, which are also highlighted in Figure 11-5-SV1.3.

Table 11-2: Streams and Declared Watercourses crossing MLA areas

Stream	Flows to	Downstream discharge point	Watercourse (Y/N)	Catchment area (ha)	Length (km)
Duck Creek	Horse Creek	Y	N	2,200	10
Un-named Creek	Horse Creek	Y	N	2,300	23
Un-named Creek	Horse Creek	Y	N	2,270	23
Spring Creek	Horse Creek	Y	Y	6,730	67
Mount Organ Creek	Juandah Creek	N	Y	11,370	114
Mud Creek	Juandah Creek	Y	Y	17,530	175
Un-named Creek	Juandah Creek	Y	N	2,410	24
Un-named Creek	Juandah Creek	Y	N	1,040	10
Blackant Creek	Wandoan Creek	N	Y	3,740	37
Wandoan Creek	Woleebee Creek	N	Y	11,640	116
Woleebee Creek	Juandah Creek	Y	Y	75,330	753
One-Arm Man Creek	Woleebee Creek	N	Y	2,260	23
Halfway Creek	Frank Creek	N	N	2,290	23
Frank Creek	Juandah Creek	Y	Y	9,120	91
Two Mile Creek	Juandah Creek	Y	N	2,450	7

11.3.4 FLOODING

The results of the expanded and refined hydraulic models of existing flood conditions in the Woleebee/Juandah Creek system and Two Mile Creek are shown in Figure 11-11-SV1-3. The updates resulted in some changes to the modelled flood levels in areas to the north of the MLA areas, but generally the mapped flood extents are similar to those presented in the EIS.

The additional flood level observations obtained from local landholders, recorded during the 1983 and 1991 flood events, were used for model verification. Insufficient continuous rainfall data was available for the 1983 event to allow this event to be modelled, but the flood level observations for this event lie within the range of the 2% AEP and 1% AEP events, as would be expected based on the measured peak flow rate at Windamere.

Rainfall data was extended to include the 1991 flood event and the model results indicate reasonable matches to the flood level observations for this event.

Full details of the updates to the flood studies are provided in the Addendum to flood study technical report in Attachment A of STR 11-1-SV1.5.

11.3.6 SURFACE WATER QUALITY

The recent daily surface water quality monitoring from March 2008 to March 2009 indicated the following water quality exceedances when compared to QWQG and ANZECC guidelines:

- turbidity at Frank Creek (downstream), Woleebee Creek (downstream and upstream), Mud Creek (upstream), Juandah Creek (downstream and upstream), Spring Creek (upstream) and Mount Organ (upstream) monitoring sites
- pH at Juandah Creek (upstream and downstream) and Woleebee Creek (downstream) monitoring sites
- dissolved oxygen (DO) at Frank Creek (downstream), Woleebee Creek (downstream and upstream), Mud Creek (downstream and upstream), Juandah Creek (upstream), Spring Creek (upstream) and Mount Organ (downstream and upstream) monitoring sites
- electrical conductivity (EC) at Juandah Creek (downstream), Woleebee Creek (upstream).

The assessment of water quality in relation to variations of water level was assessed for DO and pH, because '*extreme flow conditions affect water quality in streams, mainly DO and pH levels*' (EPA, 2006, p. 50). High pH levels generally occur in natural ecosystems when aquatic vegetation uses CO_2 for photosynthesis, causing hypoxic conditions (i.e. low O_2). Streams in the Project area are ephemeral, with streams indicating higher pH levels in stagnant water. However no trend in the relationship between DO and water levels can be established based on the available data.

The event water quality monitoring indicated the following water quality exceedances compared to QWQG and ANZECC (2000) guidelines for physical and chemical stressors and toxicants:

- total suspended solids (TSS), turbidity, total nitrogen (TN), total phosphorus (TP), iron at all sites
- Chlorophyll a at Woleebee Creek (downstream) and Mud Creek (upstream)
- chromium, copper, lead, nickel and zinc at Woleebee Creek (upstream)
- chromium, copper, lead and zinc at Woleebee Creek (downstream), Juandah (downstream and upstream), Mud Creek (upstream), and Spring Creek (upstream)
- chromium, copper, and zinc at Mud Creek (downstream)
- copper and zinc at Frank Creek (downstream) and Mount Organ Creek (upstream).

In addition to the historical monitoring programs discussed in the EIS, water quality monitoring was undertaken by the members of Taroom Shire community, as part of the Upper Dawson Sediment watch program during 2007/2008, located where the Taroom Shire Landcare Group has undertaken water quality sampling at a number of sites above Glebe Weir. This dataset was supplied to the WJV following the Taroom Landcare submission on the EIS.

Although 150 sites have been sampled by Taroom Shire Landcare, summaries of the water quality data registered at five key sites situated near NRW gauging stations were used. The data indicated similarities in comparison with other historical data discussed in the EIS.

In summary, as outlined on the 'Taroom Landcare' website, the results indicate:

- turbidity values in:
  - Woleebee Creek average 4,200 NTU
  - the Dawson River at Taroom has an average of 800 NTU during the event periods, while background values range from 200 NTU to 400 NTU.
- nitrogen under low flow conditions in the Upper Dawson was well above the trigger level compared to ANZECC guidelines, though this varied with season and flow volume. Phosphorous levels are naturally high in the Upper Dawson and vary with season and flow rate

- average electrical conductivity (EC) for a Juandah Creek sample was five times the ANZECC guideline of 110 µs/cm.

This sampling undertaken by Taroom Landcare group was considered to provide useful indicative information on water quality at Woleebee Creek and Dawson River at Taroom.

11.3.7 SURFACE WATER USE

Due to the intermittent nature of streamflow in the area and the availability of groundwater from the GAB aquifers, there is only limited use of surface water in the immediate vicinity of the Project Area. While a small number of licensed surface water users have been identified in the downstream reaches of watercourses crossing the MLA areas, a number of adjacent landholders are reliant on surface water flows for stock and domestic purposes (for which a licence is not required).

11.3.8 GROUNDWATER USE

The EIS Volume 1, Chapter 11 Water Supply and Management, sections 11.3.8 states that "*The Precipice Sandstone is exploited for the town water supplies for Taroom, Wandoan and Miles*" and "*The Hutton Sandstone is heavily exploited for stock water*." It is acknowledged that the term 'exploited', has negative connotations, although it is a commonly used and accepted term. As such these statements should be replaced with "The Precipice Sandstone is utilised for the town water supplies for Taroom, Wandoan and Miles" and "The Hutton Sandstone is heavily utilised for stock water."

11.4 DESCRIPTION OF PROPOSED DEVELOPMENT

11.4.1 POTABLE WATER SUPPLY

The proposed strategy for delivering potable water from the upgraded Wandoan Town Water Treatment Plant (WTP) has been developed further. The forecast demands and proposed infrastructure upgrades have been revised following further negotiation with WDRC, as described in the following sections.

Unit water demands have been agreed with WDRC. While the number and distribution of personnel to be accommodated has been refined with recent changes to the mining schedule, the total potable water demands remain essentially unchanged from the original EIS estimate.

The bulk of mine staff will be housed in the accommodation facilities to be constructed at a location remote from Wandoan township. The on-site population will vary over time, and will peak during the second year of construction. During the operational phase, the on-site mine staff population will reduce.

All potable water infrastructure will be upgraded to cater for the maximum expected demand during the construction phase. During the operational phase, this will result in reserve capacity for WDRC to supply other potential customers.

As part of the construction raw water supply, as discussed in section 11.4.3 below, an additional groundwater bore may be established if required. Following the construction period, the bore will be handed over to WDRC for use as a third potable water supply bore in conjunction with its other two bores.

The potable water produced will be in accordance with drinking water guidelines. Chapter 27D Draft Environmental Management Plan (Potable Water Supply) provides further information on environmental management during the construction and operational phases of the upgraded potable water treatment plant.

11.4.2 WASTEWATER TREATMENT AND DISPOSAL

The proposed strategy for transferring sewage waste from the source to the upgraded Wandoan Town Wastewater Treatment Plant (WWTP) has been further refined. The proposed upgrades have been revised following further negotiation with WDRC, as described in the Addendum to the Water Supply and Management Technical Report STR11-1-SV1.5.

Pump stations and pipework have been sized for peak Project staffing levels during the construction phase and operation phases. Downward fluctuations in these numbers will result in spare capacity in the system.

The proposed process upgrade for the Wandoan WWTP includes the intermittently decanted (extended) aeration lagoon process, which has been successfully operated in small townships throughout Australia. The process works with a continuous inflow and intermittently decanted effluent. The WWTP upgrades include:

- bar screens (existing) and pumping tank (converted from Imhoff tank) for town wastewater

- bar screens and degritter for mine wastewater
- 2 x buffer tanks
- 2 x IDAL/IDEAL unit
- 2.6 x 2,250 m^2 facultative lagoons (existing)
- effluent overflow on land or via gulley to Juandah Creek (existing)
- 2 x storage lagoons for reuse after chlorination (existing)
- aerobic digestor
- expanded sludge drying bed with disposal of dried sludge to landfill.

Waste streams from the upgraded plant will include:

- sludge – approximately 33.9 wet tonnes of sludge will be produced annually. The sludge will be pumped from the aerobic digestor onto the sludge beds for drying. The dried sludge will be removed to the local landfill site as is currently taking place
- treated effluent – treated effluent will be chlorinated and pumped mostly to the showgrounds and golf course for irrigation. The effluent will meet the quality specifications of Class B recycled water.

The treated effluent is proposed to be used predominately to irrigate the Wandoan Showground and Golf course, having a total area of 28.9ha. section 11.6.3 further discusses the outcomes of the MEDLI modelling associated with effluent disposal using land irrigation. Some treated effluent is also proposed to be discharged to Juandah Creek.

Chapter 27C Draft Environmental Management Plan (Wastewater Treatment Plant) provides further information on environmental management during the construction and operational phases of the upgraded wastewater treatment plant.

11.4.3 CONSTRUCTION RAW WATER

The total construction water demand of 700 ML is unchanged.

Further investigations of water supplies available from overland flow captured on the MLA areas and accommodation facilities area suggest it is likely that a large proportion of the construction water demand could be satisfied from existing surface water dams. Water from dams and other on-site sources (such as production bores in coal seams or existing farm water bores not tapping the Precipice Sandstone Aquifer as described in section 11.4.3 of the EIS) will be used as a priority. If the period leading up to and during the construction period is relatively wet, it is possible that the entire construction water demand could be drawn from on-site surface water supplies. However, as this supply is rainfall-dependent, it is possible that the available yields will be well below the Project construction demands.

While the alternative construction water supplies above will be used preferentially, the most reliable potential source is the Precipice Sandstone aquifer of the GAB. As a result, the WJV proposes to establish a new bore into the Precipice Sandstone at a site within the MLA area adjacent to the Jackson-Wandoan Road, as shown in Figure 11-13-SV1.3. If required, this bore will be used as a last resort to draw construction water supplies under a temporary water permit issued by DERM (formerly NRW). When the operational raw water pipeline has been commissioned, the construction water bore will be handed over to the WDRC for use as a third potable water supply bore to be used in conjunction with its other two bores.

11.4.4 OPERATIONS RAW WATER

Operations raw water demand

While there have been some changes to the production schedule and CPP unit water use since the publication of the EIS, the total adopted operations raw water demand is essentially unchanged.

The major demand for operations raw water is the CPP. During periods of peak operational demand, it can make up 80% of the total demand. The estimated net CPP raw water make-up demand, after allowing for the return of recycled decant water from the tailings management system, has increased to 290 L/t ROM coal.

Potential raw water sources

The WJV is no longer pursuing the raw water supply option of coal seam methane associated water sourced from Spring Gully (owned by Origin) and Fairview (owned by Santos) to the west of the MLA areas, as described in the EIS Volume 3 Western Coal Seam Methane (CSM) Water Supply Pipeline.

Raw water will not be obtained from the Precipice Sandstone or Hutton Sandstone aquifers of the GAB for non-potable operational supply purposes.

Raw water quality

Coal Seam Methane by-product water

The current water specification for the Coal Seam Methane (CSM) water supply option is to deliver raw water to the Project at 4,000 mg/L total dissolved solids (TDS). Water is the primary by-product of CSM extraction and is available to the WJV from a collection pond adjacent to the Condamine Power Station (refer to the EIS Volume 2, Chapter 1 Introduction, section 1.3). This option provides the opportunity to beneficially re-use CSM by-product water which is unsuitable for many direct beneficial uses.

The quality of raw water will be the responsibility of the licensed water provider, including any treatment required to achieve the stipulated water quality required by the WJV. If the licensed water provider is unable to meet the Project water specification with untreated CSM water, reverse osmosis (RO) treatment of a portion of the water will be undertaken by the licensed water provider as required. The licensed water provider will manage the RO treatment and disposal of the saline effluent within their own tenements.

The treated CSM water of 4,000 mg/L TDS is unlikely to be suitable for washing vehicles, fire water or for general wash purposes around the MIA and CPP. If required, to reduce salinity further, a reverse osmosis or similar appropriate treatment facility operated by the WJV will treat approximately 450 kL/day (equivalent to 165 ML/annum) of raw water. The treatment facility will be located near the CPP, and reject water will be disposed of in the tailings storage facilities.

Raw water storage

Sufficient raw water storage will be provided adjacent to the CPP to deliver the water demand if the supply pipeline is out of service. The dam is currently expected to store approximately 400 ML (or approximately 14 days supply), though this volume will be confirmed during later design phases to provide acceptable system reliability.

An alternative source of raw water for the Project is water stored in the Project’s water management system (WMS). Historical simulation of the WMS, suggests that with the exception of very dry periods, sufficient yields should be available from the WMS to supply a significant portion of the Project’s demands, if the water management system is designed and operated appropriately. Raw water from the raw water storage dam would only be used to make up for shortfalls in this yield where absolutely necessary.

11.4.5 WATER MANAGEMENT SYSTEM

The surface water management system has been revised to address changes to the pit layout and schedule. The same overall guiding principles have been applied in developing this conceptual design as described in the EIS Volume 1, Chapter 11 Water Supply and Management.

Under the revised mine layout and schedule, twelve potential discharge points from the MLA areas are nominated. Overflows from the WMS will drain to the various creeks crossing the MLA areas, as shown in Figure 11-2-SV1.3.

Pit water/process water management system

To maximise the opportunity for reusing pit/process water across the site, a water pipeline is proposed to be constructed along the conveyor alignment between the CPP and the dump stations in MLA 50229. During wet periods, the rate of return from the pits may exceed the capacity of the CPP to use it, and additional storage will be required to store this. As it is likely that storage will only be required in later stages of the mine life, storage of this water could occur in disused pits in either MLA 50229, prior to being pumped to the CPP, or in disused pits in the vicinity of the CPP. Large volumes of pit water are only likely to accumulate in these storages if very wet weather occurs during the later stages of mining, when the area of disturbance is at its greatest.

Overburden runoff water management system

Runoff from active overburden dumps will have high turbidity and will require settlement in sedimentation dams. It is envisaged that in the first instance these dams would be 'dry basins' with low level outlet pipes which would restrict the outflow from the sedimentation dams, but not permanently contain water. This would allow time for coarse sediments to settle, and if necessary, allow a flocculant to be added to remove very fine sediment to meet allowable receiving water quality limits for turbidity associated with receiving watercourses.

While geochemical testing results indicate that the salinity of runoff from overburden dumps is not likely to be high if the placement of overburden is managed carefully, there is nevertheless some potential for elevated concentrations of dissolved salts and/or metals in the stored water, and provision will be made for a stop valve on all sediment dam outlets, to prevent discharge if water quality is not suitable. Further description of this situation is provided in STR 11-1-SV1.5, Attachment C.

Clean water management system

The creek diversions proposed to be undertaken as part of the Project as described in the EIS, will be updated and/or modified from time to time in accordance with the Plan of Operations as the mine plan and schedule are refined. Conceptual design characteristics of the currently proposed creek diversions are provided in the EIS Volume 1 technical report TR11-2-V1.5 and compared against the hydraulic design criteria described in 'Watercourse Diversions – Central Queensland Mining Industry'. Diversions will generally be undertaken in accordance with these conceptual design characteristics described in section 11.2.3. However, during the detailed design and licensing process under the *Water Act 2000*, the diversion layouts will be refined to ensure they maintain similar geomorphology to other streams in the vicinity with minimal impacts on the extent and duration of off-lease flooding.

Staging of mine water management system

The components of the water management system will evolve as the Project expands, to be compatible with the proposed pit layout and mine schedule. Figures 11-16-SV1.3 to 11-18-SV1.3 have been revised to show the updated mine schedule, the areas of disturbance and rehabilitation, and the required water management structures at each stage. Further details are provided in STR 11-1-SV1.5,Attachment C.

Excluding in-pit pump sumps, up to approximately 53 water management dams are required to manage runoff from disturbed areas at any point during the life of the Project. The number of dams increases over time as summarised in the table below (which replaces Table 11-7 of the EIS).

Table 11-3: Total number of water management dams over the Project life

Year	Sediment dams	Environmental dams
5	20	5
10	27	7
20	35	7
30	46	7

Since July 2008, referable dams have been legislated under the *Water Supply (Safety & Reliability) Act 2008*. The exact number and design details of referable dams will not be finalised until the detailed design stage and during operation of the Project. DERM (formerly NRW) will be consulted once the design is finalised. A population at risk (PAR) assessment will be carried out in accordance with this Act, which requires a PAR assessment to be carried for any dam which is more than 8 m high and has:

- a storage capacity of more than 500 ML, or
- a storage capacity of more than 250 ML and a catchment area more than three times the maximum surface area of the dam at full supply level
- if less than two people are at risk by the dam failing then the dam is not given a failure impact rating and is not referable.

The number and characteristics of dams proposed for the site is described in detail in the Technical Report STR 11-1-SV1.5. Under the currently proposed mine site water management system, all of the seven proposed environmental dams could meet the storage and catchment criteria that define when a failure impact assessment is required.

The flood levees are also potentially higher than 8 m, and will have the potential to store large volumes of water, and thus meet the above criteria. The levees are described in more detail in the Flood Study Technical Report STR 11-1-SV1.5, Attachment A.

The final configuration of the site dams and levees will be established during detailed design stage phase and operation of the Project, and will depend on the availability of construction materials and the relative costs of excavation and embankment construction. DERM (formerly NRW and EPA) will be consulted once detailed dam designs are finalised, and population at risk assessments will be carried out for any dams that meet the above criteria nominated in the legislation. The floodplain areas downstream of these structures are sparsely populated, and it is unlikely any would be deemed Category 2 dams. However, a detailed assessment will be carried out following detailed design of any of the dam and levee structures which meet the above criteria.

Dams containing hazardous waste are not considered referable dams under the *Water Supply (Safety & Reliability) Act 2008* and are instead regulated under the EP Act. Under the definition of hazardous waste in the EP Act, it is possible that the site environmental dams may be deemed hazardous waste dams.

Construction of a number of structures on the MLA areas, as listed in Table 11-4 (replacing Table 11-8 of the EIS), will necessitate disturbance to the bed and banks of watercourses, and consequently licensing under the *Water Act 2000*.

Details of these structures will be finalised close to the construction date and submitted to DERM (formerly NRW) with an application for a Riverine Protection Permit and/or Water Licence application. The currently expected licensed works and their approximate construction dates are listed in Table 11-4 and shown in Figure 11-5-SV1.3. The list has been revised now that DERM (formerly NRW) has confirmed which streams have been determined as watercourses as defined under the *Water Act 2000*.

Table 11-4: Works potentially requiring approval

	Purpose	Watercourse	Approximate Year of construction
1	Rail crossing	Frank Creek	-1
2	Haul road crossing	Frank Creek	3
3	Conveyor, access and dragline walk road crossing	Woleebee Creek	4
4	Haul road crossing	Woleebee Creek	9
5	Conveyor, access and dragline walk road crossing	Mud Creek	9
6	Haul road crossing	Spring Creek	10
7	Stream diversion A at Turkey Hill Pit	Spring Creek/Unnamed Creek	10
8	Stream diversion B at Summer Hill Pit	Mount Organ Creek/Unnamed Creek	18
9	Stream diversion C at Mud Creek Pit	Mud Creek/Unnamed Creek	18
10	Stream diversion F at Woleebee Creek Pit	Woleebee Creek/Wandoan Creek/ Blackant Creek	9
11	Stream diversion G at Leichardt Pit	Frank Creek	15

11.5 POTENTIAL IMPACTS

11.5.1 POTENTIAL IMPACTS ON THE GAB

As the construction water demand estimates are unchanged, and the proposed construction water supply bore location will be drawing from the same vicinity as the existing Wandoan town bores, the preliminary drawdown impact assessment remains unchanged from the EIS. The proposed bore has been moved slightly further away from the existing town bores and the impact on surrounding springs and stream baseflows is therefore expected to be reduced slightly. The next nearest bores are almost 10 km from the existing Wandoan Town Bores, as shown on Figure 11-13-SV1.3.

11.5.2 DOWNSTREAM SURFACE WATER FLOWS

The potential impacts on downstream surface water flows (other than flood flows) are described in detail in the Addendum to the Site WMS Technical Report in Attachment C of STR 11-1-SV1.5. The conclusions of the analysis are essentially unchanged, but the following revised details and additional findings are drawn from the model results:

- the total flow from sediment dams make up a relatively small proportion of flows near the MLA boundary. By Year 30 of the Project, they will make up 4.1% of flows in the creeks immediately downstream of the MLA boundary. At Duck Creek, the smallest catchment crossing the MLA, overflows from sediment dams will make up 33% of total catchment flow near the MLA boundary. The relative impact is significantly reduced downstream. Downstream of the Horse Creek confluence, the overflows would make up only 0.4% of the mean annual Horse Creek flow
- during historical wet periods, up to 1,440 ML of runoff could be expected to accumulate in the larger operational mine pits. However, for 90% of the modelled climate record, surface water in the pits would be minimal. Operation of the proposed pit/process WMS would see the pits dewatered to operational in-pit storage levels with mining interruptions kept to an acceptable frequency
- if extreme wet weather occurs in later years of the mine development, when the area of disturbance and open pits is largest, the capacity of the environmental dams may not be sufficient to drain the active pits. Large water storage volumes and/or reuse will be required to manage the risk of interruptions to mining. Significant water storage is likely to be available in disused pits so that active pits can be drained to operational levels in an acceptable timeframe. An alternative solution for MLA 50229 would be to provide a high capacity water pipeline to rapidly deliver water from the active pits for use in the CPP. During wet periods similar to the wettest on record, up to 18,000 ML of additional water storage could be required for this purpose. If the quality of overburden runoff is such that water captured in sediment dams is unsuitable for release except in larger flows, this additional volume requirement increases to 33,000 ML. In either case, this volume is likely to be available in inactive mine pits
- the mine and associated WMS is expected to reduce mean annual flows immediately downstream of the MLA areas by approximately 3.2% by Year 30 of the Project. The greatest impact is at the small Duck Creek catchment, where mean annual flow will be reduced by 33%. Further downstream, at the Horse Creek/Juandah Creek confluence, where the nearest licensed surface water entitlement (a water harvesting entitlement) is held, the total impact is reduced to a decrease of 2.3% of mean annual flow by Year 30 of the Project
- in response to an issue raised in a submission on the EIS, the mine and associated water management system is expected to reduce mean annual flow in Mud Creek immediately downstream of the MLA areas by approximately 13.4% by Year 30 of the Project. Details of the analysis are provided in the Addendum to the Site WMS Technical Report included in Attachment C of STR 11-1-SV1.5
- the mine and WMS will have a relatively small impact on low flows downstream of the MLA areas. A low flow spell analysis has been used to assess the impact the Project has on the number of flow spells (periods of time with little or no flow) that occur downstream. Results provided in STR 11-1-SV1.5, Attachment C demonstrate there is minimal impact on the number of low flow spells and mean duration of low flow spells at key downstream locations.

11.5.3 FLOOD IMPACTS

Water management structures such as flood levees and creek diversions are proposed to manage flood flows around the active mine areas. Such structures have the potential to cause a loss of flood storage and increased flood levels both upstream and downstream of the MLA areas due to constriction of flood flows.

The preliminary flood assessment of the Woleebee Creek diversion conceptual design as discussed in the EIS Volume 1, indicated that flood levels directly downstream of the site could be increased by up to 300 mm. The updated flood investigations undertaken as part of the Supplementary EIS have confirmed these impact assessments and show that the impact zone extends well downstream of the site. A revised map of flood afflux for the current conceptual diversion designs is shown in Figure 11-19-SV1.5. Further details of the flood impact assessment can be found in STR11-1-SV1.5,Attachment A. Conceptual potential mitigation measures for these impacts have been investigated, and the results are described in section 11.6.4.

11.5.4 SURFACE WATER QUALITY

Having considered the refinements and changes to the Project scope and submissions raised on the EIS, the potential impacts discussed in the EIS for water quality and the associated technical report, section 5 and Table 5-1, are still valid for the Supplementary EIS.

Pit water

The conservative solute modelling capabilities of the IQQM have been used to indicate a possible range of salinities in the environmental dams over the Project life, with further information provided in the Addendum to the Site WMS Technical Report TR 11-1-SV1.5, Attachment C. The results show:

- salinity levels can become high, but under the proposed operating conditions, this would only occur if stored water volumes dropped to very low levels, that is below the pump inlet level, with concentrations increasing as a result of evaporation. Stored water quality would therefore only exceed sub-lethal concentrations when the risk of discharge was very low.
- following large rainfall events, when the risk of discharge is highest, the salinity would decrease significantly. The maximum modelled salinity when modelled water levels were less than 100 ML from the spillway crest, was typically only slightly above drinking water standard, and the stored water would therefore be considered uncontaminated or low-toxicity waste and be suitable for reuse on the site.

Overburden runoff

Surface water runoff quality is most likely to be impacted by the quality of runoff from overburden dumps prior to full rehabilitation. The characteristics of the overburden and soils are described in detail in Chapter 9.

Overburden electrical conductivity (EC) values ranged between 280 μS/cm and 1,080 μS/cm. Runoff from overburden dumps could therefore potentially have moderately elevated salinity, but with some dilution, such levels would not constitute high levels compared to the receiving waters. An indicative assessment of dilution ratios to sediment dams is presented in the Addendum to the Site WMS Technical Report TR 11-1-SV1.5, Attachment C. The results show that if the above EC is representative of overburden runoff salinity, the EC of sediment dam discharges is likely to be within the range recorded in the receiving waters.

Raw water

CSM water used for the raw water supply would be of relatively high quality compared to that often encountered in evaporation ponds at coal seam gas fields. Unlike in an evaporation pond, the water and dissolved salts will be constantly flushed out of the raw water storage dam, as water is used in the CHPP. However, the salt content and sodium adsorption ratio of the incoming water will be high enough to present some risks with regard to protecting water and land salinity where CSM water is stored and used. There is potential for CSM water to leak into shallow alluvial aquifers and into the nearby creek system, and to cause the accumulation of salts in the underlying soil. Any containing structure will need to be designed to withstand the potentially high sodium adsorption ratio (SAR) without damage. Mitigation measures are discussed in section 11.6.5.

11.5.5 POTENTIAL IMPACTS ON AQUATIC HABITAT

Additional details on the potential impacts of the Project on aquatic habitat and ecology are described in Chapter 17B Aquatic Ecology.

11.6 MITIGATION MEASURES

11.6.1 SURFACE WATER QUALITY

A site assessment of each daily monitoring site will be undertaken to identify a water level in each stream that indicates extreme low flow conditions (i.e. waterhole with stagnant water affecting DO and pH levels). This change will be reflected in the water quality monitoring procedure.

With the addition of Wubagul Pit and refinement of the Wandoan Wastewater Treatment Plant augmentation design, additional monitoring sites are proposed as part of the water quality monitoring program. Changes to the water quality monitoring locations of upstream Frank Creek and upstream Juandah Creek, are as shown in Figure 11-20-SV1.3. Tables 11-5 to 11-8 below outline the recommended parameters for monitoring, superseding Table 11-14 in the EIS Volume 1, Chapter 11 Water Supply and Management.

One of the submissions on the EIS identified an important water quality issue that came out of the '*Report to Queensland Premier Review of the Fitzroy River Water Quality Issues*', which is the need to include monitoring and analysis of selenium in both water and sediment samples. Accordingly, selenium has been added to the suite of parameters that will be monitored.

The treated effluent from the Wandoan WWTP will largely be used to irrigate the Wandoan Showground and Golf course, having a total area of 28.9 ha. The effluent will be chlorinated and will meet the quality specifications of at least Class B recycled water. As part of the proposed augmentation of the Wandoan wastewater treatment plant, monitoring of water quality in Juandah Creek immediately downstream of the discharge point in the mixing zone associated with the wastewater treatment plant is proposed. This water quality monitoring point will be part of the compliance licence for the wastewater treatment plant, with Chapter 27C Draft Environmental Management Plan (Wastewater Treatment Plant) considering this mitigation measure.

Water quality monitoring sites are shown in Figure 11-20-SV1.3.

Two types of monitoring parameters are given in Tables 11-6 and 11-7 below:

1. Receiving water quality limits – for release management and compliance – exceedance of a receiving water quality limit represents an unauthorised discharge.
2. Recommended parameters for site monitoring – levels at which an assessment of the water quality parameters is undertaken.

Due to the ephemeral nature of the watercourses, and resulting variation in parameter characteristics with flow conditions, the establishment of fixed values will not appropriately protect the environmental values of the site. The recommended values will therefore be based on percentiles of measurements of water quality parameters at reference monitoring sites which are unaffected by mining operations.

A release will be deemed to be authorised if, at the frequency permitted by the "Limit Type" column according to Table 11-6, the measured compliance parameter values are within the allowable levels.

The parameter values shown in Tables 11-6 and 11-7 will be continuously updated as more reference data is collected. Minimum receiving water quality limits have been proposed based on previously obtained background monitoring data, as summarised in the EIS and Supplementary EIS. Monitoring values have been proposed based on ANZECC (2000) or Queensland Water Quality Guidelines (2006) for upland streams in a slightly to moderately disturbed condition.

Table 11-5: Recommended parameters for water quality monitoring

Monitoring sample type	Water quality parameter	Recommended values for parameters	Sample frequency
Fully automated sampling stations	Temperature Electrical conductivity pH Turbidity DO	As per table 11-6 and ANZECC (2000) or Queensland Water Quality Guidelines (2006) levels for upland streams in a slightly to moderately disturbed condition.	At least daily, and more frequently when flow is detected.
Event Sampling	Electrical conductivity pH TSS Turbidity TN TP BOD Chlorophyll a Aluminium Arsenic (As) Cadmium (Cd) Copper (Cu) Chromium (Cr) Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Iron (Fe) Manganese (Mn) Selenium (Se) Chlorobenzene	As per ANZECC (2000) or Queensland Water Quality Guidelines (2006) levels for upland streams in a slightly to moderately disturbed condition.	During and after a major flow events.

Monitoring sample type	Water quality parameter	Recommended values for parameters	Sample frequency
	1,2-dichlorobenzene 1,4- dichlorobenzene Ethylbenzene Benzo-(a)-pyrene Toluene OC and OP pesticides Sulfate		
Aquatic Ecology	Parameters to include, but are not limited to: Taxonomic richness Richness of pollution-sensitive invertebrate taxa (Plecoptera (stoneflies), Ephemoptera (mayflies), and Trichoptera (caddisflies) (PET) DO pH Temperature EC Turbidity. Reference to the aquatic ecology technical report should be made for further mitigation measures associated with aquatic ecology.	For taxonomic richness and PET, no lower than existing environment, being, degraded to moderate water quality and habitat. For DO, pH, temperature, EC and turbidity, as per trigger values for fully automated sampling.	Seasonally as required to ensure a long-term aquatic ecology monitoring program is implemented for the Project, with at least two baseline survey events prior to construction.
Wandoan wastewater discharge location	5-day Biochemical Oxygen Demand (5-day BOD) TSS pH *E.coli* Total Dissolved Solids (TDS) DO Aluminium Arsenic (As) Cadmium (Cd) Copper (Cu) Chromium (Cr) Lead (Pb) Nickel (Ni) Zinc (Zn) Mercury (Hg) Iron (Fe) Manganese (Mn) Chlorobenzene 1,2-dichlorobenzene 1,4- dichlorobenzene Ethylbenzene Benzo-(a)-pyrene Toluene	As per ANZECC (2000) or Queensland Water Quality Guidelines (2006) levels for upland streams in a slightly to moderately disturbed condition.	Weekly sampling for 5-day BOD, TSS, pH, *E.coli*, TDS, DO. Quarterly for heavy metals and hydrocarbons.

Table 11-6: Proposed receiving water quality limits for release management

Water quality parameter	Unit	Recommended receiving water limit	Limit type[3]
pH		20th percentile[1] of reference monitoring sites[2] or 6, whichever is lower 80th percentile[1] of reference monitoring sites[2], or 9, whichever is higher	Range
EC	uS/cm	80th percentile[1] of reference monitoring sites[2] or 1000, whichever is higher	Median[1 3]
Turbidity	NTU	80th percentile[1] of reference monitoring sites[2] or 1000, whichever is higher	Median[1 3]

Notes:

1. Limits and impact monitoring level based on the 80th or 20th percentile to be derived using ANZECC (2000) accepted methodology

2. As measured at reference (ie. upstream) monitoring sites as defined in Figure 11-20-SV1.3. The percentiles will be determined prior to and during any release based on samples undertaken in accordance with the *EPA Water Quality Sampling Manual 1999* (or equivalent), using results from continuous real time sampling obtained for a minimum of 18 samples for the flow event in which the release is to occur.

3. The range or median must be determined based on at least 18 consecutive real time samples taken at each downstream monitoring site. The limit type of a downstream monitoring site is defined by the recommended receiving water quality limit of the corresponding upstream monitoring site.

Table 11-7: Recommended parameters for monitoring

Water quality parameter	Unit
Temperature	Degrees C
DO	mg/L
TSS	mg/L
TN	mg/L
TP	mg/L
BOD	mg/L
Chlorophyll a	mg/L
Aluminium	mg/L
Arsenic (As)	mg/L
Cadmium (Cd)	mg/L
Copper (Cu)	mg/L
Chromium (Cr)	mg/L
Lead (Pb)	mg/L
Nickel (Ni)	mg/L
Zinc (Zn)	mg/L
Mercury (Hg)	mg/L
Iron (Fe)	mg/L
Manganese (Mn)	mg/L
Selenium (Se)	mg/L
Chlorobenzene	µg/L
1,2-dichlorobenzene	µg/L
1,4- dichlorobenzene	µg/L
Ethylbenzene	µg/L
Benzo-(a)-pyrene	µg/L
Toluene	µg/L
OC and OP pesticides	µg/L
Sulfate	mg/L

Table 11-8: Recommended Implementation timeframes of water quality monitoring sites

Catchments	Sites	Code	Comments
Juandah Creek catchment	Upper Juandah Creek (US Upper Juandah Creek)	J-UJ	Already installed site will cease to be effective in Year 3, and be superseded by the new US Juandah Creek as shown in Figure 11-20-SV1.3, to be installed no later than one year prior to operations commencing in Wubagul Pit (e.g. no later than the beginning of Year 2) so to provide at least one year's water quality monitoring data prior to operations commencing in Wubagul Pit.
	Upper Frank Creek Dam (US Frank Creek Dam)	J-UF	Already installed site will cease to be effective in Year 3, and be superseded by the new US Frank Creek as shown in Figure 11-20-SV1.3, to be installed no later than one year prior to operations commencing in Frank Creek Pit (e.g. no later than the beginning of Year 2) so to provide at least one year's water quality monitoring data prior to operations commencing in Frank Creek Pit.
	Downstream Juandah Creek (DS Juandah Creek)	J-DJ	Already installed as a permanent water quality monitoring station. Monitoring to continue.
Woleebee Creek catchment	Upper Woleebee Creek (Alternative US Woleebee Creek)	AltW-UW	Installation of a permanent water quality monitoring station to be one year prior to construction commencing of Woleebee Creek Diversion and/or one year prior to operations commencing at Woleebee Creek Pit (e.g. no later than the beginning of Year 9), so as to provide at least one year's water quality monitoring data prior to construction of the creek diversion of Woleebee Creek.
	Wandoan Creek (Alternate US Wandoan Creek)	AltW-UWa	Installation of a permanent water quality monitoring station to be one year prior to construction commencing of Woleebee Creek Diversion and/or one year prior to operations commencing at Woleebee Creek Pit (e.g. no later than the beginning of Year 9), so as to provide at least one year's water quality monitoring data prior to construction of the creek diversion of Wandoan Creek as part of the Woleebee Creek diversion.
	Upper Woleebee Creek (US Woleebee Creek)	W-UW	The already installed Woleebee Creek upstream monitoring site will be able to provide water quality data of Woleebee Creek until Years 11/12, when diversion of Woleebee Creek will impact on or reduce the effectiveness of the site an upstream monitoring location.
	Downstream Woleebee Creek (DS Woleebee Creek)	W-DW	Installation of a permanent water quality monitoring station to be one year prior to construction commencing (e.g. no later than mid Year -3), so as to provide at least one year's water quality monitoring data prior to construction commencing in Year -2. Site will supersede already installed Woleebee Creek Downstream.
	Woleebee Creek Downstream		Already installed site will cease to be effective in Year -2, and be superseded by DS Woleebee Creek as shown in Figure 11-20-SV1.3.
Mud Creek catchment	Upper Mount Organ Creek	M-UM	Already installed as a permanent water quality monitoring station. Monitoring to continue.
	Upper Mud Creek	M-UMu	Already installed as a permanent water quality monitoring station. Monitoring to continue.
	Downstream Mud Creek (DS Mud Creek)	M-DMu	Installation of a permanent water quality monitoring station to be one year prior to operations

Catchments	Sites	Code	Comments
			commencing in Mud Creek Pit (eg. no later than the beginning of Year 3), so as to provide at least one year's water quality monitoring data prior to construction commencing of infrastructure associated with Mud Creek Pit.
	Mud Creek downstream		The already installed monitoring site will cease to be effective prior to Year 4 when infrastructure associated with mining of Mud Creek Pit (conveyors and ROM dump) commences construction. Site will be superseded by DS Mud Creek, as shown in Figure 11-20-SV1.3.
Spring Creek catchment	Spring Creek Downstream		The already installed monitoring site will cease to be effective prior to Year 9 when infrastructure associated with mining of Summer Hill and Turkey Hill Pits (conveyors and ROM dump) commences construction.
	Spring Creek (DS Spring Creek)	S-DS	Installation of a permanent water quality monitoring station to be one year prior to operations commencing at Summer Hill and Turkey Hill Pits (eg. no later than the beginning of Year 8), so as to provide at least one year's water quality monitoring data prior to construction commencing of infrastructure associated with Summer Hill and Turkey Hill Pits.
Duck Creek catchment	Duck Creek	D-DS	Installation of a permanent water quality monitoring station to be one year prior to operations commencing at Turkey Hill Pit (eg. no later than the beginning of Year 8), so as to provide at least one year's water quality monitoring data prior to mining of Turkey Hill Pit.

During operations, water quality information will also be collected from each of the on-site storage dams. The following quality characteristics will be measured:

- pH
- EC
- DO
- Turbidity
- TSS
- Sulphate
- Fluoride
- Aluminium
- Arsenic
- Cadmium
- Cobalt
- Copper
- Lead
- Nickel
- Zinc.

Data will be collected on at least a quarterly basis during normal operations. For environmental dams, the frequency of testing will be increased to monthly if the stored volume encroaches to within 0.1 AEP 72 h runoff volume of the spillway crest, and weekly samples will be taken if the stored volume encroaches to within 0.1 AEP 24 h runoff volume of the spillway crest.

11.6.2 CONCEPTUAL WATER MANAGEMENT SYSTEM DESIGN

The WJV acknowledges that targets set by the Fitzroy Basin Association (FBA) in the *Central Queensland Strategy for Sustainability- 2004 and Beyond* and FBA Interim Water Quality Target 2007, are based on cumulative action of industries across the region.

As stated in section 11.6.2 of the EIS Volume 1, the WJV has committed to managing water within the MLA areas to maintain the existing environmental values of receiving surface waters through the implementation of a site Water Management System. In line with leading industry practice, the objective of the adopted water management system design for this Project is to:

- provide sufficient on-site storage to settle coarse suspended solids from mine area runoff (from overburden dumps and other disturbed areas) during significant rainfall events, through the application of the relevant guidelines on sediment dam storage capacity
- minimise the volume of pit/process water generated by the Project
- avoid planned discharge of pit/process waters through preferential on-site reuse of site water stores. Any water captured and not released will be reused when pit water has been depleted, in the order of priority, at:
  - a nearby water truck fill station
  - conveyor dump station/crusher dust suppression system
  - the CHPP.
- provide sufficient on-site storage to give an acceptable level of risk of accidental off-site discharge of pit/process water during significant rainfall events (no unplanned discharge under modelled historical climate conditions). However, if following rainfall, on-site water storage become relatively high, and if the stored water quality, potential diluting flows and receiving water quality allow, releases may be made to the receiving environment.

The Project water management system will be operated to ensure compliance with the EA discharge conditions, and compliance will be confirmed through ongoing water quality monitoring at stations established upstream and downstream of the site.

The EIS Terms of Reference require that the proposed site water management system is designed in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (Technical Guidelines). The Technical Guidelines require that a risk management approach is adopted for the purpose of protection of the environment. Design risk criteria are specified in the guidelines for the appropriate hazard category, which is based on the potential outcomes of the failure to contain the stored water.

Water quality modelling of the water management system can potentially assist in establishing the likely variability of stored water quality on site, and hence the hazard category. However, until a large database of site-specific pit and overburden water quality data has been collected through routine monitoring during Project operations, there will be uncertainties in the modelled water quality. Given these uncertainties, the results of stored water quality modelling must be used with caution. However, water quality modelling of the water management system would consider the following site characteristics and Project design elements:

- overburden runoff which has not mixed with pit/process water, will not be stored on site. Overburden characterisation data supports the assumption that overburden runoff will be neither acid generating nor high in dissolved solids, and therefore can be treated in dry sediment dams only, that is, there *is no stored overburden runoff water to model*
- regardless of on-site water quality, there will be no planned discharge of pit/process water unless the discharge will achieve the receiving water quality limits for the Project. This approach is achievable, because:
  - runoff to active mine pits can only make its way to receiving surface waters by pumping, uncontrolled discharge is not possible from active pits with the proposed site layout
  - pit water quality is likely to be suitable for reuse as an alternative raw water source for coal processing and dust suppression. It is a common practice to reuse water from pits and environmental dams, even when dissolved salt levels are very high. Dissolved salt levels in tailings reclaim water are likely to be higher than other water types on the MLA areas, such as from sediment or environmental dams
  - the pits will be protected from flooding in the adjacent creeks through a levee system designed to a minimum annual risk of exceedance of 1 in 1,000. As a result, the quantity of water captured will be small compared to the volume of mine pits. If a historically wet period occurs, water can be

temporarily managed in inactive pits while maintaining mine production, until the water can be re-used

- excess pit/process water will be temporarily stored in environmental dams prior to reuse. The risk of unplanned discharge from these dams will be managed by operating such that a storage allowance will be provided to receive summer rainfall inflows. As stated in the EIS, the WJV commits to working with DERM (formerly EPA) to establish a suitable storage design criteria based on industry best practice experience with pit water and process water dams. The impact assessment described in detail in the Addendum to the Site WMS Technical Report, being Attachment C of STR 11-1-V1.5, demonstrates that it is possible to design and operate a system to achieve no discharge of pit/process water under measured historical climate conditions
- the available overburden and groundwater geochemical data of the Project area are consistent with similar Bowen Basin projects. The Hazard Category adopted for these environmental dams can therefore be confidently established based on experience with similar dams at other sites, without resorting to detailed simulation of stored site water quality. A High Hazard category rating is likely to be realistic, based on these assumptions.

Water quality data collected within the site water management system will guide the ongoing refinement and detailed design of the water management system as it evolves during the Project's operations. Water quality modelling will be used to aid this process as more information, such as the quality characteristics of runoff originating from various areas of the site, is collated.

Sediment management

Sediment dams will be sized and configured to achieve efficient sediment removal. These measures have been designed so that any releases should comply with licensed receiving water quality limit for turbidity without further preventative action.

Even where sediment dam overflows make up a large proportion of downstream flow, the impact on downstream water quality is likely to be small. An indicative estimate of sediment dam discharge, made by applying estimated runoff salinity concentrations to various on-site catchment types, suggests overflow salinities at the MLA boundary are likely to be well within the proposed licensed receiving water quality limits for salinity, even before allowing for further dilution between the MLA boundary and the compliance monitoring points. The results are shown in Table 11-9 and details are provided in the Site WMS Technical Report, given in Attachment C of STR 11-1-SV1.5.

Table 11-9: Indicative EC (μS/cm) of sediment dam discharge (all dams discharging)

Stream	Year 5	Year 10	Year 20	Year 30
Two Mile Creek	617	200	619	200
Frank Creek	442	268	200	200
Juandah Creek	272	200	316	200
Woleebee Creek	529	414	338	200
Mud Creek	238	668	484	282
Spring Creek	n/a	592	466	229
Duck Creek	n/a	710	200	200

In the event that suspended solids concentrations are unexpectedly high, the preferred contingency plan will be to convert the sediment dams to 'wet basins' and prioritise the use of the captured water for dust suppression or coal washing without release. However, the WJV will investigate potential flocculants to enable releases to be made if there is a need to rapidly reduce on-site water inventories. Given the results of the water balance modelling, this outcome is considered unlikely, and will only be considered if an effective environmentally inert flocculant can be identified.

Discharge management

During a flow event in the receiving waters, releases may be made from the site water management system to reduce the quantity of stored water and the risk of uncontrolled discharge. Under these circumstances, releases will only be made if pH, EC and Turbidity measured at the downstream monitoring station will comply with the receiving water quality limits listed in Table 11-6.

Release rules will be developed to determine the quantity of mine water that can be released to ensure that the receiving water quality limits are not exceeded. No releases will be made when there is no receiving water flow. It is anticipated that EC or TSS will determine the rate at which water may be released from the site. The release rules may take the following form:

If Dam Stored Water WQ < Downstream Receiving Water Quality Limit then Dam Release Rate is unlimited

If Dam Stored Water WQ < Upstream Receiving Water WQ then Dam Release Rate is unlimited

Else

((Upstream Receiving Water Flow Rate x Upstream Receiving Water WQ) + (Dam Release Rate x Dam Stored Water WQ)) < (Downstream Receiving Water Flow Rate x Downstream Receiving Water Quality Limit)

NB: Where WQ is the measured water quality parameter (for example EC or TSS).

CSM water

CSM by-product water may be used as the water source for dust suppression on haul roads. Submissions on the EIS queried the long-term impact of soil salinity and sodium adsorption ratio (SAR) in relation to haul road dust suppression with CSM water. Measures to limit the potential for impacts from the use of CSM water for dust management include:

- when it is available, using water captured in the site water management system as a raw water source in preference to CSM water
- providing small catch dams to intercept runoff from haul road table drains during low flows, this will help limit the extent of salt discharge during small rainfall events
- the WJV has commissioned an experimental program to assess potential accumulation of salt in the road surface, the potential for precipitated salts to be dissolved and mobilised by rainfall, in relation to rainfall intensity. The results of this program will guide future management of salt on haul roads. Further details are provided in Supplementary EIS Volume 1, Chapter 9
- conducting periodic monitoring of salinity and sodicity during the operation of haul roads, including the road drains and adjacent land. If monitoring suggests a build-up of high levels of salinity or SAR, suitable management measures will be investigated and implemented
- a large portion of the haul roads requiring dust suppression are associated with pit ramps. These ramps will be removed and buried as a component of decommissioning and rehabilitating mine pits
- conducting measurements of soil salinity and sodicity prior to the decommissioning of a haul road, including the road surface, drains, sediment ponds and adjacent land. Where required, material with high salinity or SAR will be excavated, appropriately disposed of, or otherwise remediated, during haul road rehabilitation.

Final voids

At this stage, no water balance studies are necessary for final voids. Hydrological modelling of voids will form part of the mine closure planning process, and will be carried out once the number and locations of mine voids has been finalised. Measures for managing final voids will include minimising the catchments discharging to final voids to maintain flows in downstream watercourses. As described in Chapter 10 Groundwater, groundwater flows into pits are expected to be small, and so the interaction of groundwater with final voids is expected to be limited.

11.6.3 SURFACE WATER FLOW

Clean water diversion

As described in the EIS Chapter 11 Water Supply and Management, section 11.6.1, a watercourse diversion strategy will be developed for the life of the Project. The final number and location of diversions required to facilitate mining will be confirmed and finalised as the mine plan and schedule are refined during mine operations. The strategy will ensure that sufficient time will be allowed for statutory licensing and approval prior to construction and vegetation establishment.

During the licensing process, the diversion layouts will be refined. Local geomorphological characteristics of local watercourses will be taken into account in the detailed design. The design and construction will be to a standard that allows relinquishment of the licence prior to the end of the mine life. The following specific design criteria outlined in DERM's guideline document '*Watercourse Diversions – Central Queensland Mining Industry*' will be applied:

- the channel capacity must be at least equivalent to the capacity of the channel existing in that vicinity
- the length of the channel must be nearly equivalent to the length of the channel it replaces
- the channel must exhibit features similar to the natural existing watercourse such as meanders, terraces, benches, etc
- the design must consider the capacity of the floodplain to deal with out of channel flows
- the design must consider potential impacts on the adjoining reaches of the watercourse
- a channel geometry design should be developed that considers the upper limits for the hydraulic characteristics shown in Table 11-10 below.

Table 11-10:Streams and Declared Watercourses crossing MLA areas

Scenario	Stream Power (W/m^2)	Velocity (m/s)	Shear stress (N/m^2)
2 year ARI (no vegetation)	<35	<1.0	<40
2 year ARI (vegetated)	<60	<1.5	<40
50 year ARI	<220	<2.5	<80

Release from WMS

As presented in the EIS Volume 1, Chapter 11, section 11.6.3, various measures will ensure that the existing flow regime will be maintained to the greatest extent possible. A key design philosophy has been to limit the construction of dams only to those areas where they are required to either prevent flows into the open pits or to mitigate the potential impact of runoff from disturbed areas on downstream water quality.

The indicative assessment of on-site water quality presented in section 11.2 above, shows that it is unlikely that water captured in sediment dams will exceed the proposed licensed receiving water quality limits once suspended sediment has settled. As a result, it will be possible to release from sediment dams to mitigate the potential impacts on downstream flows.

WWTP effluent discharge to Juandah Creek

The proposed WWTP upgrades will result in improvements to the water quality of discharges to Juandah Creek. However there will be an increase in the volume of treated effluent. This impact is to be mitigated by increased irrigation of the Wandoan Showground and golf course using the treated effluent.

According to the Queensland Water Recycling Guidelines (EPA 2005), sewage effluent treated to Class B recycled water standard may only be used for irrigation under controlled conditions. For the golf course, this effectively means irrigation must occur during the night. During wet weather, additional effluent storage will be required to prevent excessive discharge to waterways.

A nutrient and water balance has been carried out using the MEDLI software model to confirm the effluent irrigation would be sustainable at rates approaching 90% reuse. If a 20 ML wet weather effluent storage pond is provided, it is possible to achieve greater than 90% reuse during operational phases. Details of the MEDLI modelling are provided in Attachment D of STR 11-1-SV1.5.

In order to achieve the above reuse rates and to comply with normal discharge license conditions and Queensland Water Recycling Guidelines (EPA 2005), the following infrastructure and procedural commitments will be required from WDRC as owners of the showgrounds, and from the golf course owners:

- controlled access to irrigation areas
- monitoring of shallow groundwater quality in the proposed irrigation areas
- monitoring of soil conditions in the irrigation areas
- development of a Recycled Water Management Plan
- a total of 20 ML of effluent storage to manage wet weather flows
- adequate irrigation equipment to achieve the required irrigation rate on dry days.

11.6.4 FLOODING

As described in the EIS Volume 1, Chapter 11 Water Supply and Management, section 11.6.4, a system of stream diversions and flood levees is proposed to prevent the ingress of flood waters to the mine pits in events up to the 0.1% AEP (1,000 year average recurrence interval (ARI) design flood event), and to ensure that during Project operations, flow in major streams will pass through the site and maintain downstream processes.

As described in the EIS Volume 1, Chapter 11 Water Supply and Management, section 11.6.1 and section 11.6.3 above, a detailed creek diversion strategy will be developed for all creek diversions, with timeframes allowing establishment of stable, vegetated creek channels prior to carrying entire flows of diverted creeks. The strategy will be part of the Plan of Operations, including consultation with and associated licensing from relevant government agencies. The proposed diversion designs will aim to mimic conditions in the existing channels of the creeks to be diverted, including in-channel storage. As a result, the diversions should largely have no impact on the frequency and volume of flows passing to downstream users. With regards to Woleebee Creek diversion, the results of flood modelling show that it is possible to mitigate the impacts on downstream flooding by re-introducing flood storage in the diverted reaches of the various creeks that contribute to flow in the proposed creek diversion. The final design of the diversion will include this flood storage. The configuration will depend on the final mine pit layout and rehabilitation schedule.

As the mine pit layout and schedule is finalised, the diversion designs will also be finalised. Wherever possible, during detailed design, the WJV will incorporate mitigation measures to confine flood afflux to the MLA areas, however, this may not always be possible without sterilising coal reserves. If there are residual off-site impacts, any potentially affected properties and infrastructure will be identified, and the owners notified during the licensing process.

As described in the EIS Volume 1, Chapter 23 Hazard and Risk, section 23.8, the risk posed by flooding will vary during the life of the Project as changes occur as part of the Project, such as changes in landforms, catchment areas, storage areas, structures and creek diversions as required. Emergency response procedures will be developed and regularly reviewed throughout the Project in response to changes in the site hydrology, mining operations, assessed risk and available controls.

During the project, as floodplain works are designed and constructed, the impacts on flooding will be monitored and reassessed so as to ensure the risks to the community and the environment are appropriately mitigated.

11.6.5 RAW WATER STORAGE

If coal seam gas water is adopted as the supply source, it is possible the raw water dam will need to be lined to protect nearby groundwater and soils. Consideration will be given to clay-lining the dam subject to foundation conditions and local availability of suitable lining materials. It is likely that a polyethylene liner will be used to provide an impermeable barrier to leakage. Sufficient monitoring bores will also be installed to detect leakage before it contaminates downstream water resources. Details of the proposed groundwater monitoring network are provided in Supplementary EIS Volume 1, Chapter 10 Groundwater.

11.6.6 AQUATIC HABITAT

Additional measures for mitigating the potential impacts of the Project on aquatic habitat and ecology are described in Chapter 17B Aquatic Ecology.

11.6.7 WATER SUPPLY IMPACTS ON THE GAB

Drawdown on the Wandoan town bores and other nearby bores will be carefully monitored. While no significant impacts are expected, any reductions in flow will be made good where they are the result of the construction water extraction. Details of the proposed groundwater monitoring network are provided in Supplementary EIS Volume 1, Chapter 10 Groundwater, section 10.8. At this time, no suitable on-site water-producing gas bores have been identified as being available to contribute to raw water supplies. If future gas exploration activities produce water of suitable quality for construction, this source will be considered, subject to all regulatory requirements being satisfied.

11.7 REFERENCES

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