11 WATER SUPPLY AND MANAGEMENT

11.1 INTRODUCTION

This chapter outlines the existing environment, impacts and mitigation measures associated with the supply and management of water for the Wandoan Coal Project (the Project).

Details are provided of the Project's proposed:

- potable water supply and treatment system
- wastewater collection and treatment systems
- construction raw water supply system
- on-site operational raw water storage and distribution system
- mine site water management infrastructure.

Three potential raw water supply options exist, being southern coal seam methane (CSM) water supply pipeline, western CSM water supply pipeline, and the Glebe Weir Raising and Pipeline (the Glebe Option), with discussion on each of these provided in Volumes 2, 3 and 4 respectively of the EIS. Final selection of the preferred raw water supply option will be subject to detailed design and commercial supply arrangements.

The purpose of the water management system is to mitigate the potential impacts of the mine on local environmental values and manage water-related operational disruptions. The residual impacts of the mine and water management system on flooding, water supplies and water quality are detailed.

Full details of the impact assessment are included in the Water Supply and Surface Water Management Technical Report TR 11-1-V1.5, which includes the Flood Study Technical Report TR 11-2-V1.5, Surface Water Quality Technical Report TR 11-3-V1.5 and Water Management System Technical Report TR 11-4-V1.5. Note that figures/documents with numbering ending in V1.5 refer to figures/documents contained in Volume 1, Book 5 of the EIS.

Figure 11-1-V1.3 shows the relevant Study Area and Project area discussed in this chapter.

11.2 METHODOLOGY OF ASSESSMENT

A number of impact assessment studies have been undertaken for this Chapter:

Water Management:

- fluvial geomorphology assessment
- water quality assessment
- conceptual water management system design
- historical simulation water balance assessment
- flood impact assessment.

Water supply:

- water demand assessment
- conceptual water supply system design
- groundwater impact assessment for Great Artesian Basin (GAB).

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 and guidelines are described in the sections below, which describe the methodology adopted for each impact assessment.

Water Act 2000

In Queensland, the Water Act is the primary statutory document that establishes a system for the planning, allocating and using of non-tidal water. The Act is administered by the Department of Natural Resources and Water (NRW).

The Water Act prescribes the process for preparing Water Resource Plans (WRPs) and Resource Operation Plans (ROPs) for specific catchments within Queensland. Under this process, WRPs are prepared to identify a balance between waterway health and community needs, and to set allocation and management objectives. The ROPs provide the operational details on how this balance can be achieved.

The WRPs and ROPs determine conditions for granting water allocation licences, permits and other authorities, as well rules for water trading and sharing.

The Water Act makes the provision for the preparation of land and water management plans in specific areas. NRW has advised there are no such plans in place in the vicinity of the Project.

The Water Act also specifies requirements for licensing of structures requiring disturbance to the bed and banks of watercourses. Declared watercourses potentially impacted by the Project are listed in Section 11.3.2.

Environmental Protection Act 1994

The EP Act provides the key legislative framework for environmental management and protection in Queensland.

Chapter 5 of the EP Act establishes a process for obtaining an environmental authority (EA) for mining activities. A Level 1 EA (mining activities) is applicable to the Project. In addition, an Environmental Management Plan (EMP) is also required under section 201 of the EP Act.

Under the EP Act, the Environmental Protection Agency (EPA) is the regulatory authority which has responsibility for granting the EA, as well as compliance, auditing and monitoring of the environmental management of the Project mining activities. Conceptual details and design criteria of the water management systems for the Project are described in the following sections.

The Environmental Protection (Water) Policy 1997 (EPP Water) is subordinate legislation under the EP Act that functions as an important tool for ensuring that the broad environmental protection measures are better defined when it comes to the specific issues of protecting water.

11.2.1 FLUVIAL GEOMORPHOLOGY ASSESSMENT

A geomorphology assessment was undertaken to:

- describe the existing topographic, geomorphologic and geological characteristics of the streams within the Project MLA areas, including characteristics that may impact on or be impacted by the Project
- understand the processes that govern the channel and floodplain morphology
- assess channel parameters that can be used for design of civil and mining infrastructure that may affect the streams during the operational phases of the Project.

The assessment comprised a review of available published geologic, soil and geomorphology data and a field survey on 25 and 26 August 2008.

Ten major streams potentially impacted by the Project MLA areas were assessed: Spring, Mount Organ, Mud, Unnamed Tributary of Woleebee, Blackant, Wandoan, Woleebee, One Arm Man, Halfway, and Frank Creeks. These streams are shown in Figure 11-2-V1.3

11.2.2 WATER QUALITY ASSESSMENT

The purpose of the surface water quality impact assessment is to describe the existing environment for water resources that may be affected by the Project MLA areas and gas supply pipeline in the context of environmental values as defined in such documents as the EP Act, Environmental Protection (Water) Policy 1997 (EPP(Water)) and ANZECC 2000.

The methodology of the surface water quality impact assessment included:

- review of legislation and guidelines potentially relevant to the surface water assessment
- description of the background surface water quality values examining available historic and recent water quality datasets
- description of the features and activities of the Project in the MLA areas and gas supply pipeline that are relevant to the surface water quality assessment
- description of potential impacts
- description of mitigation strategies and measures required to manage the potential impacts on surface water quality
- description of the residual impacts, following implementation of recommended mitigation strategies and measures.

Environmental Values (EVs) and Water Quality Objectives (WQOs) have been established under Schedule 1 of the EPP Water for freshwater. The EPP Water defines an indicator for an environmental value as a property that is able to be measured or decided in a quantitative way. WQOs are generally developed based on the review of the available site specific information that pertains to the associated environmental value. In the policy, it is stated that the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 Guidelines are appropriate to be used to decide water quality trigger values for environmental value indicators for a waterbody.

EVs for the Wandoan area have not been identified and are under development. In this case, where the site specific information is not available, the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines *'are used as a general* *tool for assessing water quality and are the key to determining water quality objectives that protect and support the designated environmental values of water resources, and against which performance can be measured'* (ANZECC 2000, p 2.9).

The water quality guidelines are numerical concentrations or statements for indicators that protect a stated environmental value. The following document types were considered in determining the water quality guidelines for environmental values:

- site specific documents
- the Australian water quality guidelines
- documents published by a recognised entity.
- The EVs of waters to be enhanced or protected under the EPP Water (1997) are:
- biological integrity of a modified aquatic ecosystem
- suitability for recreational use
- suitability for minimal treatment before supply as drinking water
- suitability for agricultural use
- suitability for industrial use.

The ecosystem condition that is most appropriate to be applied to the default guideline value (ANZECC 2000) is a 'slightly to moderately disturbed system'. The guideline values refer to the following levels of protection:

- physical and chemical stressors
- toxicants
- biological indicators.

Background water quality data was obtained from historical and recent water quality sampling, with sampling locations shown in Figure 11-3-V1.3. The datasets used for this assessment include:

- historical data sourced from MIM Holdings, from June 1985 to January 1987
- historical water quality monitoring undertaken by NRW from 1964 (earliest) to 2005 (latest)
- daily data from permanent monitoring stations using automated sampling, from March to mid September 2008
- event data sampling with two events sampled on 13 March 2008 and 24/25 July 2008.

At the time of installation of the automated sampling monitoring stations, constraints were identified associated with the logistics of installation and on-going access to the sites nominated in the original water quality monitoring program. Given the constraints, datasets from the monitoring stations will not provide spatially independent coverage of the Project MLA areas for the operational life of the MLA areas, but do provide some background water quality data for the MLA areas. Other limitations for the recent sampling included a lack of heavy rainfall and surface water flow in the study area contributing to some gaps in measured water quality data, and insufficient data available to discuss seasonal variations or variations with flow.

Further details on the methodology adopted for the water quality assessment is provided in TR 11-3-V1.5.

11.2.3 CONCEPTUAL WATER MANAGEMENT SYSTEM DESIGN

The purpose of the water management system is to mitigate the potential impacts of the mine on local environmental values and manage water-related operational disruptions.

The greatest risk for potential off-site impacts on water quality is the discharge of pit/process water and mine industrial area (MIA) runoff. These water sources may contain contaminant concentrations in exceedance of acceptable limits for the preservation of downstream environmental values.

In line with leading industry practice, the objective of the adopted water management system design for this project is therefore to:

- minimise the volume of pit/process water generated by the Project
- avoid planned discharge of pit/process water under normal operating conditions through preferential on-site reuse of site water stores. Following rainfall, if stored water quality, potential diluting flows and receiving water quality allows, releases may be made to reduce on-site water inventories
- 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 conditions)
- 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 guideline sediment dam storage capacity.

The water management system is a mitigation measure for protecting water quality, but is also a key part of the Project which potentially impacts on the environment.

A conceptual water management design has been developed which complies with the key guidelines and legislation described below.

Technical Guidelines for Mine Water Management

As the administering authority for the environmental management of mining in Queensland, the EPA intends to release guidelines for 'regulated dams' in mine water management systems. However, at the time of writing, final guidelines had not been published. The terms of reference for the Project, require all dams are sized in accordance with the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (Technical Guidelines). The Technical Guidelines were prepared for the former Department of Minerals and Energy and published in 1995. It is understood that the future '*regulated dams*' guidelines developed by the EPA will have a similar intent.

The Technical Guidelines require that design of a site water management system for any mining and processing operation should be based on the concept of risk management for the purpose of protection of the environment.

Design risk criteria are selected based on the appropriate hazard category for the structure under consideration. The selection of the hazard category is based on the potential outcomes of the failure to contain the waste water, i.e. the toxicity of the waste and the attributes of the receiving environment.

Non-environmentally sensitive receiving waters are defined as having '*no environmental features of significance or no environmental damage expected*' and '*no sensitive ecology within 5 km*' (DME 1995). Based on the aquatic and terrestrial ecological studies undertaken for Chapter 17 of the EIS, this description applies to the nearby receiving waters of the Project.

Runoff from mine areas not impacted from pit/process water or mine industrial area may only require the removal of the bulk sediment through the use of Sediment Dams.

The Technical Guidelines suggest that treatment is best carried out at the source of the sediment using silt fences, silt traps, wetlands or sedimentation basins. These are designed to remove the sediment from the runoff at its source. The Technical Guidelines recommend that the design of these localised sediment trapping systems should be based on the time of concentration of the catchment of the device and the 10% annual exceedance probability (AEP) storm. The 10% AEP storm has a 10% chance of being exceeded in any year. These sediment dams should be designed to by-pass when full. The contents of this dam should be drawn down within 10 days of following rainfall.

For dams containing contaminated runoff, the Technical Guidelines recommend that sufficient reserve storage should be available in all dams and ponds to contain the Design Storage Allowance (DSA) of the required design AEP. DSA is the storage required at 1 November each year that will be filled by the process inputs and the runoff from the four month critical wet period if it should occur.

The technical guidelines also refer to the Mandatory Reporting Level (MRL). The MRL is defined as the available storage volume below the spillway crest, equivalent to the lower of the AEP (design risk) 72 hour storm or the AEP wave allowance, at which the EPA must be advised.

The design AEP is assigned based on the Hazard Category for the Dam under consideration. For low toxicity waste (and the minimum standard), the design AEP is 10%. For toxic waste with no downstream riparian users within 5 km or no significant ecology, the design AEP is 1%.

The Technical Guidelines have been addressed in developing the conceptual water management system design.

Code of environmental compliance for High Hazard Dams containing hazardous waste

The EPA has developed a Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste.

The code defines hazardous waste as 'any substance, whether liquid, solid, or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health'. The code notes that such dams are "primarily used for storing process water, recycling treatment liquors and for tailings disposal." Under this definition, it is possible that the following dams on the Project will be designated hazardous waste dams, and be regulated by the EPA:

- the tailings dams and any associated return water dams (see Chapter 6 Project Operations)

- environmental dams in the vicinity of the Coal Handling and Preparation Plant (CHPP) receiving process water
- environmental dams near dump stations collecting runoff and pit water
- the raw water storage dam.

A dam is a high hazard dam only if the dam contains hazardous waste and one or more of the following situations occur:

1. In the event of dam failure or overflow, the dam's content would have one or more of the following actions:
   A. Flow to a sensitive or commercial place.
   B. Flow to a riverine area containing permanent water.
   C. Contaminate a water supply for human consumption.
   D. Contaminate a water supply for stock.
2. The dam is located within a:
   - declared catchment or sub artesian area
   - watercourse and the dam's surface area exceeds 1 ha.
3. The dam has a surface area greater than 2 ha.

While all of the above dams currently meet criteria 1D and 3 only, they could potentially be considered high hazard dams if the stored water quality meets the hazardous waste criteria.

Adopted design criteria

As described in TR 11-3-V1.5, on the basis of overburden geochemical testing results, much of the overburden material is highly dispersive and will erode if left exposed on the soil surface. However, on the basis of various investigations of the overburden physical geochemical characteristics:

- the overburden and interburden rocks are generally not acid forming
- the overburden is not expected to pose a risk of heavy metal contamination
- there is unlikely to be an increase in nutrients in waters flowing from the overburden
- electrical conductivity levels may be slightly elevated, but are likely to be less than 1,100 μS/cm.

With consideration of the above Technical Guidelines, the following criteria have been set for the purposes of the conceptual design.

Sediment dams

So long as areas of particularly sodic or saline material are managed in accordance with the strategies proposed in Chapter 9 Geology, Mineral Resources, Overburden and Soils, the water captured in sediment dams from overburden dumps would be considered uncontaminated (with high suspended solids concentrations only), in which case the appropriate design criteria would be the 10% AEP time of concentration event. The dams will be designed as *'dry'* sediment basins – that is they will have permanently open low-level outlet works sized to ensure they are emptied within 10 days of filling.

Provision will be made in the outlet works to allow an outlet control valve to be fitted to release flows as stored water quality and receiving water conditions dictate. Water may then be pumped out for dust suppression on haul roads or dump stations, or returned to the CHPP if required.

Natural suspended solids concentrations in local soils are observed to be high (see TR 11-3-V1.5), however, if stored suspended solids concentrations are significantly higher than background levels due to the presence of dispersive clays in the overburden, flocculant may be added to sediment dams to treat the water before release. Alternatively, the water may be returned to an environmental dam for on-site reuse.

In the event that overburden runoff has higher than anticipated salinity, the quality of water in the environmental dams will be monitored during the early years of mining, and if required, these dams will be resized and constructed to contain the 10% AEP 24 hour event.

Environmental dams

It is likely that concentrations of potential contaminants in pit water stored in environmental dams will be low enough to ensure that the dam hazard category will not be *'High'.* Discussions will be held with the EPA to confirm acceptable dam design AEPs for mandatory reporting level (MRL) and DSA, however, as a historical simulation water balance model has been applied in this case, the DSA guidelines are not specifically applicable. For the purposes of this conceptual design and impact assessment, all environmental dams have been sized to achieve no discharge when operated as part of the overall site water management system under historical climate conditions, as determined through water balance modelling. The adopted design criteria have been compared to the DSA and MRL requirements defined in the Technical Guidelines.

Guideline for watercourse diversions

NRW Central West Regional Office has prepared a guideline document 'Watercourse Diversions – Central Queensland Mining Industry'. The intention of these guidelines is for use in:

> *'assessing applications submitted by mining companies for authorisations for watercourse diversions. It is also intended as a guide for mining companies and their consultants for use in the planning of diversions and when making applications for authorisations for diversions.'* (NRW, 2008, p. 2)

While these guidelines were prepared for application in the Bowen Basin, it is likely that similar geomorphic criteria would apply in the Upper Dawson. Conceptual designs have been prepared to demonstrate that it will be possible to divert the nominated streams in compliance with the Guidelines without significant impacts on flooding. During the water licensing process, consideration will be given to establishing Project-specific design criteria based on local geomorphic processes.

11.2.4 HISTORICAL SIMULATION AND WATER BALANCE ASSESSMENT

The proposed water management system needs to mitigate the potential impacts of the Project under predictable climate extremes. The typical means of assessing its effectiveness is to use a computer model to simulate the behaviour of the system using recorded rainfall, and evaporation data to predict the daily runoff, dam volumes, evaporation, water use, and dam overflows.

A historical simulation daily water balance modelling approach has been used to quantify the performance of the water management system based on historical climate data.

The Integrated Quantity Quality Model (IQQM) was used for this purpose. The IQQM was developed by the Department of Land and Water Conservation (DLWC) and NRW to assess the possible impacts of current and proposed water management policies on water users. It was developed as a tool for planning and evaluating water resource management policies at the river basin scale. It is the primary modelling tool used by NRW in formulating and managing the Water Resource Planning Process in Queensland River Basins.

Daily rainfall and evaporation data for the Project area were obtained for a 108 year period from 1900 to 2007. The climate time series were used to generate time series of catchment runoff from the various site catchments, which were directed to the various mine pits and water management dams, which were in turn linked via the likely system of pumps and pipelines to points of demand.

The purpose of the assessment was to:

- assess the effectiveness of the proposed water management system in preventing off-site discharge of pit water and thereby protecting downstream water quality
- assess the potential volumes of water intercepted from the MLAs for use in haul road dust suppression and CHPP operation
- assess the impact of the Project on downstream streamflow, in terms of mean annual flow
- the results are used to check compliance with a number of key guidelines and legislation described below. Details are provided in the Water Management System Technical Report TR 11-4-V1.5.

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

Various provisions have been added to the Fitzroy WRP to extend its application to the management of overland flow (OLF) to ensure the environmental flow and allocation security objectives of the WRP are not compromised.

The August 2005 WRP amendment made the taking of overland flow subject to authorisation, except under a limited range of scenarios. The provisions of the amendment do not apply to activities authorised on a mining tenement until the Fitzroy ROP has been amended to include OLF and the release of unallocated OLF has occurred. This is subject to completion of ongoing overland flow planning studies.

The WRP is in the process of being revised by NRW as part of the 10 yearly revision process, and should be complete by the end of 2009.

Fitzroy Basin ROP amended April 2006

The Fitzroy ROP sets down the rules by which water allocations and licences may be granted.

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.

Management of overland flow is not yet covered by the ROP, but after the ongoing revision of the WRP is completed after the end of 2009, the ROP will be updated to include OLF. It is expected that some form of exemption from regulation for constructing works for mining purposes will remain in place for works that are part of an approved water management system. There may be a requirement to demonstrate that overland flow storage is at the minimum capacity required to facilitate mining, and that undisturbed areas have been diverted around the mining activities where possible, to maintain downstream flows.

Referable dams

Under the *Water Act 2000*, a referable dam is one that in the event of failure would put a population at risk. If less than two people are at risk then the dam is not given a failure impact rating and is not referable. A population at risk assessment is required if the dam is more than 8 m high and has:

- a storage capacity of more than 500 ML
- 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.

There are two categories of referable dams:

- Category 1 — Between 2 – 100 people at risk by the dam failing
- Category 2 — More than 100 people at risk by the dam failing.

Dams exceeding the height and volume criteria above, that have not already been assessed as being Category 2, must be reassessed every five years.

11.2.5 FLOOD IMPACT ASSESSMENT

It is important to ensure that there is a very low probability that the mine operations could be flooded by creek flooding throughout the mine life. Flood levees creek diversions and other hydraulic structures such as bridges and culverts for conveyor, road and rail crossings are usually required to ensure operations can be restored shortly after flooding ceases. However, the presence of these structures can impact on flood levels upstream and downstream of the MLAs.

- typically, mathematical computer models are used to develop an understanding of flood behaviour using historical flood records, rainfall records and topographic information of the Project area, and the creek catchments upstream. The guideline document Australian Rainfall and Runoff (Pilgrim, 1999), describes the methodologies which are generally applied, and have been used for this assessment. Full details can be found in the Flood Study Technical Report, TR 11-2-V1.5.

The purpose of this flood impact assessment was to provide the following information:

- the existing extent, level and frequency of flooding in affected waterways, over a range of annual exceedance probabilities (AEPs)
- identification of infrastructure required for flood mitigation, including the management strategies and infrastructure that is needed to minimise impacts on flood levels and frequencies upstream and downstream of the Project Mining Lease Application (MLA) areas

- assessment of the hydrological impacts of the Project, particularly with regard to scouring, erosion, and changes to flooding levels and frequencies both upstream and downstream of the Project.

Only those creeks likely to flood significant areas in the vicinity of the proposed infrastructure and mine operations have been assessed in detail (ie. Two Mile Creek and Duck Creek were not modelled on the basis that proposed works are not proposed on their floodplains).

The assessment was carried out in two parts, with slightly different methodologies in the two areas described in the following sections:

- creeks passing through MLAs 50230 and 50231 (i.e. Juandah Creek tributaries upstream of the Woleebee Creek confluence)
- creeks passing through MLA 50229 (i.e. downstream tributaries of Juandah Creek and Horse Creek).

Creeks passing through MLAs 50230 and 50231

- Estimation of the magnitude and frequency of flood flows using a XP-RAFTS hydrological model. The XP-RAFTS model was calibrated to observed flood hydrographs sourced from NRW stream flow gauge 130344A at Windamere on Juandah Creek, which is located downstream of the MLA areas. The resultant peak design flows were compared with those estimated using a Log Pearson Type III flood frequency curve fitted to the peak annual flow series.
- Identification of the extent of existing flooding for a range of design AEPs using the hydraulic model MIKE11. MIKE11 was used in this area as it allows an assessment of the importance of loss flood storage on downstream flows. This was shown to be important for Woleebee Creek – but less so elsewhere on the site. MIKE21 was also used to help identify flow patterns in the flood plain.
- Preparation of inundation plans using the results of the hydraulic model, in the vicinity of the MLA areas.

Creeks passing through MLA 50229

- estimation of the magnitude and frequency of flood flows using the rational method
- comparison of the magnitude and frequency of flood flows in using the same XP-RAFTS hydrological model that was used for the creeks passing through MLAs 50230 and 50231
- identification of the extent of existing flooding and flow velocities for a range of design AEPs using the hydraulic model, HEC-RAS.
- preparation of inundation plans using the results of the hydraulic model, to highlight existing infrastructure currently affected by flooding in the vicinity of the MLA area.

Impacts and mitigation measures were assessed by modifying the model geometry to reflect the inclusion of proposed stream diversions and flood levees, the outputs included:

- changes to the extents of flooding
- changes to flood levels
- changes to flows
- further details of the methodology can be found in TR 11-2-V1.5.

11.2.6 WATER SUPPLY AND WASTEWATER ASSESSMENT

The purpose of this assessment was to estimate the water requirements for all phases of the Project, and the infrastructure and upgrades required to service the Project. Three broad categories of supplies and discharges were been assessed:

- potable water supply
- wastewater discharge
- construction raw water supply system
- operational raw water supply system
- on-site operational raw water storage and reticulation system.

The existing potable supply and wastewater treatment facilities in Wandoan township were assessed using published data and through site visits with Dalby Regional Council personnel.

Existing water supply and wastewater treatment rates were obtained from data published in the former Taroom Shire Strategic Plan, and further detailed data from the Dalby Regional Council.

Future Project-related potable and wastewater demands were based on the forecast personnel schedule and historical water usage rates from similar accommodation facilities, town water supplies and mine industrial areas.

General potable water and wastewater design parameters were adopted in accordance with the Queensland Water Supply and Sewerage Guidelines.

Construction raw water demands were based on experience on similar construction projects in Central Queensland. A number of sources have been investigated and are being considered for sourcing construction water supplies over the two year construction period. The most reliable potential source is from the Precipice aquifer of the GAB, via the existing Wandoan Town bores. The potential impacts of this extraction on the bores and aquifer are discussed in the following section.

Operational raw water demands were estimated using the proposed production schedule and an estimated unit water use rate developed in the CHPP design based on previous project experience from the expected raw coal and product coal moisture content, product yield and likely tailings storage facility water return rates. These demand estimates have been used in the design of the pipelines referred to in Volume 2, Volume 3 and Volume 4 of the EIS.

A preliminary design of the onsite raw water storage and reticulation system has been prepared to reliably distribute raw water to the primary points of demand, and will be finalised in the design stage. The raw water storage volume has been nominated to allow the plant to operate continuously in the event of temporary interruptions to supply from the supply source.

11.2.7 GROUNDWATER IMPACT ASSESSMENT FOR SUPPLIES DRAWN FROM GREAT ARTESIAN BASIN

A hydrogeological investigation was carried out to assess the impact of drawing the additional potable water and construction water demands described above. The analysis considers the impact on nearby water users in the related aquifers, and nearby springs and baseflow streams. Details of the analysis are contained in the Technical Report in TR 11-1-V1.5.

The Water Resource (Great Artesian Basin) Plan 2006 (GAB WRP) defines the water availability in the plan area and the individual management areas. Furthermore it provides a framework for sustainably managing water use and identifying priorities and mechanisms for dealing with future water requirements.

The GAB WRP defines 25 groundwater management areas within the GAB. The Project is situated within the Surat North Management Area (Area 20) and is located close to the junction of two other management areas, Surat (Area 19) to the south-west and Surat East (Area 21) to the south-east. The GAB WRP covers artesian water, subartesian water and water in springs connected to either of these sources.

Each of the management areas is divided into a number of management units, which are comprised of individual aquifers or groups of aquifers. It is noted that a water licence granted for taking water in the plan area must be consistent with the criteria for the protection of the flow of water to springs and baseflow to water courses that are provided in the Great Artesian Basin Resource Operations Plan (GAB ROP).

The GAB WRP states that unallocated water is held as a general or State reserve. Unallocated water may be granted from the general or State reserve under a process set out in the GAB ROP. For a given management area unallocated water must be granted, as far as is practical, based within the volumetric limits stated for each management unit.

In section 26 of the GAB WRP that 10,000 ML is available for allocation from the State reserve. A water allocation may be granted from the State reserve only if the Project is:

- of State significance
- of regional significance or
- for water granted to local government – i.e. town water supply purposes.

Water licences stated in the resource operations plan must be granted to local government to allow for the continued taking of water. The licences must state a volumetric limit, based on the number of lots in the town area, the plan area where the town is situated and the existence of existing or alternative supplies. The volume that may be taken may be the greater of the stated volume or the new specified volumetric limit.

It is noted in the GAB WRP (s31) that the GAB ROP must contain criteria for protection of the flow of water to springs and baseflow in watercourses. The criteria may include the maximum acceptable reduction of artesian water pressure or subartesian water levels at stated distances from the springs or parts of water courses.

The GAB ROP's purpose is to provide the details necessary to implement the GAB WRP and ensure the long-term water supply security of future and existing licence holders while protecting environmental flows. Some key features of the GAB ROP include:

- water entitlements are not separated from land title that is, they remain as licences rather than being converted to allocations, and will not be tradable in the same way as surface water entitlements have become under some surface water ROPs (except under limited circumstances, that is where the existing licence specifies a volumetric limit, within a management area, between other similar water uses)
- the assessment methods include simplified processes for impact assessment of new or relocated licenses, as they relate to:
  - the protection of existing entitlement (identifying a minimum separation distance)
  - the protection of springs and connected watercourses (using spring factors).

If applicants satisfy these criteria, the proposed release is taken to satisfy the requirements of the plan. However, the applicant will have the option of undertaking detailed analysis if they believe the simplified method unfairly overestimates the impact of the proposal.

Approval for the taking of construction water for the Project will be sought under section 237 of the Water Act. .

11.3 EXISTING ENVIRONMENT

11.3.1 CLIMATE

The local climate is described in detail in Chapter 7. Surface water-related climate data used for this assessment is also described in more detail in the Technical Report TR 11-1-V1.5 section 3 and TR 11-4-V1.5.

11.3.2 CATCHMENTS AND DRAINAGE

Juandah Creek, the most prominent watercourse in the study area, flows north to the Dawson River (64 km north of the MLAs). The greater Juandah catchment is largely undulating with some isolated rocky peaks to elevations above RL 490 m. Most of the catchment is cleared for grazing, with forested areas in the steeper upper catchment on the slopes of the Great Dividing Range.

The Project MLAs make up an area of 32,200 ha. Approximately 83% of this area drains to Juandah Creek, with the remainder draining to Horse Creek. The total catchment area to the confluence of Juandah Creek and Horse Creek is 357,600 ha, being 9% of the total catchment area to this confluence is contained within the MLAs.

The Project is located in the southern portion of the Fitzroy River drainage basin, in the upper catchment of the Dawson River. The location of the site in relation to the rest of the Fitzroy Basin is shown in Figure 11-4-V1.3.

Mean annual flows from the Project area compared to key downstream locations in the Fitzroy Basin area summarised in Table 11-1. The mean annual runoff from the Project MLAs (9,000 ML/a), makes up about 1.4% of the mean annual inflow to Glebe Weir on the Dawson River and less than 0.2% of the total mean annual flow at the Fitzroy River mouth.

Table 11-1: Project area runoff compared to flow at key locations in Fitzroy Basin

Location	Stream	AMTD	Distance to Fitzroy River Mouth	Estimated mean annual discharge
		km	km	ML/a
Wandoan MLAs			~765	9,000
Windamere	Juandah Creek	62.8	761.6	46,500
Juandah Creek u/s of Horse Creek		*33.3*	*732.1*	*71,700*
Horse-Juandah confluence		**33.3**	**732.1**	**99,100**
Juandah Creek u/s of Dawson River		**0**	**698.8**	**135,000**
Juandah-Dawson confluence		***388.5***	***698.8***	***362,000***
Taroom	Dawson River	384.6	694.9	578,000
Glebe Weir	Dawson River	330.1	640.4	628,000
Theodore	Dawson River	230.0	540.3	1,120,000
Baralaba	Dawson River	84.7	395.0	
Dawson-Fitzroy confluence		**310.3**	**310.3**	
Yaamba	Fitzroy River	108.8	108.8	5,363,000
Fitzroy Barrage	Fitzroy River	59.6	59.6	
Fitzroy River Mouth	Fitzroy River	0.0	0.0	

The Project area consists of undulating to near flat terrain, with gently-sloping ridges aligned north-south. Two main terrain elements are present:

- alluvial floodplains, which vary in width from less than 500 m to about 2 km, and generally have a slope towards the creek channel and downstream of less than 2%. These landscapes occur at a surface elevation (RL) of approximately 230 m to 250 m Australian Height Datum (AHD). The floodplains have largely been cleared for beef cattle grazing and limited fodder cropping. Remnant riparian vegetation is present along the creek lines
- low undulating hills, with an RL of between 250 m and 295 m AHD, make up the majority of the Project area. Slopes are generally less than 4%, but locally the upper slopes are up to about 15%. Land in the undulating terrain is largely cleared for agricultural uses, with fodder crops on the flatter gradients, and beef cattle grazing on steeper slopes.

Photo 11-1: Grazing land and peaks in upper Juandah Creek catchment

The northern MLA boundaries run essentially parallel to Juandah Creek, which flows adjacent to the Project from south-east to north-west. Horse Creek flows from south-west to north-east at the north-western edge of the site, and joins Juandah Creek about 10 km downstream.

Photo 11-2: Juandah Creek channel upstream of Windamere streamflow gauge

With the exception of a very small area at the far western edge of MLA 50229, which drains to Horse Creek via Duck Creek, all streams located within the Project area are tributaries of the four key streams shown in Figure 11-2-V1.3 and Table 11-2.

Table 11-2: Key stream characteristics

Stream	Stream order	Stream length (km)	Catchment area to downstream MLA boundaries (ha)
Juandah Creek	3rd	83.3	86,469
Woleebee Creek	3rd	68.8	77,776
Mud Creek	3rd	40.7	18,786
Spring Creek	2nd	18.3	5,454

A number of smaller, north-flowing parallel tributaries drain the MLAs toward Juandah Creek and Horse Creek. These streams are listed from west to east in the Table 11-3. Streams which cross the MLA boundaries (i.e. are downstream discharge locations) are highlighted in Figure 11-2-V1.3.

The table also indicates which streams NRW has declared (provisionally, pending a field assessment) as Watercourses under the Water Act. These streams are also highlighted in Figure 11-5-V1.3.

Table 11-3: Streams and Declared Watercourses crossing MLAs

Stream	Flows to	Downstream discharge Point	Watercourse (Y/N)	Catchment area (ha)	Length (km)
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
Unnamed Creek	Juandah Creek	Y	N	2,410	24
Unnamed Creek	Juandah Creek	Y	Y	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	N	Y	9,120	91
Two Mile Creek	Juandah Creek	Y	N		

11.3.3 STREAMFLOW

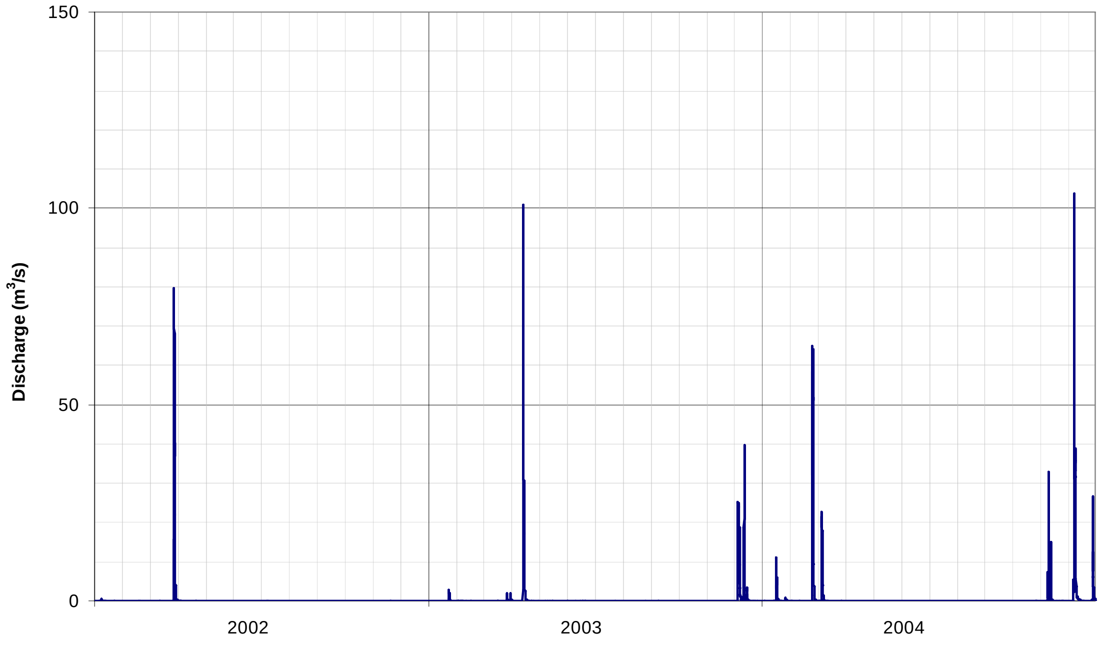
NRW has measured streamflow at the Juandah Creek at Windamere streamflow gauge (130344A) since late 1974. The gauge is located just downstream of the MLA 50230 boundary at Adopted Middle Thread Distance (AMTD) 62.8 km, as shown in Figure 11-2-V1.3. The catchment area to this location is 167,800 ha.

Based on the NRW gauged streamflow data, the mean annual flow in Juandah Creek downstream of Woleebee Creek confluence is 46,500 ML/a, or 27.7 mm of runoff, with a runoff to rainfall ratio of 4.3%. This is in the typical range for Fitzroy basin streams. Assuming a similar rainfall/runoff relationship for all sub-catchments crossing the MLAs, the mean annual discharges in the tributary catchments are as summarised in Table 11-4.

Table 11-4: Mean annual flow in major creeks crossing the MLAs

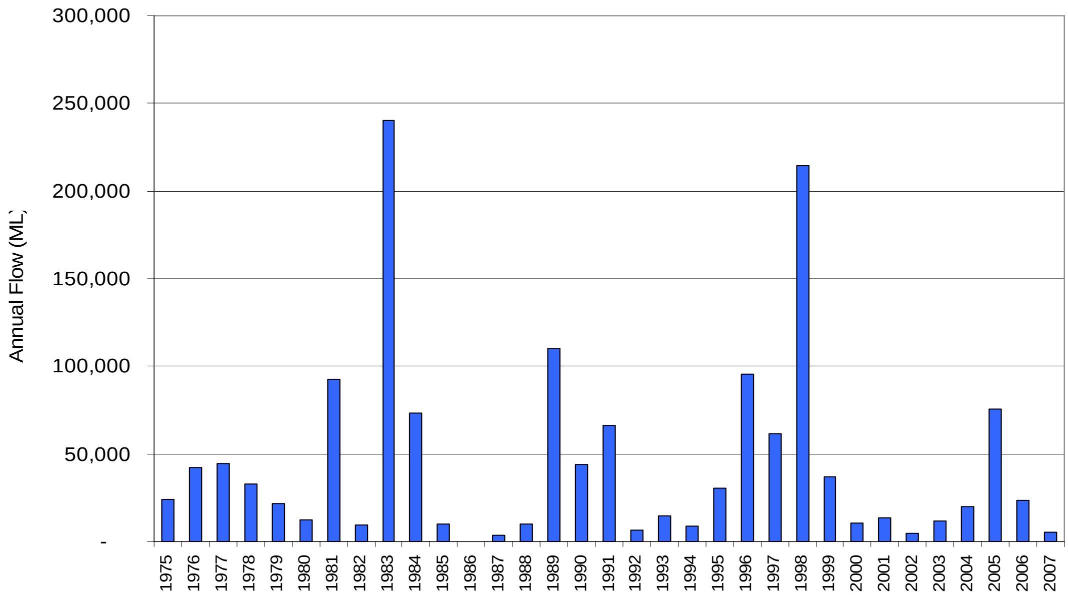
Location	Mean annual flow (ML/a)
Juandah Creek at Windamere	46,500
Juandah Creek at MLA boundary	23,854
Woleebee Creek at Juandah Creek confluence	20,470
Mud Creek at MLA boundary	5,184
Frank Creek at Juandah Creek confluence	2,480
Spring Creek at Juandah Creek confluence	1,830

Figures 11-6 and 11-7 show measured streamflow in Juandah Creek is highly variable. Intermittent episodes of high flow are interspersed with long periods of no flow during which the bed is dry except for small isolated waterholes.



SOURCE: NRW Watershed database, 2008

Figure 11-6: Example of Juandah Creek streamflow 2002 to 2004

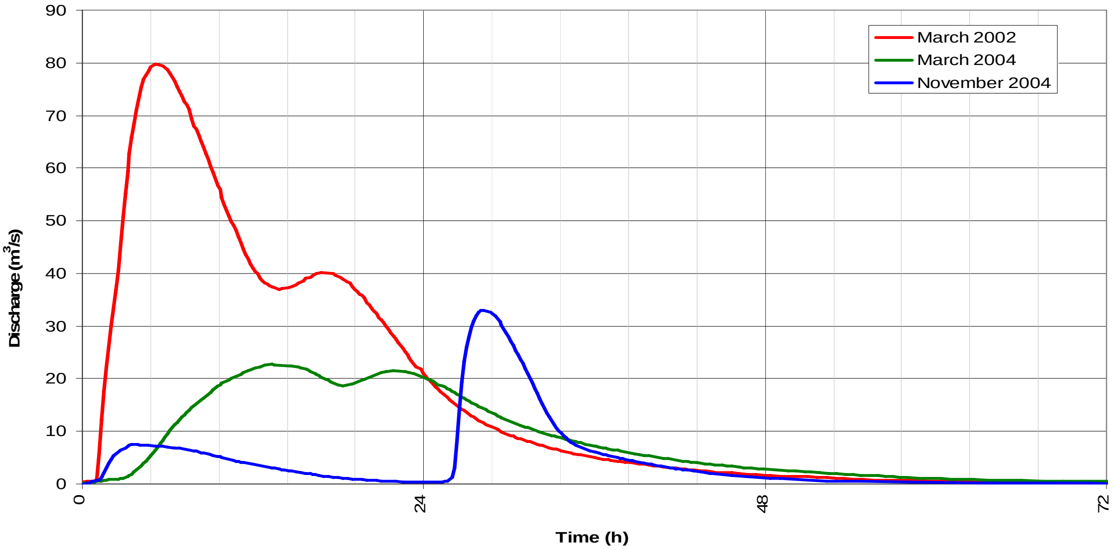


SOURCE: NRW Watershed database, 2008

Figure 11-7: Observed annual streamflow at NRW Juandah Creek gauge from 1975 to 2007

Streamflow events tend to be of relatively short durations. Figure 11–8 shows some typical flow hydrographs in Juandah Creek, with flows persisting for several days following rainfall events:

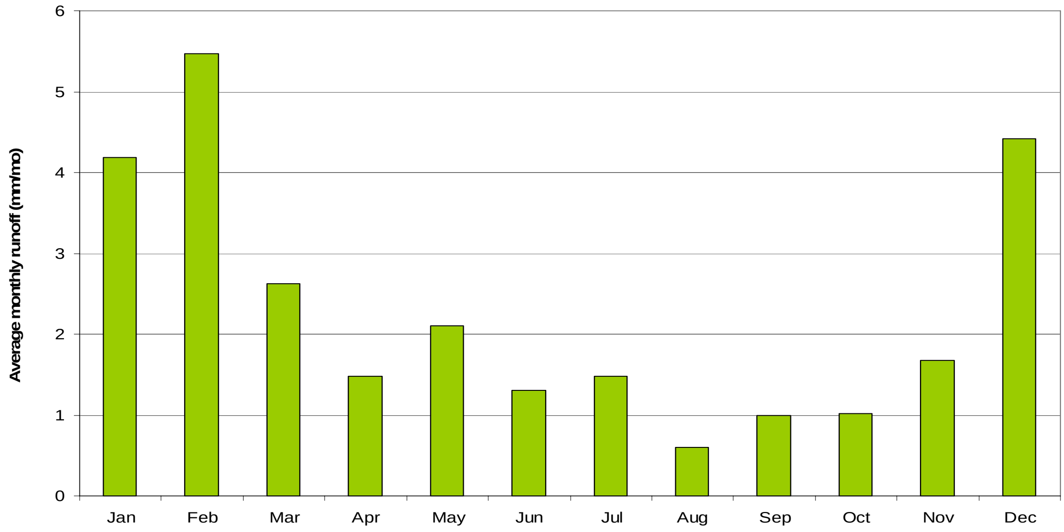
- March 2002 – 80 mm of rain over two days
- March 2004 – 54 mm of rain in one day
- November 2004 – 44 mm of rain over two days.



SOURCE: NRW Watershed database, 2008

Figure 11-8: Some typical Juandah Creek streamflow events

Flow events occur all year round, but most occur between November and March. The largest contribution to annual runoff comes from events occurring in December, January and February, as shown in Figure 11-9.



SOURCE: NRW Watershed database, 2008

Figure 11-9: Seasonal variation in monthly run-off (modelled 1900-2007)

11.3.4 FLOODING

The maximum recorded flow in Juandah Creek at Windamere streamflow gauge is 891 m^3/s, which occurred in May 1983. The annual series flood frequency curve shown in Figure 11-10 indicates that the design peak 1% Annual Exceedance Probability (AEP) flow (i.e. the flow that has a 1% chance of being exceeded in any year) for Juandah Creek at the Windamere gauge is 1,852 m^3/s.

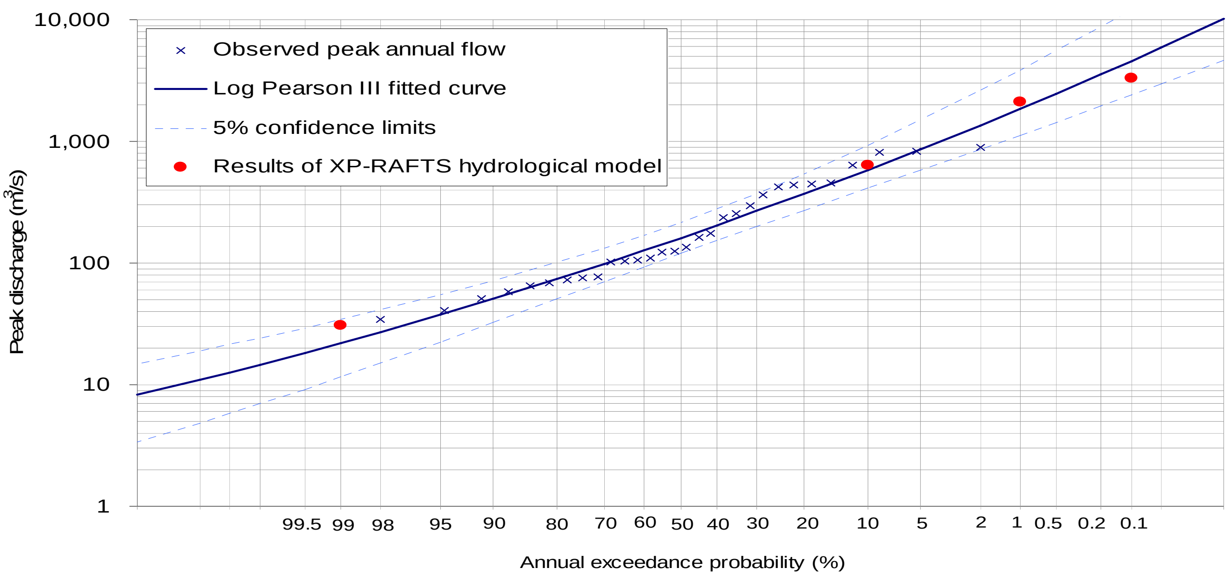


Figure 11-10: Annual series flood frequency curve–Juandah Creek at Windamere

Peak flood discharges have also been estimated over all significant tributaries for a range of design AEPs.

The extent of flooding in major stream crossing the MLAs is shown in Figure 11-11-V1-3. Full details of the flood impact assessment can be found in the Technical Report TR 11-1-V1.5.

11.3.5 FLUVIAL MORPHOLOGY

Most stream valleys in the Project area have been slowly widened via sheet erosion and vertical accretion of the floodplains. Lateral channel migration by formation of incipient meanders and splays appears to be common to all streams. Meanders appear to be controlled by the interaction between streamflow, regional topographic gradients, and underlying geology. As a result, sinuosity and wavelength to amplitude ratios vary both along streams and between streams.

Photo 11-3: Typical channel form of Mud Creek

Woleebee, Wandoan and One Arm Man Creeks carry mainly sandy bedload. Spring Creek and the major unnamed tributary of Woleebee Creek carry mixed sandy and clayey sediments, while the other creeks have clay draped channels with no noticeable sandy bedload sediments.

Photo 11-4: Typical form of Wandoan Creek channel

Bankfull flow is thought to carry out most of the channel-modifying work in a stream, however flows of such magnitude are relatively infrequent and of short duration at the Wandoan area. Most streams appear to be in a juvenile stage of evolution, with relatively narrow floodplains and poor alleviation. Channel deepening or widening of the incised channels would occur at less than bankfull discharge but even these lower flows are relatively infrequent.

There is generally low habitat variability, and moderate to extensive bank erosion. With the notable exception of Mud Creek, the upstream reaches are relatively straight and shallow, with little riparian vegetation to provide canopy cover to the channel or terrestrial debris for in-stream habitat. The downstream reaches generally have more riparian vegetation, including a higher cover of large trees. This vegetation provides shading of the channel, roots, fallen branches and logs for in-stream physical habitat, and stabilises the banks at some sites.

Degraded creeks in the catchment are characterised by riparian vegetation loss, erosion, invasion of weed species, poor water quality and sedimentation (Telfer 1995). Biodiversity is relatively low, with only fish and macro-invertebrate species that are tolerant of varying and often harsh conditions inhabiting the study areas.

Further details of the fluvial morphology of streams crossing the MLAs, including a detailed photographic record can be found in the Technical Report TR 11-1-V1.5.

11.3.6 SURFACE WATER QUALITY

This section provides a summary of the existing environmental values for water quality based of historical and recent datasets. Section 4 of the Technical Report for water quality (refer TR 11-3-V1.5) provides further details.

A water quality monitoring network has been established across the MLA areas. However, some limitations exist with the spatial coverage of the datasets, as mentioned in Section 11.2.2 and described further in Section 2-2 of Technical Report TR 11-3-V1.5.

Historical and recent daily and event data obtained for the Project MLA areas have been reviewed and compared against the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines.

The historical water quality values for pH, nitrate (NO_3), nitrite (NO_2), orthophosphate (PO_4), total phosphorus (TP) and total nitrogen (TN) exceed ANZECC (2000) guideline values. This identifies the historical nutrient pollution in the Project MLA areas. The recent data recorded confirmed that the Project MLA areas have elevated nutrient (TN and TP) levels compared to guidelines, as recorded at Woleebee Creek (downstream), Mud Creek (downstream) and Juandah Creek (downstream). Given the nutrient pollutants identified and agricultural land use in the MLA areas, nutrient pollutants are likely to result from fertiliser application and other nutrient concentrating activities.

Recent daily monitoring showed that the area is slightly disturbed, having no guideline exceedances for the majority of water quality parameters.

The findings based on the recent daily monitoring were:

- the electrical conductivity (EC) for the Juandah Creek (upstream and downstream) sites were somewhat greater than the other sites. The Mud Creek (upstream) site had the lowest EC levels
- pH was high for most of the monitoring sites, with exceedances recorded at Frank Creek (upstream), Juandah Creek (upstream and downstream), Woleebee Creek (upstream and downstream) and Mud Creek (downstream) monitoring sites
- the percentage of dissolved oxygen (DO) saturation was somewhat low for all monitoring sites, excluding Juandah Creek (downstream) and Woleebee Creek (upstream)
- the available turbidity data was found to be very high in particular at Frank Creek, Mount Organ (downstream) and Mud Creek (upstream), and elevated at Woleebee Creek (upstream). The Mud Creek (upstream) site had the highest turbidity levels. However, Mud Creek (downstream) was within a healthy range, although limited results were available.

The daily and event water quality monitoring indicates high turbidity. This suggests that the catchment condition is somewhat degraded, and is likely to be impacted during heavy rainfall events. This is related to sediment-laden runoff associated with soil erosion from hillslopes, gullies and banks, and associated distribution via runoff.

The water quality analysis also indicated elevated heavy metal levels, including aluminium (Al) levels. For the historical data, most of the samples taken for heavy metals exceed the 95% protection trigger values as well as less stringent guideline trigger values including protection of 90% and 80%. The 95% trigger values are typically associated with 'slightly to moderately disturbed systems'.

The recent rainfall event sampling confirmed ongoing elevated heavy metal values, particularly for Iron (Fe). The changes in toxicity of metals with pH are usually associated with changes in bioavailability and speciation states of the metals. Outside the pH range of

6.5 to 9, metals vary markedly in toxicity with hardness (given low hardness 30 mg/L of calcium carbonate ($CaCO_3$) and pH) (ANZECC 2000, p.8.3–44).

The recent event water quality data indicates the following water quality exceedances:

- physical and chemical stressors and toxicants: total suspended solids (TSS), turbidity, TN, TP, Iron at all sites; Chlorophyll a at Mud Creek (downstream), Copper (Cu) and Zinc (Zn) at Woleebee Creek (downstream) and Frank Creek (downstream); and Chromium (Cr) at Frank Creek (downstream)
- Organochlorine Pesticides (OC) were below detection and therefore no exceedances were recorded at the sites measured for OC
- Organophosphorus Pesticides (OP), dichlorvos and fenthion, were above detection at Juandah Creek (downstream), and dimethoate and chlorpyrifos exceeded the guideline values at all sites (excluding dimethoate at Mud Creek downstream site).

The ANZECC (2000, p. 8.3–44) guideline also states the following in relation to stated guideline trigger values for metals:

> '*Natural background concentrations of some chemicals, particularly metals, may exceed the stated guideline trigger values due to mineralisation from the catchment substrate, as distinct from anthropogenic sources. In such cases, it would be unreasonable to insist on a guideline value below the background concentration. High levels of naturally-occurring metals in highly mineralised areas are not necessarily indicative of adverse environmental effects due to possible adaptation of the local fauna*.'

Overburden and interburden material was assessed for acid mine drainage as part of Chapter 9 Geology, Mineral Resources, Overburden and Soils for the MLA areas. The assessment estimated the potential for acid mine drainage from oxidation of pyritic ores (e.g. iron sulphide). The chapter concludes that heavy metal concentrations within the overburden are below the concentrations requiring investigating under the National Environment Protection (Assessment of Site Contamination) Measure 1999 (National Environment Protection Council 1999).

The recent monitoring also identified degraded water quality associated with OP pollution, indicating that dichlorvos and fenthion were above detection, and dimethoate and chlorpyrifos exceeded the guideline values.

There was insufficient data available to discuss the existing water quality in terms of seasonal variations or variations with flow.

The EVs of the study areas are relatively low. EVs are dictated by the ephemeral nature of the waterways, and agricultural development within the MLA areas.

11.3.7 SURFACE WATER USE

Due to the intermittent nature of streamflow in the area (and the availability of groundwater from the Great Artesian Basin (GAB) aquifers), there is only limited use of surface water in the immediate vicinity of the site.

The locations of nearby surface water entitlement holders (within 100 km downstream of the site) are shown in Figure 11-12-V1.3.

A water entitlement is held for stock water supplies drawn from a dam on an unnamed tributary of Mud Creek on the southern edge of MLA 50229.

The nearest downstream licensed water entitlement is for water harvesting from Juandah Creek at the Horse Creek confluence. Several water harvesting and irrigation licenses are located at the Juandah Creek/Dawson River confluence near Taroom, a further 35km downstream of the Project area.

All other downstream supplies within 100 km are associated with the Dawson Valley Water Supply Scheme, whose upstream storage is Glebe Weir, approximately 95 km downstream of the MLAs.

There are numerous weirs downstream of Glebe Weir to the Fitzroy River, including, Gyranda Weir, Orange Ck Weir, Theodore Weir, Moura Weir, Neville Hewitt Weir, Eden Bann Weir and the Fitzroy River Barrage. These weirs provide supplies of urban use at Theodore, Moura, Baralaba and Duaringa, industrial use at downstream coal mines, and agriculture.

11.3.8 GROUNDWATER USE

Nearby groundwater use in the area is largely to supply urban water demands to the town of Wandoan, and to supply stock or domestic supplies to rural properties. Nearby groundwater bores and aquifers in the Project area are described in Chapter 10 Groundwater. Most supplies are drawn from the Precipice and Hutton aquifers of the GAB. Nearby bores in these aquifers are shown in Figure 11-13-V1-3, which also shows the closest springs and baseflow streams which are associated with these aquifers.

Precipice Sandstone aquifer

The depth to the Precipice Sandstone around Wandoan is very great, with its base at around 1,150 m below surface. The majority of existing bores tapping the Precipice Sandstone are mainly located to the northeast of Wandoan, within the area where the aquifer outcrops or is close to surface. This reflects the lesser drilling costs to target this formation in areas where it is relatively close to the surface.

The Precipice Sandstone aquifer is capable of supplying relatively high individual bore yields, and in general, provides water of better quality (lower salinity) than the Hutton Sandstone. The Precipice Sandstone is exploited for the town water supplies for Taroom, Wandoan and Miles.

Precipice Sandstone aquifer springs occur in the recharge areas on the northern margin of the Surat Basin. The nearest springs to the Project area are located approximately 50 km to the north and north-east of Wandoan township.

Hutton Sandstone aquifer

The Hutton Sandstone is heavily exploited for stock water. Generally bores tapping the Hutton Sandstone are located in the area where the Hutton Sandstone and Injune Creek Group are close to the surface.

The majority of Hutton Sandstone bores are located up-gradient of Wandoan, closer to the inferred recharge areas on the basin margins, where the bores are installed in the Hutton Sandstone from close to surface or bores drilled through overlying formations to reach the Hutton Sandstone.

The depth to the Hutton Sandstone at Wandoan is approximately 500 m. The aquifer is lithologically variable and generally low yielding.

Existing Wandoan potable water supply and treatment system

The Dalby Regional Council owns, operates and maintains a potable water supply system for the town of Wandoan. The existing system comprises:

- two bores into the GAB Precipice Aquifer
- borehole No.1 provides up to 10 L/s. The 5 L/s from borehole No. 2 nominally acts as standby and when town demand exceeds the primary plant capacity
- ground level treated water storage capacity of 1,650 kL in two tanks of 450 kL and 1,200 kL capacity
- a pump station which delivers treated water from ground level storage to either the elevated storage or directly to the network. The pump station pressurizes the network during normal daytime operation
- an elevated 136 kL storage tank which gravity feeds treated water to the town’s potable water reticulation system over night.

11.3.9 EXISTING WASTEWATER TREATMENT SYSTEM

The Dalby Regional Council operates and maintains the existing wastewater system. Underground sewer mains are reticulated throughout the townships developed areas and Council has confirmed that the WWTP comprises:

- a screen chamber
- an Imhoff tank treatment plant
- a series of aerobic lagoons for secondary treatment
- a tertiary collection pond.

Disposal of the treated effluent is by irrigation of the adjacent showgrounds and golf course, and discharge to an area adjacent to Juandah Creek.

The system has a theoretical treatment capacity of 550 km per day (kL/d), although flows in recent years have been well below this level, typically around 104 kL/d corresponding to a population served of 380. The ‘Taroom Shire Council Strategic Asset Management Plan for Water Supply and Sewerage Services’, prepared in 2004, reported that final effluent quality at the plant has not always met license standards. That report attributes this non-compliance to short-circuiting of flows due to poor lagoon configuration or excessive detention times within the lagoons.

11.4 DESCRIPTION OF PROPOSED DEVELOPMENT

The aim of the Project is to establish an open cut mine of thermal coal. Associated activities that could have an impact on the natural environment in relation to water supply include:

Water will be required for three principal purposes:

- potable water supply — to supply the mine workforce both on and off the Project area – in the accommodation village and within Wandoan Town

- construction raw water — to supply the project with water during the two year construction period
- operations raw water supply — to deliver a washed export coal product during mine operations.

Associated activities that could have an impact on the natural environment in relation to the management of surface water include:

- vegetation and topsoil stripping of topsoil and stockpiling of topsoil for reuse in rehabilitation of disturbed areas.
- excavation of overburden
- excavation of mined material
- the creation of water storage dams and tailings dams.

11.4.1 POTABLE WATER SUPPLY

Potable water for both the mine and accommodation facilities will be sourced from the existing water treatment plant and storage facilities located in Wandoan.

Potable water demand

Historical data indicates potable water usage in Wandoan Township averages 205 ML/a, or 562,000 kL per day. For a population of 380, this represents an extremely high per capita consumption of 1,480 L per person per day. However, it is not necessarily representative of household use, as the town water supply is used for other purposes.

Experience at other similar operations such as Rolleston Mine suggests that a per capita consumption rate of 240 L per person per day is typical for accommodation facilities such as that proposed for the Wandoan Project. The increase in potable water demand due to the Project has therefore been estimated based on this rate multiplied by the expected workforce during construction and operation. Water efficiency and conservation measures will be put in place to ensure that the potable water use is not unnecessarily high.

The change in expected workforce accommodation numbers over the implementation and operation of the Project is described in Volume 1 Chapter 6 Project Operations. As shown in Figure 11-14, demand is expected to peak in the second year of construction, before falling slightly, then climbing as production increases over the following three years, after which it is expected to remain relatively steady.

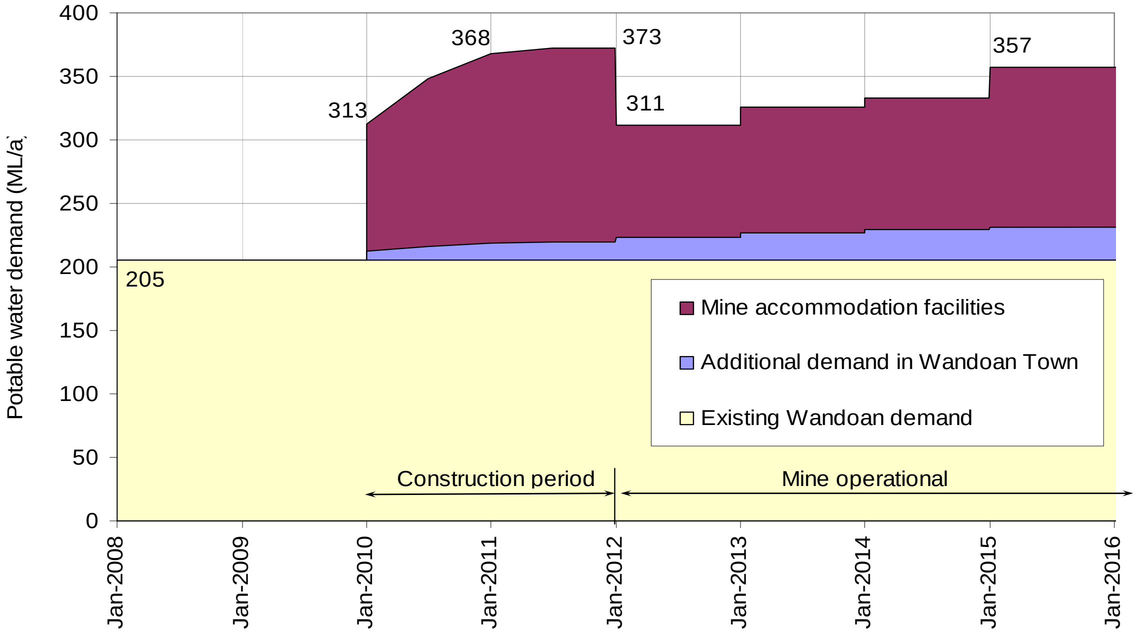


Figure 11-14: Potable water demand 2010-2016

The peak Project-related demand is 168 ML/a. Most of this will be required at the accommodation facilities, but the demand in Wandoan town is expected to increase slightly due to the small proportion of personnel to be housed in town, and due to additional population attracted to support the mine population.

The new total Wandoan Township demand (including the Project requirements) of 373 ML/a, is still less than the 400 ML/a currently allocated from the GAB to the Wandoan Township water supply. However this demand is greater than the capacity of the existing potable water treatment plant, which is unable to reliably sustain supplies to the existing population during mid-summer.

Proposed potable water infrastructure upgrades at Wandoan water treatment plant

Given the above, the existing water treatment facilities are proposed to be upgraded to meet the new combined town and Project demand.

In addition, a new pump station at Wandoan and a dedicated pipeline to the accommodation facilities and MIA will be required.

Potable water connections to any new houses within Wandoan will be made direct from the existing potable water reticulation network within the township or from new delivery mains constructed as part of residential subdivision activities.

Dalby Regional Council has advised that the current temperature of the water entering and leaving the current potable water treatment plant is unacceptable to the Wandoan Township residents and a potential safety risk, in particular to children. The Proponent proposes, as part of the potable water treatment plant expansion and upgrade to meet the demands of this Project, to install a cooling tower to reduce delivery water temperature to within acceptable and safe levels.

Required improvements at the existing water treatment plant include:

- installation of an additional coagulation dosing pump
- installation of an additional chlorine dosing pump
- upgrade of the existing borehole pumps to provide 25 L/s
- installation of a pump station and rising main to mine facilities.

It is considered that the existing Wandoan town storage capacity of 1,635 kL is sufficient to meet the requirements of the combined town and Project demands.

In order to meet increased demand, in conjunction with Dalby Regional Council, the WJV proposes replacing the borehole No.2 treatment system with a clarification process similar to the existing borehole No.1 treatment system; this option is considered the most efficient because of operator familiarity with the water and process units. The existing borehole No. 1 treatment plant will remain operational.

Additional proposed potable water infrastructure

In addition to the upgrades at the Wandoan water treatment plant described above, the infrastructure listed below will be required to convey potable water to the accommodation facilities, the MIA and throughout the mine.

- installation of a pumping station and rising main to the accommodation facilities
- installation of water storage capacity at the accommodation facilities
- installation of a pump station at the accommodation facilities to supply the facilities and the Project MIA
- installation of a rising main from the accommodation facilities to the MIA
- installation of a potable water storage tank at the MIA
- installation of a rising main from the MIA storage tank to the CHPP.

Construction of a third bore

Initial investigations indicate that with some upgrades to the bore pumps, there is sufficient capacity within the existing two town bores to meet the Project's peak demand requirements. The WJV will work with Dalby Regional Council to confirm the condition of both town bores, and if necessary, provision of an additional bore will be investigated further. This would provide additional standby capacity for the town, and provide a more reliable supply to the community.

Temporary potable water supply

Prior to construction of the above works, potable water supply will be required for initial construction activities. Potable water will be trucked to the initial construction accommodation storage. If a supply source cannot be found, a temporary potable water treatment plant will be leased to treat construction raw water to potable standard.

11.4.2 WASTEWATER TREATMENT AND DISPOSAL

It is proposed to collect all sewage at the mine site and pump it back to Wandoan wastewater treatment plant (WWTP) for treatment and disposal.

Sewage treatment demand

The peak total estimated treatment demand likely to be placed on the existing Wandoan WWTP by the combined Wandoan Township demand, including anticipated expansion and the Project is shown in Table 11-5. The peak construction phase demand is based on the peak construction workforce during the second year of construction (which is larger than operations demands) and is the basis of design.

Table 11-5: Average daily demand for sewerage (kilolitres per day)

Details	Maximum requirement (kilolitres/day)
Current town population (380 persons current demand)	104
New Wandoan residents & visitors resulting from growth in economic activity	14
Peak Accommodation village residents during construction	336
Estimated peak WWTP requirements (kilolitres/day)	**454**

While these requirements are less than the 550kL/d theoretical capacity of the existing WWTP, design guidelines require the WWTP to have capacity to treat 3 times average dry weather flow (ADWF). All system components must be able to convey this flow in 20 hours of a 24 hour period. Based on these requirements, the WWTP must be upgraded. In addition to treating 3 times ADWF, the WWTP must provide initial screening and sedimentation of flows up to 5 times ADWF.

Upgrading of Wandoan WWTP

Elements of the existing WWTP at Wandoan will need to be upgraded to meet the requirements of the mine development. The WJV will work with the Dalby Regional Council to achieve this prior to construction of the mine. The following required improvements have been identified:

- had works must be improved to allow for the combination of flows from the mine and town and initial screening of flows
- tree additional Imhoff tanks the size of the existing tank are required
- additional drying bed area of twice the existing drying bed area is required
- all ponds will be baffled to prevent short circuiting. In the first pond aerators will occupy the first half of the pond, the second half will be baffled
- four 5.5 kW aerators are proposed first pond
- In order to increase treatment and provide sufficient depth for aerator operation, the first pond depth must be increased from the current depth of 1.2 m to 2.5
- in order to increase retention time it is also recommended that the depth in the second pond be increased from the current depth of 1.2 m to 2.5
- the proposed retention time and incorporation of aeration should provide sufficient treatment to meet EPA standards
- sludge deposited at the downstream end of the baffled section of the first pond will either be wasted to the sludge drying bed or pumped to the aerated section of the first

pond. Recirculation of the sludge will be managed to maintain efficient digestion of BOD.

Additional infrastructure requirements

Sewage from the MIA and CHPP will flow by gravity to a pump station located at the low point near the rail loop. Sewage will be pumped to a second pump station near the security building, joining flows from the accommodation village and security building. All sewage will then be pumped via a rising main from the accommodation village to the Wandoan WWTP at an estimated maximum pumping rate of 14.7 litres per second (L/s). This is adequate to meet the required 3 times ADWF capacity. Pumps and pipe networks installed to meet the construction phase flows will be more than adequate to meet peak operational phase demands.

It is assumed that each pump station will comprise two submerged sewage pumps. Pumps will be sized so that each pump is able to deliver half of the maximum design flows. Emergency storage will be sized at each pump station, so that in the event of a pump failure one pump will be able to empty the storage between the two daily peaks.

11.4.3 CONSTRUCTION RAW WATER

Construction raw water will be required throughout the construction period in the amounts described below. Several alternative water supply options, as set out below, have been assessed. The most reliable is to draw from the Precipice Aquifer of the GAB, and investigations are continuing into drawing these supplies from the existing town bores under a construction water permit.

Construction raw water demand

The expected total construction water demand is 350 ML/a over the period of construction, made up as follows:

- dust suppression (270 ML/a, 825 kL/d)
- moisture adjustment (35 ML/a)
- concrete mixing (5 ML/a over the construction period)
- evaporation (40 ML/a).

Investigations are continuing to identify one or more sources for this demand. Options being considered are described below in order of preference. All sources are likely to be able to provide useful volumes, and the options later in the list will only be developed if the other sources are found to be unsuitable.

Surface water

Based on flow testing for the new Wandoan Town Bore No.1, RN58700, and the adoption of some reasonable and conservative assumptions for seasonal drawdown and interference from other bores, the bore appears to be capable of continually supplying at least 40 L/s.

Given the likely high yield capacity of Wandoan Town Bore No.2, RN58700, it appears that there are reasonable prospects for Wandoan Town Bore No.1, 15793, to provide a significant supply.

Downhole camera inspections will be undertaken before proceeding further with any proposed upgrades.

The Wandoan Town Bores will be subject to test pumping (including step rate testing) to confirm yield as this is considered to provide more reliable Projection of long-term and short-term pumping rates.

Surface water

Numerous small farm dams exist within the initial Project area on land already owned by WJV. These dams potentially will provide useful quantities of construction water. However, these supplies are rainfall dependent and dispersed across the MLAs, the volume of water potentially available from these dams is currently unknown.

Production bores in the coal seams to be mined as part of the Project

Investigations into the water yields of the coal seams are ongoing – production bores could be established in water-bearing areas of the coal seams to supplement construction water supplies while dewatering the coal aquifers ahead of mining – however as discussed in Chapter 10, yields are extremely low – and thus the volume of water potentially available from this source is limited.

Existing bores in the GAB on WJV land

An existing bore (Bore RN22117) at 'Pecos Valley' – now owned by the WJV ('Ward's bore') – has been considered as a construction water supply. Bore RN22117 is a very deep water bore and draws water from the Hutton Sandstone which is present at depth from 534.9 m to 797.7 m below ground level.

The results of investigations into the potential use of this bore by EHA Pty Ltd are included in TR11-1-V1.5. The potential yield from this bore is limited due to the restricted diameter of the casing, the high temperature of the water (42 deg C) and the production of relatively large volumes of gas. A practical maximum yield is probably of the order of 2.5 L/s (80 ML/a).

The water is moderately saline, with total dissolved solids content of 1,200 mg/L and electrical conductivity of 2,740 μS/cm, which precludes its use for drinking without desalination or blending with lower salinity water. However the quality is suitable for construction raw water supplies.

A new bore into the precipice aquifer of the GAB

An option to construct a third bore into the Precipice aquifer is under consideration. This would involve the drilling and casing of a bore to a depth of around 1,300m. The bore would need to be equipped with a suitable pump, power supply and control system. A detailed siting study considering issues such as the proximity and drawdown of adjacent bores would be conducted in conjunction with Dalby Regional Council if this water source was adopted.

11.4.4 OPERATIONS RAW WATER

Operations raw water demand

Operational raw water requirements include process water, fire fighting services, site dust control and light and heavy vehicle washdown. The adopted operations raw water demand is summarised in the following table.

Table 11-6: Adopted total design operational water demand

Year	Demand (ML/a)
2012	3,000
2013	5,000
2014	8,000
2015	8,400
2029	9,100

The major demand for operations raw water on the site is the CHPP.

The estimated unit raw water requirement for the CHPP (including coal handling at 46 L/t ROM), is estimated to be 241 L/t ROM. This is the net make-up demand after allowing for the return of recycled decant water from the tailings system.

Other miscellaneous water use e.g. for light and heavy vehicle washdown, and general washdown at the MIA and CHPP, was estimated as 90 ML/a based on experience at other sites.

The change in total raw water demands throughout the Project is shown in Figure 11-15 below. Demands will peak around 2030 when haul road dust suppression requirements are highest. The CHPP raw water demand can make up over 80% of the total demand — depending on the length of haul roads to be watered.

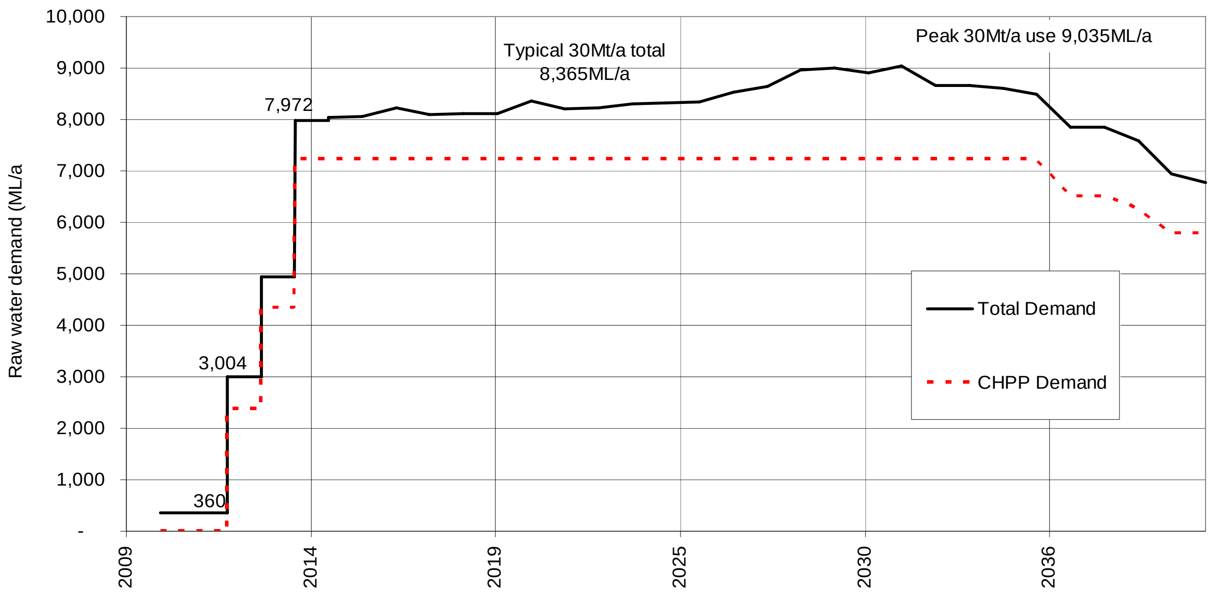


Figure 11-15: Operations raw water demand

During average weather conditions, the surface water management system will be able to yield significant quantities of water to reduce the volumes required to be imported (3,700 ML/a on average for the Year 30 plan) — however, there will be significant periods, particularly during drought early in the project life, when most or all of the site water demands will be drawn from the water pipeline.

Potential raw water sources

Consideration was originally given to drawing operational supplies from the GAB. However, initial estimates of the impacts of drawing such a large demand over an extended period were assessed to be unsustainable. The Proponent is currently assessing three alternative options for the supply of operational raw water, being:

- coal seam gas associated water sourced from Spring Gully (owned by Origin) and Fairview (owned by Santos) to the west of the Project site
- coal seam gas associated water sourced from Berwyndale (owned by Queensland Gas Company) and Talinga (owned by Origin) to the south of the Project site
- Glebe Weir on the Dawson River (owned by SunWater).

Each raw water supply option is the subject of a separate impact assessment (see Volumes 2, 3 and 4 to this EIS). The development of the water supply will also be subject to negotiation of a commercial agreement with water service providers during the detailed design of the Project, and subject to the State and Commonwealth regulatory approvals.

Raw water quality

Coal seam gas water is often rich in salts and other constituents that render it unsuitable for many direct beneficial uses. The poor quality of the produced water makes the management of this water one of the major concerns associated with coal seam gas development.

Typical coal seam gas water quality parameters affecting corrosion and scaling potential are summarised below:

- pH 8.5 to 9.4
- Total dissolved solids 1,700 to 6,900 mg/L
- Total Alkalinity (as $CaCO3$) 980 to 2250
- Chloride 390 to 2,793 mg/L
- Sulphate less than 2 mg/L.

Coal seam water quality varies with location — and tends to deteriorate at individual wells over time. However, the proposal is to collect water from a large number of wells in a collection pond before pumping to site. This will tend to at least partially compensate for variability by blending.

The proposal is to deliver raw water to the site for use in the CHPP at 4,000 mg/L TDS, however, if the suppliers are unable to meet the Project water specification with raw water, reverse osmosis (RO) treatment of a portion of the water will be undertaken by the supplier as required. The water suppliers will manage the RO treatment and disposal of the saline effluent within their own tenements.

Raw water storage

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

If coal seam gas water is adopted as the supply source, it is possible the dam will need to be lined to protect nearby groundwater and soils. Consideration will be given to clay-lining the dam if suitable materials can be obtained locally. Alternatively, a polyethylene liner may be used to provide an impermeable barrier to leakage. Sufficient monitoring bores will also be installed to detect any leakage before it contaminates downstream water resources.

11.4.5 WATER MANAGEMENT SYSTEM

A surface water management system has been devised to mitigate the potential impacts of the Project on receiving water quality, and to protect the operation of the Project from interruptions due to flooding.

The overall guiding principle in the arrangement of the water management system is to wherever possible, separate water of varying quality to minimise the stored volumes of water with high concentrations of contaminants. For the purposes of the Project, three separate water management systems (in ascending order of cleanliness) are considered:

- pit/process dirty water management system – managing water captured in pits and running off dump stations and other areas with the potential to contribute high concentrations of dissolved salts, such as the CHPP and coal product stockpiles
- overburden runoff water management system – treating water running off overburden dumps and other disturbed areas of the site with the potential to have large concentrations of suspended solids
- clean water system – water from undisturbed areas of the MLAs and the catchments discharging through the site from upstream.

Under this arrangement, ten potential discharge points from the MLAs are nominated. All but one (Duck Creek) is located on the northern boundary. Downstream of the discharge points, the receiving waterways make their way to one of four major stream systems crossing the Project area, as summarised in Table 11-2, and shown in Figure 11-2-V1.3.

Pit water/process water management system

While water flows will be carefully managed to minimise the volume of water discharging to mine pits, some will make its way there either via direct rainfall, runoff from and seepage through overburden dumps, or small catchments upslope of pits which cannot be diverted around or captured in highwall dams.

The pit water/process water management system comprises:

- small sumps in the pit floor to collect and contain inflows from groundwater seepage and local surface water runoff from the pit floor, highwall, lowall and endwalls
- pit dewatering pumps and associated dewatering pipelines to transfer pit water to the nearest environmental dam, if necessary via a small staging dam

- dirty water drainage system to contain runoff and process water from the disturbed areas and direct it to the nearest environmental dam
- environmental dams to store and contain water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas reporting to dams, so as to minimise the storage requirements
- a return water pump station from the environmental dam to deliver stored water to either (in order of priority):
  - a nearby water truck fill station
  - conveyor dump station/crusher dust suppression system
  - the CHPP.

To maximise the opportunity for reusing pit/process water across the site, a water pipeline is proposed to be constructed along the conveyor between the CHPP and the dump stations in the western half of the site. During wet periods, the rate of return from the pits may exceed the capacity of the CHPP to use it, and additional storage will be required.

Water captured in the pit/process water management system will be used as the highest priority water source to minimise the stored quantities of water and hence the risk of off-site discharge.

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 'ry basins' with low level outlet pipes which would restrict the outflow from the dam, 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 turbidity discharge limits. 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 outlets, to prevent discharge if water quality is not suitable.

Most pits are located on ridge tops across the undulating terrain, and drainage generally flows away from the pit areas to the adjacent creeks. Sediment dams are required to intercept sediment laden runoff from these catchments before it reaches the receiving water.

The overburden water management system comprises:

- dirty water drainage system to contain runoff from overburden dumps and nearby disturbed areas and direct it to the nearest sediment dam
- sediment dams to store and contain water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas reporting to dams, so as to minimise the storage requirements. Normal operation is as "dry basins"
- If the dams are operated as wet basins due to elevated salinity levels, to minimise the stored quantities of water and hence the risk of off-site discharge, any water captured and not released will be reused when pit water has been depleted (in order of priority):
  - a nearby water truck fill station

- conveyor dump station/crusher dust suppression system
- the CHPP.

Clean water management system

The clean water management system ensures that neither local runoff nor flood waters from the significant creek systems flowing through the Project area enter the mine pits. The system comprises:

- diversions of streams around active mining areas where the cross creek channels
- flood levees adjacent to pits and dumps to prevent flood waters entering the pits. Flood levees are sized to provide flood immunity during a 0.1% AEP (1,000 year average recurrence interval (ARI)) design flood event
- highwall bunds and clean water catch drains — to divert minor catchments upslope of highwalls around the endwall. Relatively few are required at Wandoan due to the nature of the site topography and the pit layout. The proposed drains will largely follow existing contours to minimise the risk of erosive velocities.

The design and performance of these components are described in the flood study Technical Report TR 11-2-V1.5.

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-V1.3 to 11-18-V1.3 show the mine progression, the areas of disturbance and rehabilitation, and the required water management structures at each stage. Further details are provided in the Technical Report in TR 11-4-V1.5.

Excluding in-pit pump sumps, a total of 39 water management dams are required to manage runoff from disturbed areas during the life of the project. The number of dams increases over time as summarised in the table below.

Table 11-7: Total number of water management dams over project life

Year	Sediment Dams	Environmental Dams
1	6	4
5	16	5
10	22	6
20	27	7
30	32	7

The number and characteristics of dams proposed for the site is described in detail in the Technical Report TR 11-1-V1.5. The final configuration of the site dams will be established during later design stages, and will depend on the availability of construction materials and the relative costs of excavation and embankment construction.

Dams containing hazardous waste are not considered referable dams under the Water Act 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.

Under the currently proposed mine site water management system, several of the proposed environmental dams meet the storage and catchment criteria that define when a failure impact assessment is required.

There are also several proposed flood levees greater than 8 m high, which will have the potential to store large volumes of water, and thus meet the referable dam criteria. The levees are described in more detail in the Technical Report TR 11-1-V1.5.

The floodplain areas downstream of these structures are sparsely populated, and it is unlikely any would be deemed category two 2 dams. However, a detailed assessment will be carried out following detailed design of any the dam and levee structures, which meet the relevant assessment criteria.

A number of declared watercourses (provisionally declared pending field confirmation by NRW) cross the site. Construction of a number of structures on the MLAs will necessitate disturbance to the bed and banks of these watercourses, and consequently licensing under the Water Act. Details of these structures will be finalised close to the construction date and submitted to NRW with a Water Licence application. The currently expected licensed works and their approximate construction dates are listed below and shown on Figure 11-5-V1.3.

Table 11-8: Works potentially requiring approval

	Purpose	Watercourse	Approximate Year of construction
1	Rail crossing	Frank Creek	Y-1
2	Haul road crossing	Frank Creek	Y3
3	Haul road and dragline walk road crossing	Spring Creek	Y9
4	Haul road crossing 1	Woleebee Creek	Y10
5	Haul road crossing 2	Woleebee Creek	Y12
6	Conveyor, access and dragline walk road crossing	Woleebee Creek	Y5
7	Conveyor, access and dragline walk road crossing	Unnamed Creek	Y5
8	Conveyor, access and dragline walk road crossing	Mud Creek	Y9
9	Demolition of dam adjacent Mud Creek East pit	Mount Organ Creek/Unnamed Creek	Y27
10	Stream diversion A at Turkey Hill Pit	Spring Creek/ Unnamed Creek	Y9
11	Stream diversion B at Summer Hill Pit	Mount Organ Creek/Unnamed Creek	Y17
12	Stream diversion C at Mud Creek Pit	Mud Creek/ Unnamed Creek	Y17
13	Stream diversion D at Mud Creek Pit	Unnamed Creek	Y15
14	Stream diversion E at Mud Creek East Pit	Unnamed Creek	Y24
15	Stream diversion F at Woleebee Creek Pit	Woleebee Creek/ Wandoan Creek/ Blackant Creek	Y10
16	Stream diversion G at Leichardt Pit	Frank Creek	Y15

11.5 POTENTIAL IMPACTS

11.5.1 POTENTIAL IMPACTS ON THE GAB

The Project will result in additional demands on the Precipice Sandstone aquifer of the GAB.

The projected increase in potable water demand is within the 400 ML/a currently allocated for the Wandoan town water supply under the GAB ROP.

While alternative construction water supplies are potentially available, the most reliable, and therefore preferred, source is either the Wandoan Town bores (with upgraded pumps) or a new bore into the Precipice Sandstone aquifer of the GAB, to be owned and operated by the Dalby Regional Council in conjunction with its other bores. Construction water supplies would be drawn under a water permit issued by NRW with the permission of the Dalby Regional Council. Water would be delivered via a new raw water pipeline to the mine construction site.

If a new bore is to be established, a siting study will be conducted in association with DRC to determine an appropriate location. The water permit application and (if necessary) siting study will be accompanied by an impact assessment report outlining the additional drawdown the extraction would create in the Precipice Sandstone aquifer. Drawdown could potentially impact a number of nearby receptors:

- **Spring vents** – the closest mapped spring vents are near Cockatoo Creek, over 50 km from Wandoan. NRW has mapped these spring vents as being sourced from the Precipice Sandstone.
- **Baseflow streams** – A number of baseflow streams have been identified by NRW and Australasian Groundwater and Environmental (AGE) Consultants (2005) in the area. The closest of these streams to Wandoan Town is Bungaban Creek, 30 – 35 km to the north east of Wandoan, and NRW has indicated that this stream receives baseflow input from either the Hutton Sandstone and/or the Evergreen Formation (i.e. management unit Surat North 2 of the Water Resource (Great Artesian Basin) Plan 2006). Approximately 35 km to the south west of Wandoan, NRW has recognised some reaches of the east tributary branch of Horse Creek as receiving some baseflow from the Precipice Sandstone. As this stream is remote from the outcrop of the Precipice Sandstone, and AGE (2005) has indicated the relevant reaches to occur over sections of the outcrop of the Mooga Sandstone and Gubberamunda Sandstone (other major GAB aquifers), it appears likely that the Horse Creek inflow is not from the Precipice Sandstone (although this would require field investigations to confirm this). Cockatoo Creek, located approximately 50 km to the north east of Wandoan has been mapped by NRW as hosting baseflow input from the Precipice Sandstone, as does the Dawson River well downstream of Glebe Weir.
- **Other bores drawing from the Precipice Sandstone aquifer** – could potentially be affected by the additional extraction. Based on preliminary drawdown analysis, 13 bores shown in Figure 11-13-V1.3 have been identified as penetrating Precipice Sandstone within 35 km of Wandoan. Of these, only six (excluding the Wandoan Township bores) are likely to be water bores that continue to tap the Precipice Sandstone, all are subartesian. The nearest other bores are approximately 10 km from the existing Wandoan Town Bores.

A preliminary analysis of drawdown from construction water demands was carried out on the assumption that the demands would be drawn at the peak requirement throughout the 2 year construction period, that is, at a total average demand of 743 ML/a.

It was assumed that following construction, potable water supplies would be drawn at the projected long-term demand of 350 ML/a.

The results of the analysis are summarised in the points below, and Table 11-9 and Table 11-10. The results show that if all the construction water and potable water demand is drawn from the Wandoan Town Bore, the impact is as follows:

- At a radius of 50 km, the predicted maximum additional drawdown at the end of construction is 0.22 m. Of this, 0.15 m is attributable to construction demand. However, within 10 years, groundwater levels at this radius would be within 0.08 m of where they would have been had no construction water been extracted. The net long term impact on springs and baseflow is negligible, as the effect of the construction water take is only to bring forward drawdown which would occur anyway as part of the overall supply of potable water for town water supplies already provided for in accordance with the provisions of the Water Resource Plan (Great Artesian Basin) Plan 2006 and the Great Artesian Basin Resource Operations Plan. For example, the total drawdown from 30 years of potable water supplies at 350 ML/a is estimated to be 0.74 m. If construction water supplies are also taken, this total drawdown would occur approximately 4 years earlier.
- At a radius of 10 km, in the short term, there will be an initial additional drawdown of 2.2 m, reducing to 1.1 m over 10 years. The additional drawdown is unlikely to significantly affect the rate of supply from other bores in the area.
- At a radius of 1 k m, in the short term, there will be an initial additional drawdown of 5.8 m, reducing to 2.0 m over 10 years. If the additional supplies are drawn from an existing Wandoan Town Bore, the only other Precipice Sandstone bore to be impacted by such an extent would be the other Wandoan Town Bore. The additional drawdown is unlikely to significantly affect the rate of supply from either of these bores. After 10 years, water levels would be within 0.1 m of where they would have been had no construction water been extracted.

Table 11-9: Additional drawdown (m) at end of construction

Total demand from bores during construction	373 ML/a	556 ML/a	743 ML/a
Distance from source	Due to increased potable water demand (included in ROP)	Due to increased potable demand and approximately half construction demand for 2 years	Due to increased potable demand and full construction demand for 2 years
1 km	1.81	3.77	5.79
10 km	0.69	1.44	2.21
30 km	0.22	0.45	0.69
40 km	0.12	0.26	0.40
50 km	0.07	0.14	0.22

Table 11-10: Additional drawdown (m) 10 years after construction

Total demand from bores	373 ML/a	556 ML/a	743 ML/a
Distance from source	Due to increased potable water demand (included in ROP)	Due to increased potable demand and approximately half construction demand for 2 years	Due to increased potable demand and full construction demand for 2 years
1 km	1.94	1.99	2.04
10 km	0.97	1.02	1.07
30 km	0.52	0.57	0.61
40 km	0.41	0.45	0.50
50 km	0.32	0.36	0.41

11.5.2 FLUVIAL GEOMORPHOLOGY

The diversion of creeks around the mine workings will have a permanent impact on the natural drainage systems crossing the site. Potential impacts include changes to flow depths, velocity, stream power and shear stress, and subsequent erosion and sediment transport rates. There will also be changes to the riparian vegetation and instream habitat.

11.5.3 DOWNSTREAM SURFACE WATER FLOWS

The Project could potentially impact downstream water flows – specifically in the waters of Duck Creek, Horse Creek, Spring Creek, Mud Creek, Woleebee Creek, Juandah Creek, the Dawson River, and the Fitzroy River.

The potential impacts on downstream surface water flows (other than flood flows) are described in detail in the Site Water Management System Technical Report TR 11-4-V1.5. The following conclusions are drawn from the modelling undertaken for the report:

- During typical weather conditions the surface water management system will be able to yield significant quantities of water to reduce the volumes required to be imported via the raw water pipelines — however, there will be significant periods when most or all of the site water demands will be drawn from the water pipeline.

- The volume of water captured in the water management system will increase as the project proceeds and the mine footprint grows.
- With the proposed dam sizing and operational procedures, the simulated Project water management system would not discharge pit/process water or mine industrial runoff from the site under historically observed climate extremes. All pit/process water and mine industrial runoff is predicted to be contained within the Project's environmental dams.
- Runoff from mine areas not impacted by pit/process water or mine industrial area may only require the removal of the bulk sediment through the use of Sediment Dams. These dams (designed as 'dry' sediment basins) will be provided to allow coarse sediment to settle before discharging from the site over 10 days following rainfall (in accordance with the recommendations of the Technical Guidelines). The total flow from these dams make up a relatively small proportion of flows near the MLA boundary. By year 30 of the Project, they will make up 5% of flows in the creeks immediately downstream. At Duck Creek, where the proportion of flow is greatest, overflows will make up 43% of total catchment flow at the MLA boundary.
- In later years of the mine development, re-use of large quantities of water captured at the CHPP will be critical to managing the risk of interruptions to mining and off-site discharge. The model results indicate that unless significant water storage is available in the vicinity of the Mud Creek and Summer Hill pits, a high capacity water pipeline (of approximately 400 L/s) will be required to return water to the CHPP for this purpose.
- During wet periods, up to 890 ML of runoff could be expected to accumulate in the larger mine pits. However, for 90% of the time, surface water in the pits would be minimal. Operation of the proposed pit/process water management system would see the pits dewatered to operational in-pit storage levels with minimal unacceptable operational interruptions.
- The adopted environmental dam sizes have been chosen to provide a reasonable level of pit availability without spills from the site. The volume adopted to meet these operational criteria is in excess of the 10% AEP DSA volume recommended in the Technical Guidelines (and in most cases the 1% AEP DSA). However, in very wet periods, sufficient storage will also be required to receive the excess water, as the combined capacity of the dewatering pumps will exceed the capacity of the CHPP to use it.
- During wet periods similar to the wettest on record, up to 12,000 ML of water storage in addition to the proposed environmental dams could be required to manage pit/process water from throughout the site without significant off-site discharges. If the quality of overburden runoff is such that water captured in sediment dams is unsuitable for release except in larger flows, this volume requirement increases to 26,000 ML. A number of potential storage locations are likely to be available for this excess water.
- The mine and associated water management system is expected to reduce mean annual flows immediately downstream of the MLAs by approximately 3.0% by year 30

of the Project. The greatest impact is at the small Duck Creek catchment, where mean annual flow will be reduced by over 22%. The impacts of the Project on the various major streams crossing the MLAs are summarised in the tables below.

Table 11-11: Reduction in mean annual flow from MLA (ML/a)

Creek	Year 1	Year 5	Year 10	Year 20	Year 30
Juandah Creek	-7	249	91	225	328
Woleebee Creek	79	217	169	260	289
Mud Creek	—	75	103	345	796
Spring Creek	—	—	12	156	100
Duck Creek	—	—	46	55	61
Total	**72**	**541**	**421**	**1,041**	**1,574**

Table 11-12: Percentage reduction in mean annual flow at downstream discharge point

Creek	Year 1	Year 5	Year 10	Year 20	Year 30
Juandah Creek	0.0%	1.0%	0.4%	0.9%	1.4%
Woleebee Creek	0.4%	1.0%	0.8%	1.2%	1.3%
Mud Creek	0.0%	1.4%	2.0%	6.7%	15.4%
Spring Creek	0.0%	0.0%	0.8%	10.4%	6.7%
Duck Creek	0.0%	0.0%	16.6%	19.7%	22.1%
Total	**0.1%**	**1.0%**	**0.8%**	**2.0%**	**3.0%**

- While the local impacts on mean annual streamflow in the smaller tributaries crossing the MLA could be significant, the modelled impact on flows further downstream, is relatively small due to the contribution of the larger tributaries diverted across the Project area.
- The nearest licensed water user downstream of the Project area is a water harvester just upstream of the confluence of Horse Creek and Juandah Creek. The mean annual flow at this location is estimated to be 71,700 ML/a. The impact of the project on mean annual flow at this location is estimated to be 1,570 ML/a, or 2.2% of existing mean annual flow. The impact of the project on the ability to take the larger flows usually accessed under a water harvesting licence, and consequently the available yield, is therefore likely to be relatively small.
- An irrigator is also licensed to take supplies from Juandah Creek just upstream of the Dawson River confluence. At this location, the estimated mean annual flow is 135,000 ML/a, and the reduction in mean annual flow makes up approximately 1.2% of the total. The impact on the available yield at this location is therefore likely to be small.

- Other downstream water users are located closer to Taroom, downstream of the Dawson River confluence, and further downstream at Glebe Weir. As described in Table 3-3, the mean annual flow in the Dawson River downstream of the Juandah Creek confluence is very large (362,000ML/a) compared to the flow at Wandoan (<0.5%), and the effect of the project on water yield is likely to be negligible.

11.5.4 FLOOD IMPACTS

The construction of creek diversions, flood levees, and road, rail or conveyor crossings will potentially result in increased flood levels (afflux) due to reduced flood conveyance capacity on the floodplains.

Works are proposed to manage flood flows around the active mine areas. These in turn could potentially cause:

- increased upstream flood levels due to construction of flood levees and creek diversions.
- increased downstream flood flows and flood levels due to loss of flood storage by construction of flood levees and diversions.

The impact of road bridge and culvert crossings will be relatively small, as all crossings will be low-level structures. For high level conveyor and rail bridge crossings, the impacts will be localised and will not extend upstream of the MLA boundaries.

An assessment of conceptual designs prepared for the proposed stream diversion works at Wandoan, indicates that designs complying with the NRW Watercourse Diversion Guidelines will result in only small upstream flood level increases.

Where the floodplain storage capacity is reduced, it is also possible that downstream flow rate can be reduced. This is potentially the case at Woleebee Creek, where the existing floodplain is very wide, and peak flood flows are significantly reduced as the flood wave moves downstream.

A preliminary assessment of the Woleebee Creek diversion conceptual design, indicates that flood levels downstream of the site could be increased by up to 300 mm downstream of the site. This will have a small impact on the frequency of flooding of the Booral road bridge, and will slightly reduce the flood immunity of the Windamere homestead.

The conceptual diversion designs will be refined during future design phases, and it is possible that the some additional upstream, afflux will be introduced during this process. A detailed assessment of affected properties will be made as part of the licensing process.

A map of flood afflux for the current conceptual diversion designs is shown in Figure 11-19-V1.5. Further details of the flood impact assessment can be found in TR11-2-V1.5.

11.5.5 SURFACE WATER QUALITY

Where rock and soil are exposed to rainfall, resultant overland flow will carry sediments, salts, metals, trace elements, and/or organic compounds that may impact surface water quality.

The potential impacts associated with construction and operational activities in the MLA areas, including vegetation clearing, creek diversions, and drainage structures, may result in:

- increase and/or exacerbation of erosion and sediment deposition, and poor drainage, with effects on the environment of:
  - loss of topsoil
  - buried vegetation and buffer zones
  - siltation of watercourses and aquatic habitat
  - irregular and unstable land forms due to gully, channel and bank erosion
  - adverse ecological effects from de-silting waterways
  - reduced ecology and aesthetic value of waterways and riparian vegetation
  - visual impact
  - increased electrical conductivity and turbidity due to erosion of sodic soils
  - periodic water-logging of low-lying areas
  - revegetation difficulties
  - clogged drainage infrastructure and increased localised flooding
  - silting and bank damage to trench works and drainage structures
  - increased downtime during construction after storm events
  - siltation and loss of storage capacity in sedimentation dams.
- pollutants contaminating waterbodies due to inappropriately stored and handled materials, hydrocarbons and other potentially hazardous substances
- seepage of potentially saline groundwater to surface waters
- infiltration of additional surface water to groundwater
- leaching of salts, metals and trace elements into groundwater causing potential surface water and groundwater quality impacts
- increased potential for weed infestation, with weed distribution downstream from initially affected areas
- environmental incidents resulting from unplanned discharges of pollutants or polluted waters that do not meet water quality discharge standards into waterbodies.

The greatest risk for potential off-site impacts on water quality is the discharge of pit water and MIA runoff. Both these water sources may contain contaminant concentrations in exceedance of acceptable limits for the preservation of downstream environmental values.

Pit water

While water flows will be carefully managed to minimise the volume of water discharging to mine pits, some will make its way there either via direct rainfall, runoff from and seepage through overburden dumps, or small catchments upslope of pits which cannot be diverted around or captured in highwall dams.

A field program was undertaken to identify the quality and quantity of groundwater likely to be encountered during mining of the Project area. EC values recorded during the pumping test are consistent with values recorded in the field following bore construction and are relatively high, in the range 11,300 µS/cm to 23,100 µS/cm. However, it should be noted that expected groundwater inflow rates are relatively low, so the net impact of these elevated salinities on stored water quality is unlikely to be high.

MIA runoff

Water running off dump stations and other areas such as the CHPP and coal product stockpiles have the potential to contribute high concentrations of dissolved salts

Water from the above sources will be stored in environmental dams – if these dams were to overflow, water with potentially high levels of dissolved solids and hydrocarbons would make its way to the environment.

Overburden runoff

The available geochemical testing indicates that the potential for acid generation and heavy metal contamination of overburden runoff is low. Salinity levels in overburden runoff may be elevated – but the salinity of runoff captured in overburden dump sediment dams is not likely to be high compared to natural levels. This water will have relatively high levels of suspended solids due to erosion of disturbed areas, and without capture and treatment, water of very high turbidity would make its way into downstream waterways.

- raw water.

Raw water stored in the on-site raw water dam could seep into local groundwater or waterways. If CSM water is the adopted source, this water would have elevated dissolved solids compared to natural levels.

11.5.6 POTENTIAL IMPACTS ON AQUATIC HABITAT

The potential impacts of the Project on aquatic habitat are described in detail Chapter 17B. Key impacts include:

- barriers to fish movement and impacts to the riparian environment due to the construction of creek crossings
- impacts on fish movement and impacts to the riparian environment due to creation of stream diversions
- dam operation and stormwater discharge changing flow regime.

11.6 MITIGATION MEASURES

11.6.1 SURFACE WATER QUALITY

The mitigation strategies and measures associated with surface water quality are divided into six main areas:

- drainage, and erosion and sediment control
- creek diversions
- interface with groundwater
- pollutant control
- weed infestation
- monitoring of discharges.

Drainage, and Erosion and Sediment Control

Mitigation measures associated with temporary and permanent drainage, and erosion and sediment control include:

- develop understanding of local physical limitations that may affect drainage structures and supporting facilities, including soil type, topography, water supply and vegetation
- recognise temporary and permanent drainage requirements early in the design phase
- design erosion and sediment control measures as part of the temporary and permanent drainage systems
- avoid disturbance to natural watercourses and riparian areas, and reinstate any disturbed areas
- diversion of upslope water to reduce on-site erosion by limiting catchment size, thereby reducing total volume of contaminated runoff requiring treatment and reduced downtime following prolonged rain events
- reduce or limit overland flow runoff volume and velocity by minimising catchment size, increasing flowpath length, and providing for water infiltration into soils
- during the construction phase, early planning and construction of temporary drainage systems will minimise erosion and avoid delays in initial earthworks
- drawings detailing existing flowpaths, both temporary and permanent drainage, including design capacities, identification of all proposed temporary and final overland flow paths, and any proposed diversions of overland flowpaths
- install permanent drainage structures as early as possible, including stabilised drainage outlets
- develop and implement an approved Erosion and Sediment Control Plan (ESCP) for each phase of construction and operations, being included in the Plan of Operations for the operational phase of the Project. Development and application of the ESCP will include:
  - identification of soil and water management issues, including existing site conditions, topography, soil and climatic data, erosion prone areas, location of the nearest and other relevant environmentally sensitive areas
  - clear understanding and application of control measures including the following actions — minimise disturbance, provide temporary and permanent drainage measures as early possible, identification of suitable erosion and sediment controls for the site, implement effective revegetation
  - drawings to accompany the ESCP identifying the development and staging of works of temporary erosion and sediment control measures, including measures to cope with heavy rainfall events to aid in limiting unforseen construction delays due to wet weather
  - compliance with the recognised approval processes
  - maintain and supervise implementation of the ESCP, and undertake scheduled inspections of the implementation of the ESCP
  - undertake monitoring of the effectiveness of the ESCP including diary notes/logbook entries of control techniques used on-site, and water quality sampling both upstream and downstream of disturbed areas.

Creek Diversions

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.

Development of the detailed creek diversion strategy will include, but may not be limited to:

- detailed geomorphology assessment of affected creeks
- detailed topographical survey of affected creeks and areas to be diverted into.
- detailed terrestrial and aquatic ecology assessments of the existing creeks
- detailed water quality assessments of the existing creeks
- detailed hydrological studies
- detailed design of creek diversion which meet guidelines of NRW Watercourse Diversions – Central Queensland Mining Industry
- detailed rehabilitation and revegetation plans of each creek diversion to define and establish requirements, based on assessments as given above and detailed design.
- establishment of additional water quality monitoring program specifically for each diversion, augmenting monitoring already established under normal mine operations.

Interface with groundwater

Mitigation measures associated with the infiltration of surface waters to groundwater via water in pit voids, environmental dams, sediment dams and tailings dams is discussed further in Chapter 10 Groundwater.

Saline groundwater seepage into pits and surface waters will be controlled by environmental dams, as discussed in Section 11.4.5. Historical simulation water balance modelling shows it is possible to operate the environmental dams without unplanned discharges. Under normal operating conditions water in the environmental dams will not be released from the site. However, following rainfall, if it is possible to meet the site discharge licence requirements, water may be released to reduce on-site stored water inventories so that the risk of future discharge from extreme rainfall can be reduced.

Pollutant control

Suitable containment and bunding will be installed and maintained for potential surface water pollutants such as hydrocarbon based products, including fuels, oils, greases, and lubricants; solvents such as paints, and thinners; powders/dusts/granular materials including powder coating materials, cement; and ammonium nitrate. Containment, storage, handling and bunding of potentially contaminating substances and materials will depend on the type and quantity of each. Chapter 6 Project Operations outlines measures to be used for containment of materials in the Mine Infrastructure Area.

Weed infestation

Measures to minimise weed infestation will include washdown of off-site equipment prior to use on site, ensuring only clean imported fills and soils are brought onto site, and appropriate application of herbicides.

As part of the Plan of Operations and Biodiversity and Land Management Plan, a Weed Management Plan will be developed, implemented and audited across the MLA areas and gas supply pipeline alignment. The plans will establish requirements for rehabilitation and revegetation, so that vegetative groundcover is established that will be self regenerating and provide sustainable erosion and weed control.

Monitoring of discharges

Water quality monitoring will continue for the MLA areas, with augmentation of the existing monitoring locations to include locations presented in Figure 11-20-V1.3 and Table 11-13. Table 11-14 presents the parameters that will be monitored and frequency of monitoring. Augmentation of the monitoring locations will ensure spatial coverage of areas potentially influenced by activities on the MLA areas, and detection of a range of pollutants.

Table 11-13: Water quality monitoring sites, including timeframes for implementation

Catchments	Sites	Code	Comments
Juandah Creek catchment	Upper Juandah Creek (US Upper Juandah Creek)	J-UJ	Already installed as a permanent water quality monitoring station. Monitoring to continue.
	Upper Frank Creek Dam (US Frank Creek Dam)	J-UF	Installation of a permanent water quality monitoring station to be no later than beginning of Year 2, so as to provide at least one year's water quality monitoring data prior to operations commencing in Frank Creek Pit. Site will supersede currently installed Frank Creek Upstream site.
	Frank Creek Downstream	J-DF	Already installed as a permanent water quality monitoring station. Monitoring to continue.
	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 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 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 no later than mid Year -3 (being mid 2009), 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.

Catchments	Sites	Code	Comments
	Woleebee Creek Downstream		Already installed site will cease be to effective in Year -2, and be superseded by DS Woleebee Ck as shown in Figure 11-20-V1.3.
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	Should mining operations necessitate the relocation of the existing Mud Creek downstream monitoring station, installation of a permanent water quality monitoring station will occur, so as to provide at least one year's water quality monitoring data prior to construction commencing of relevant infrastructure associated with Mud Creek Pit.
	Mud Creek downstream		Should mining operations necessitate the relocation of the existing Mud Creek downstream location, the already installed monitoring site will cease to be effective when relevant infrastructure associated with mining of Mud Creek Pit (conveyors and ROM dump) commences construction. Site will be superseded by DS Mud Ck, as shown in Figure 11-20-V1.3.
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 no later than the beginning of Year 7, 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 no later than the beginning of Year 7, so as to provide at least one year's water quality monitoring data prior to mining of Turkey Hill Pit.

Table 11-14: Parameters for water quality monitoring

Monitoring sample type	Water quality parameter	Sample frequency
Fully automated sampling stations	pH Temperature Electrical conductivity (EC) Turbidity Dissolved oxygen (DO)	At least daily, and more frequently when flow is detected.
Event Sampling	EC pH Total suspended solids (TSS) Turbidity Total nitrogen (TN) Total phosphorus (TP) Biological oxygen demand (BOD) Chlorophyll a Aluminium	During and after major flow events.

Monitoring sample type	Water quality parameter	Sample frequency
	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 Organochlorine (OC) and organophosphorus (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	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.

As a minimum, discharge licence requirements should meet appropriate and recognised guidelines established under legislation and regulation, such as relevant sections of ANZECC guidelines or any site specific guidelines developed for the Wandoan area, unless background monitoring indicates parameters are significantly varied from the guidelines (eg. naturally elevated parameters, such as those for turbidity). In the event that background monitoring is significantly varied compared to guideline requirements, then discharge requirements should be no greater than 10% of the background levels.

Monitoring of all point discharges into surface waters will ensure that water quality requirements are met, with flows regulated in accordance with the water quality requirements by licence.

Water treatment and water management devices, including sedimentation and environmental dams, will be designed to meet discharge requirements before being released into receiving surface waters.

11.6.2 CONCEPTUAL WATER MANAGEMENT SYSTEM DESIGN

The key water quality mitigation measure is the site water management system. The system will evolve over the project life, to the Year 30 layout shown in Figure 6-1-V1.3. Details are provided in the Site Water Management System Technical Report TR 11-4-V1.5. In summary:

- the WMS will be established such that there will be no planned off-site discharge of pit/process water into natural surface waters under normal operating conditions unless the flow meets discharge criteria
- the pit/process water system will be established such that there would be no unplanned discharge from the system when simulated under historical climate conditions
- overburden runoff will be directed into sediment dams
- clean water will be diverted around the mine pits where practical
- a Mine Water Management Plan will be prepared to guide the site WMS
- monitoring of water quality within the site WMS will be conducted during the initial years of mining, and the design of the WMS modified if indicated as required by the monitoring results.

In later years of the mine development, re-use of large quantities of water captured at the CHPP will be critical to managing the risk of interruptions to mining and off-site discharge.

During wet periods similar to the wettest on record, up to 12,000 ML of water storage in addition to the proposed environmental dams could be required to manage pit/process water from throughout the site without significant off-site discharges (for the year 30 pit layout). If the quality of overburden runoff is such that water captured in sediment dams is unsuitable for release except in larger flows, this volume requirement increases to 26,000 ML. A number of potential storage locations are likely to be available for this excess water.

11.6.3 SURFACE WATER FLOW

These measures will ensure that the existing flow regime will be maintained to the greatest extent possible:

- the water management system will be laid out to where possible, minimise the areas of undisturbed catchment captured in the dams and pits
- where possible, diverting undisturbed catchment water through the site without capture in the WMS
- the catchment area reporting to the pit/process water management system will be minimised
- runoff from rehabilitated overburden will be diverted around the WMS as soon as runoff quality is suitable for off-site discharge without treatment

- following heavy rainfall, if stored water quality and receiving water quality allows, water may be discharged from the Project area according to the licensed discharge conditions. Discharge will only occur during or immediately following natural streamflow events, resulting in longer periods of streamflow, but not flow episodes which would not otherwise have occurred
- the discharge of water from the sediment dams to the natural environment will be designed to allow releases to coincide with natural flow events and meet discharge requirements.

11.6.4 FLOODING

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.

- the diversions and levee structures themselves have the potential to increase upstream flood levels and to impact on the sustainability of the local drainage system through increased flow velocities. The impact of the proposed diversion designs on flood levels was investigated using flood models. The results of the modelling show that at the Woleebee Creek diversion, peak flood flows may increase slightly due to a loss of flood storage, and consequently, downstream peak flood levels in Juandah Creek increase by up to 300 mm during a 1% AEP flood. At other locations, the modelling of the diversion design concept showed limited upstream increases in flood levels.

Refinements of the conceptual diversion arrangements to ensure they meet all current acceptable design criteria, may introduce afflux not currently predicted by the flood modelling. If this is the case, any potentially affected properties and infrastructure will be identified, and the owners notified during the licensing process.

The impact of the proposed diversions and levees on upstream and downstream flood conditions is described in detail in the Flood Study Technical Report TR 11-2-V1.5.

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 if suitable materials can be obtained locally. Alternatively, a polyethylene liner may be used to provide an impermeable barrier to leakage. Sufficient monitoring bores will also be installed to detect any leakage before it contaminates downstream water resources.

11.6.6 AQUATIC HABITAT

The following measures are proposed for preserving aquatic habitat:

- where feasible, box culverts will be used at major creek crossings to minimise impacts to aquatic fauna passage
- creek diversions will be designed sized to meet the requirements of the NRW Central West Regional Office guideline document "Watercourse Diversions – Central

Queensland Mining Industry" to ensure that natural geomorphological processes can be maintained

- creek rehabilitation and design/construction of diversion channels will provide a stable, sinuous low-flow channel with dimensions similar to the existing natural channel such that similar flow conditions are maintained
- a Vegetation and Rehabilitation Plan will be prepared for the creek diversions, detailing the in-stream and stream bank rehabilitation measures to create a self-sustaining system. This plan will include provision for the diversion to be designed and constructed to provide bed, bank and in-stream habitat of a similar character to that of natural watercourses within the region
- diversions will only be opened to flows once geotechnical stability and vegetation requirements have been satisfactorily established. Until this time, the existing channels will be maintained to continue to function normally
- fish (and other aquatic fauna) will be captured from the creek to be diverted using gear appropriate to the waterways and species present (this is likely to include electrofishing, cast nets, seine nets and set traps)
- on-site dams will be regularly surveyed for the presence of exotic fish species.

11.6.7 WATER SUPPLY IMPACTS ON THE GAB

The results of the analysis shown in Section 5 indicates the impacts of drawing additional construction water from the Precipice Sandstone aquifer are relatively small and temporary. While significant material impacts are therefore not anticipated, existing Precipice Sandstone bores will be monitored to gauge the impact of the proposal where possible. If impacts on nearby bores attributable to the project are greater than anticipated, the WJV will work to make good any loss of water supply.

11.7 REFERENCES

ACARP Project C8030 (Stage 1) – Maintenance of Geomorphic Processes in the Bowen Basin River Diversions.

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