8

SURFACE WATER

ENTER HERE

BACK TO CONTENTS

SUPPLEMENTARY REPORT TO THE EIS

arrow energy
go further

8 Surface Water

8.1 Introduction

This chapter presents the findings of the supplementary surface water quality study (see Surface Water Technical Report (Appendix F) of this SREIS). The technical studies were undertaken to provide baseline water quality information on a sub-catchment basis, with special consideration given to the baseline water quality of the Isaac River; this river has been tentatively identified as a possible receiving environment for CSG water discharges. The potential impacts and mitigation measures arising from possible releases of treated or untreated CSG water into the Isaac River are provided in this chapter. This assessment builds upon, updates and consolidates the findings and conclusions of the EIS. It also provides an updated impact assessment based on a revised project description and updates the water quality assessment included in the EIS. A field assessment of water quality was not possible for the SREIS due to a lack of rain in the catchment during the wet season of 2013/14. Further site specific assessments of water quality shall be undertaken as part of the Environmental Authority (EA) application process.

The most significant change to the project description as presented in the EIS which has the potential to impact the surface water environment is the inclusion of preferred localities for two potential water treatment facilities (WTFs). Subsequently, the updated project description provides two indicative reaches of the Isaac River main channel for the potential discharge of treated (or in certain instances untreated) CSG water, based on the general localities of the two WTFs. Other changes to the project description such as the reduction of wells and changes in the infrastructure configuration have also been considered in terms of their potential impacts to the surface water environment.

Studies undertaken to characterise flow regimes, hydraulic parameters and geomorphology of the Isaac River reaches being considered as possible receiving environments, as well as flood immunity of the localities identified as preferred localities for the two water treatment facilities, are presented in the Hydrology and Geomorphology chapter (Section 9) and surface water impacts on aquatic ecosystems are described in the Aquatic Ecology chapter (Section 10) of this SREIS.

8.1.1 Study Objectives

The objectives of the surface water quality assessment are to:

- Evaluate the impact assessment presented in the EIS for surface water in the context of an updated project description;
- Address stakeholder comments relating to the EIS surface water quality assessment;
- Undertake a desktop baseline water quality assessment and derive relevant water quality objectives (WQOs) using data from local operational mines and confirm representativeness of water quality data gathered for the EIS; and

- Develop an approach that informs and guides the CSG water discharge strategy that minimises potential impacts to identified environmental values (EVs).

8.1.2 Studies and Assessments Completed for the EIS

This section provides a summary of the surface water quality studies completed for the EIS and the main conclusions from the assessments.

The surface water impact assessment undertaken as part of the EIS comprised a desktop study and field investigation of representative sites to characterise the existing environment of watercourses in the sub-catchments of the Project area. The desktop assessment and field studies identified EVs associated with watercourses and wetlands in the study area on which to base the assessment of impacts and the development of mitigation measures. The EVs of these surface waters were identified in accordance with the Environmental Protection (Water) Policy 2009 (EPP (Water)), Queensland Water Quality Guidelines 2009 (QWQG) (EHP, 2009) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000). The characteristics and EVs of surface water features within the Project area that were considered included:

- Values identified in the EPP (Water);
- Physical integrity, fluvial processes and morphology, including riparian zone vegetation and form, if relevant;
- Hydrology of watercourses;
- Sustainability, including both quality and quantity;
- Dependent ecosystems;
- Existing and other potential surface users; and
- Any water resource plans relevant to the affected catchments.

The desktop assessment comprised a literature review to collect all available baseline information and data, on existing water resources that may be affected by the Project in the context of EVs as defined in such documents as the *Environmental Protection Act 1994* (EP Act), EPP (Water), the QWQG (EHP, 2009) and other relevant documents.

Sources of information gathered for the assessment included:

- Streamflow and water quality data obtained from the database maintained by NRM;
- Climate data obtained from the database maintained by the Bureau of Meteorology;
- Water licencing data obtained from the water licensing database maintained by NRM;
- Environmental values and WQOs defined for the Project area under the EPP (Water);
- Land use mapping data obtained from government sources;
- Digital drainage and topography data for the study area;
- Queensland Government Water Resource Plans (Queensland Government, 2007 and 2011); and
- Project specific water quality data provided by Arrow.

Targeted field investigations were undertaken during three sampling rounds in April and May 2012 at 22 locations for geomorphology and surface water quality with a focus on sites located upstream and downstream of the Project. The water quality results showed that for the majority of the analytes measured in the catchments the concentrations were consistent with trigger values for slightly to

moderately disturbed aquatic ecosystems. However the water quality data also identified a number of contaminants that consistently exceeded the WQOs for watercourses within the study area.

Field assessments for the SREIS of the water quality of the Isaac River at the reaches identified as potential receiving environments for CSG water releases were not undertaken due to a lack of suitable rainfall in the catchment during the 2013/14 wet season. Arrow has committed to undertake field surveys at confirmed discharge locations as part of the EA application process.

8.1.3 SREIS Study Purpose

The supplementary surface water resources assessment summarised in this chapter was undertaken to address updates to the project description, to provide additional information made available since publication of the EIS, and to incorporate legislative updates that may impact on the management of surface waters.

8.1.3.1 Project Description Update

Updates to the project description presented in the EIS, that have the potential to change or refine the EIS surface water impact assessment are described below.

Field Development Concept

A field development concept based on 14 development regions and 17 drainage areas of approximately 12 km radius was presented in the EIS. The field development concept has evolved and is now based on eight development regions and 33 drainage areas of approximately 6 km radius. Across the lifecycle of the Project, the planning basis is that two CGPFs and WTFs will be installed early in the development, which will both treat the gas for pipeline specification and treat the produced water for onward use. One CGPF and WTF will serve the drainage areas in the north, whilst the second CGPF and WTF will service the drainage areas in the south of the basin with the potential for a third WTF to be located near Blackwater.

Siting of Facilities

Arrow has tentatively identified two localities on which the CGPF and WTF may be located. It is intended that all properties identified for possible major facility locations will be either owned or leased under a long-term arrangement. The exact location of the facilities on each of the two localities being considered is still being investigated. Consequently, this assessment has focused on identifying and assessing site-specific impacts of development on the general localities, not at a specific location.

Coal Seam Gas Water Discharge

The EIS stated that the four CGPFs would have a capacity ranging from 10 to 22 ML/d each. The updated project description proposes only two CGPFs each with an associated WTF; each WTF will have the capacity to treat up to 20 ML/d. Both facilities may discharge CSG water to the Isaac River under both normal operations and emergency situations to manage variations in seasonal conditions and for distribution to water users for beneficial use. Any CSG water discharge will occur as required

and will be within the prescribed limits, to be determined by a site specific impact assessment that will support the application for the relevant EA approval. The exact location of any CSG water discharge has not yet been determined, although there are some potential options for consideration. Consequently, this assessment has focused on identifying and assessing specific impacts of CSG water discharges on the water quality of the Isaac River in the general vicinities of any discharge points.

8.1.3.2 Investigations Undertaken

The following studies were undertaken for the supplementary surface water quality assessment;

- Surface Water Desktop Assessment:
  - Review of EVs; and
  - Establishment of baseline water quality conditions; and
- Discharge Assessment. This assessment was undertaken to determine the capacity of the tentatively identified receiving waters to accept any CSG water discharges.

8.2 Legislative Context

8.2.1 Environment Protection and Biodiversity Conservation Amendment Act 2013 (Commonwealth)

Changes made to the EPBC Act on 22 June 2013, resulted in water resources in relation to CSG and large coal mining developments now being considered as a MNES. In accordance with this legislative change, on 17 October 2013, the Commonwealth Minister for Environment determined that water resources were a controlling provision under Sections 24D and 24E of the EPBC Act for the Project. This was due to the information available to the Minister at that time, indicating that the Project may potentially directly or indirectly result in a substantial change to the hydrology and quality of water resources impacted by Project activities. In making the decision, the Minister recognised that previously submitted documents, as well as subsequent documentation will be considered in the decision regarding the water resources controlling provision. Further details regarding the relevance of the EPBC Act updates to the Project are outlined in the Project Approvals chapter (Section 2.2.1) of the SREIS.

8.2.2 Coal Seam Gas Water Management Policy 2012 (Qld)

The Coal Seam Gas Water Management Policy 2012 was finalised on 21 December 2012 (subsequent to the compilation of the EIS). It was established to provide direction for the treatment and disposal of CSG water, and streamline the implementation of existing CSG water management policies under the EP Act. The Policy encourages the management of CSG water "in a way that protects the environment and maximises its productive use as a valuable resource". Under the Policy, CSG water and 'saline waste' (such as brine and associated salt solids) must be managed consistently in accordance with defined 'prioritisation hierarchies' and management criteria. Beneficial

use is identified as being the highest priority for managing CSG water, followed by management and disposal options. The Policy also prefers that saline wastes such as brine or salt residues are processed by the operator to create useable products, before considering alternative disposal options.

Further details on how the Policy applies to the Project are included in the Surface Water Technical Report (Appendix F) and Arrow's Coal Seam Gas Water and Salt Management Strategy (Appendix D) of this SREIS.

8.2.3 Single State Planning Policy (Qld)

Since the finalisation of the EIS, the Queensland Government has developed a single State Planning Policy (SPP) (replacing the 12 previous SPPs and incorporating the revised policies into a single policy document) which was adopted on 2 December 2013. The single SPP sets out policies on matters of state interest in relation to planning and development and provides a key framework for the government's broader commitment to planning reform. It includes a provision for the protection and enhancement of water quality throughout Queensland, which is directly relevant to the Project. The single SPP is related to the *Sustainable Planning Act 2009* and EP Act.

Further details regarding considerations of the single SPP for the Project are outlined in the Project Approvals chapter (Section 2) of this SREIS.

8.3 Existing Surface Water Environment

8.3.1 Description of Surface Water Environment within Study Area

The study area for the surface water component of the SREIS assessment remained the same as that initially delineated for the EIS; it encompasses 7,670 km^2 and spans the Fitzroy and Burdekin Basins in eastern / central Queensland. The study area includes the headwaters of the Bowen and Suttor Rivers (Burdekin basin) in the north, and the Mackenzie River in the south, while the Isaac-Connors catchment of the Fitzroy Basin encompasses the largest portion. A map of the study area and associated sub-catchments is provided in the Surface Water Technical Report (Appendix N) of the EIS. Major study sub-catchments include

- Bowen River Tributaries;
- Suttor River Tributaries;
- Isaac River Main Channel;
- Isaac River Northern Tributaries;
- Isaac River Western Upland Tributaries;
- Connors River Central Tributaries;
- Mackenzie River Main Channel;
- Mackenzie River North-Western Tributaries, and
- Mackenzie River Southern Tributaries.

The surface water quality assessment contained within the Surface Water Technical Report (Appendix F) of this SREIS is predominantly focussed on the Isaac River Main Channel sub-catchment, which has been tentatively identified as the receiving environment for possible CSG water discharges.

8.3.2 Additional Data from Operational Mines

In response to submissions made by EHP as part of the EIS approvals process, a detailed desktop assessment of surface water quality was undertaken throughout the study area for the SREIS.

This assessment included a review of Project data originally collected in the field during April 2012, and also incorporated further water quality data obtained from operational mines within the Bowen Basin. This data were generally collected during the period between 2010 and 2013. Analysis found that the results included in the EIS were representative of the condition of the wider surface water environment at the time. The sample locations selected as part of the baseline monitoring program for the EIS appear to have been appropriate and representative of the defined study sub-catchment. As such, it was deemed appropriate to proceed with analysing the available dataset (including data from both the EIS and operational mines) as a whole to assess the baseline water quality of the existing surface water environment within the Project area. This additional data analysis was used to refine the existing WQOs as described in Section 8.3.3.

Further detail regarding the data analysis methodology employed to assess the representativeness of the EIS field data can be found in the Surface Water Technical Report (Appendix F, Section 3.2.1) of this SREIS.

8.3.3 Surface Water Quality Objectives (WQOs)

Preliminary WQOs for the protection of EVs associated with the surface water bodies within the study area were identified during the EIS approvals process (refer to the Surface Water Technical Report (Appendix N, Section 7.1) of the EIS). Some revisions were implemented as part of the SREIS review; the updated WQOs relevant to the Project area are presented in Table 8-1 to Table 8-4 below. The overall purpose of the water quality assessment within the SREIS, given that greater volumes of data are now available for the study area, was to determine whether the WQOs that were identified for the EIS were still appropriate. Where significant exceedances to the published WQOs were identified, local WQOs were calculated at the sub-catchment level and recommended for consideration by EHP when considering future EA conditions. The process of deriving WQOs for the Project area was based on the methodology recommended in the QWQG (EHP, 2009).

Water quality data collected as part of the EA application for specific locations identified as the receiving waters for CSG water discharges, shall be used to update the WQOs using the same methodology adopted in this report.

8.3.4 Environmental Values for Surface Water

The EVs assessed as part of the EIS process (refer to the Surface Water Technical Report (Appendix N, Section 4) of the EIS) are still applicable to the Project at SREIS stage. An assessment of the

sensitivity of these values, with regards to potential impacts arising from proposed Project activities, is outlined in the Surface Water Technical Report (Appendix F, Section 6.3) of this SREIS.

Table 8-1 WQOs for Physico-chemical Stressors in Surface Waters within the Project Study Area (derived from ANZECC and ARMCANZ, 2000; EHP, 2009 and Queensland Government, 2009)

Parameter	Water Quality Objectives			
	Upper Isaac River	**Connors River**	**Mackenzie River**	**Suttor River and Bowen River* (Burdekin Basin)**
Suspended Solids (mg/L)	55	15	110	N/A
Sulphate (mg/L)	25	5	10	N/A
Total Nitrogen (µg/L)	500	485	775	250
Total Phosphorus (µg/L)	50	75	160	30
pH (pH units)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-7.5
Ammonia Nitrogen (µg/L)	20	20	20	10
Oxidised Nitrogen (µg/L) (NOx)	60	60	60	15
Organic Nitrogen (µg/L)	420	420	420	225
Filterable reactive Phosphorus (µg/L)	20	20	20	15
Chlorophyll-a (µg/L)	5	5	5	N/A
Dissolved oxygen (% sat)	85-110	85-110	85-110	90-110
Turbidity (NTU)	50	50	50	25
Electrical conductivity (EC) base flow (µS/cm)	720	430	310	200-500[#]
EC high flow (µS/cm)	250	250	210	N/A

**Guidelines for Burdekin Basin sub-catchments were derived from QWQG (EHP, 2009) Table 3.2.1a, regional guideline values for physico-chemical indicators – Central Coast region freshwater upland streams; elevation typically between 200 – 350 metres above sea level in Bowen and Suttor Rivers based on digital elevation models developed for geomorphology assessment undertaken for the EIS.*

[#]80th percentile value for EC (derived from QWQG (EHP, 2009), Figure G-3, Appendix G).

N/A- not available

Table 8-2 WQOs for Toxicants (Heavy Metals) in Surface Waters within the Project Study Area

Parameter	Water Quality Objective(s)	Source/Reliability
Aluminium (µg/L)	55 if pH>6.5 0.8 if pH <6.5	Moderate Reliability with 95% protection of fresh water ecosystems (ANZECC and ARMCANZ, 2000)
Chromium (III) (µg/L)	See Table 8-4	Low Reliability with 95% protection of fresh water ecosystems (ANZECC and ARMCANZ, 2000)
Copper (µg/L)	See Table 8-4	High Reliability with 95% protection of fresh water ecosystems (ANZECC and ARMCANZ, 2000)
Iron (µg/L)	300	Canadian WQ Guideline level (CCME, 1999)
Lead (µg/L)	See Table 8-4	Low Reliability with 95% protection of fresh water ecosystems (ANZECC and ARMCANZ, 2000)
Nickel (µg/L)	See Table 8-4	EPP (Water) 2011 – (ANZECC and ARMCANZ, 2000)
Zinc (µg/L)	See Table 8-4	EPP (Water) 2011 – (ANZECC and ARMCANZ, 2000)
Molybdenum (µg/L)	34	Low Reliability (ANZECC and ARMCANZ, 2000)
Selenium (µg/L)	11 (Total Se only)	High Reliability with 95% protection of fresh water ecosystems (ANZECC and ARMCANZ, 2000)
Uranium (µg/L)	0.5	Low Reliability (ANZECC and ARMCANZ, 2000)
Vanadium (µg/L)	6	Low Reliability (ANZECC and ARMCANZ, 2000)

Table 8-3 Conversion of ANZECC and ARMCANZ (2000) Guideline Values Based on Observed Hardness of Local Waters

Study sub-catchment	Median hardness (mg/L)	Hardness category (from Table 3.4.4, ANZECC and ARMCANZ, 2000)	Cadmium (µg/L)	Chromium(III) (µg/L)	Copper (µg/L)	Lead (µg/L)	Nickel (µg/L)	Zinc (µg/L)
Bowen River Tributaries	514	Extremely hard	27.72	12.6	90.78	99	72	27.72
Suttor River Tributaries	612	Extremely hard	27.72	12.6	90.78	99	72	27.72
Isaac River Main Channel	71	Moderate	0.54	8.25	3.5	13.6	27.5	20
Isaac River Northern Tributaries	69	Moderate	0.54	8.25	3.5	13.6	27.5	20
Isaac River Western Upland Tributaries	110	Moderate	0.54	8.25	3.5	13.6	27.5	20
Connors River Central Tributaries	393	Extremely hard	27.72	12.6	90.78	99	72	27.72
Mackenzie River Main Channel	139	Hard	0.84	12.21	5.46	25.84	42.9	31.2
Mackenzie River North-Western Tributaries	281	Very hard	1.14	16.17	7.28	40.12	57.2	41.6
Mackenzie River Southern Tributaries	54	Soft	0.2	3.3	1.4	3.4	11	8
ORIGINAL WQO (Table 3.4.1, ANZECC and ARMCANZ, 2000)			**0.2**	**3.3**	**1.4**	**3.4**	**11**	**8**

Table 8-4 Calculated Sub-regional WQOs for selected parameters within the Isaac River Main Channel

Parameter	20th percentile values		Median (50th percentile) values		80th percentile values		Existing regional WQO	Revised sub-regional WQO
	Mean	Standard error (±)	Mean	Standard error (±)	Mean	Standard error (±)		
Turbidity (NTU)	188.5	50	354.1	102.9	704.3	225.3	50	354
TSS (mg/L)	187.6	40.5	261.9	47.1	400.1	67	55	262
Aluminium (µg/L)*	177.9	45.8	375.1	123.6	818.9	392.5	55	375

**Based on water quality results for dissolved fraction*

8.4 Summary of Potential Impacts to Surface Water Environmental Values

8.4.1 Changes to Potential Impacts

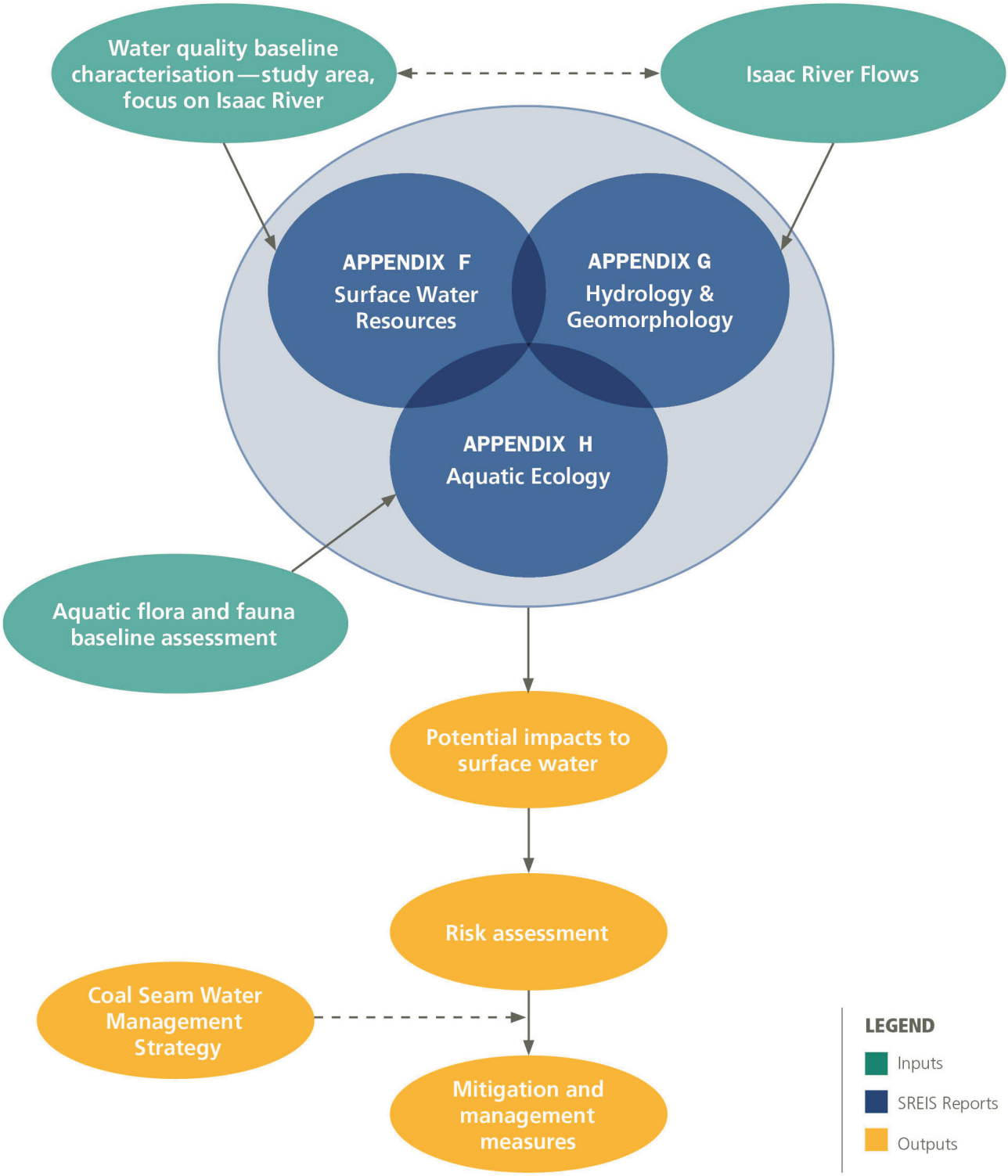
The assessment of potential impacts to the surface water environment associated with the Project was updated as part of the SREIS process, and includes an assessment of both the sensitivity of the receiving environment, and the magnitude of potential impacts that may arise as a result of the proposed development. Key changes to the proposed development since the EIS submission were also identified, along with any associated perceived changes to the type and extent of impact that may be incurred. Table 8-5 provides a summary of the key changes to the project description since the EIS, and associated potential impacts that formed the basis of the revised impact assessment.

Whilst this chapter specifically addresses the surface water quality aspects of any likely impacts related to activities described in the updated project description, these studies are considered together and in a holistic manner with Project impacts related to hydrology and geomorphology (see the Hydrology and Geomorphology Technical Report (Appendix G) of this SREIS) and aquatic ecology (see the Aquatic Ecology Technical Report (Appendix H) of this SREIS). The different and inter-relating aspects that determine river health such as water quality, river hydrology, geomorphology and aquatic ecology were assessed in order to identify potential impacts on environmental values associated with the Isaac River. This approach was utilised in the assessment of impacts associated with potential discharges of CSG water. This interrelationship is depicted in Figure 8-1.

Table 8-5 Comparison of EIS and SREIS Scenarios: Revised Surface Water Impact Assessment

Project Component	EIS Scenario	SREIS Scenario	Associated potential impacts	Key changes in degree of potential impact
Drainage areas	17 'drainage areas' of approximately 12 km radius, over approximately 8,000 km^2 Project area.	33 'drainage areas' of approximately 6 km radius.	• Alteration of flows and flow paths; • Erosion and sediment mobilisation; • Improper disposal of wastes from construction and operations activities; and • Potential release of contaminants to watercourses (adverse effects on surface water quality).	• Reduction in size of each drainage area, but increase in number of drainage areas; contributing to an overall reduction in the intensity of development on a regional scale; and • May result in increased localised impacts compared with EIS scenario.
Production wells	• 6,625 production wells drilled over 40 years; and • Single well pads only.	• Approximately 4,000 production wells drilled over 36 years; and • Multi branch lateral (MBL) wells will be clustered together onto multi-well pads.	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation.	• Reduced intensity of development on a *regional* scale, however the introduction of multi-well pads may increase the degree of potential *localised* impact and risk to surface waters.
Gas compression infrastructure	• Four integrated gas and water processing facilities of 800 x 250 m area, with dams up to 1 km^2 in area; and • One field compression facilities (FCF) per drainage area, with a footprint of up to 200 m x 250 m.	• Two (2) central gas processing facilities (CGPFs) located near Peak Downs and Red Hill (adjacent to Isaac River); and • One FCF per drainage area (skid-based, modular design with footprint up to 200 m x 380 m in area).	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation.	• Reduced footprint and number of CGPFs; and • Larger overall footprint area for FCFs.

Project Component	EIS Scenario	SREIS Scenario	Associated potential impacts	Key changes in degree of potential impact
WTF	• Maximum dam footprint 0.6 km^2; and • WTFs may have peak flows of between 15-30 ML/d of field produced water, allowing that some areas will produce more water than others.	• Water transfer stations in field (pumping and surge tanks), typically associated with an FCF; • One (1) WTF associated with each CGPF. Feed water dams, treated water dams, and brine storage facilities will be located at each WTF; • WTF1: Expected peak flow of 12.9 ML/d; • WTF2: Expected peak flow of 20 ML/d; and • Raw water can be transferred between WTFs.	• Controlled release of treated (and in certain instances untreated) CSG water to surface watercourses (potential adverse effects on surface water quality); • Uncontrolled release of treated or untreated CSG water, and contaminated process water to grade and/or watercourses due to flooding, dam failure or spills (from water gathering lines; trucks transporting wastewater and treated water from water transfer stations); and • Reduced risk of adverse impacts to water quality, with fewer discharge points (a function of having fewer WTFs).	• Reduction in number of WTFs, but retained a similar treatment capacity to that proposed for the EIS scenario; • Significant reduction in maximum area for WTF dams, potentially decreasing the overall impact of WTF construction/operation; and • Potentially lower risk of uncontrolled release to surface waters, due to reduced number of WTFs and discharge locations.
Linear Infrastructure (e.g. roads and pipelines)	Network of roads and pipelines designed to cater for Project layout	Updated linear infrastructure to be constructed as per new Project layout.	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation.	• Extent of linear infrastructure required reflects updates to the project description under the SREIS scenario.



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BOWEN GAS PROJECT SREIS

OVERVIEW OF IMPACT ASSESSMENT PROCESS FOR THE SURFACE WATER ENVIRONMENT

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SURFACE WATER

Figure: 8-1

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8.5 CSG Water Release Impacts and Mitigation Options

As stated in the revised Project Description chapter (Section 3.5), CSG water will be produced throughout the Project life cycle. Produced water will be processed by water treatment facilities; at times being stored in locations such as water transfer stations (at FCFs; prior to being pumped or transported to the WTFs); feed water dams (storage and settlement dams for water collected throughout the gas fields, and stored prior to being processed through a WTF), and treated water dams (for storage of treated CSG water prior to beneficial use or release). Water will firstly be directed to beneficial uses (detailed in Section 8.5.1 below), but may need to be released to surface watercourses periodically if any of the following conditions occur:

- Constraints to supply for beneficial use occur;
- Unforeseen events occur such as significant weather events; or
- The structural and operational integrity of dams is at risk.

In the event that any of the above circumstances arise, management options have been identified for minimising the potential impacts of releasing CSG water to the surface water receiving environment. These options are outlined in the Project Description chapter (Section 3.5) of the SREIS and detailed in Sections 8.5.1 and 8.5.2 below.

8.5.1 Beneficial Use Options

A full outline of the strategy for water management is provided in the Project Description chapter (Section 3.5) of the SREIS. A brief description of aspects relevant to potential surface water impacts and mitigation is provided in this chapter.

The preferred option for mitigating the potential impacts associated with management of CSG water produced as a result of Project operations is beneficial use. Options with the highest priority for Arrow include:

1. Supply of treated CSG water to augment the domestic water supply within the Project area;
2. Supply of treated CSG water to water service providers (such as Sunwater);
3. Supply of treated (and in certain instances untreated) CSG water to coal mines within the Bowen Basin;
4. Supply of treated CSG water to third party agricultural users; and
5. Own use (within Project operations) of treated (and in certain instances untreated) CSG water.

Further details regarding the circumstances under which each option may be utilised are included in the Surface Water Technical Report (Appendix F, Table 7-6) of this SREIS.

8.5.2 CSG Water Management

As discussed above, CSG water may need to be released to surface watercourses periodically if certain conditions occur in relation to Project operations.

The maximum release limits included in this report should be used as a guide only, to inform the reader of the high assimilative capacity of the Isaac River for CSG water discharges. These upper limits documented in this report are based on the protection of water quality, flows, and hydraulic

baseline parameters of an indicative stretch of the Isaac River proposed as an indicative receiving environment, that may be different from the final location of discharge points identified at later stages of the regulatory process. Further baseline assessments of the exact locations of the receiving environment, as well as that on the quality of the treated CSG water, will therefore need to be undertaken before a CSG water discharge strategy can be confirmed.

The characterisation of the baseline condition of the Isaac River indicates that Arrow is able to manage the possible controlled releases of treated or untreated CSG water without causing significant impacts to the receiving watercourse. Site-specific assessments of the water quality at the confirmed locations of potential CSG discharge points will be undertaken as part of the EA application process. Discharge of CSG water has the potential to adversely impact the receiving watercourse by affecting the EVs associated with receiving water's quality, stream flow and geomorphic conditions. As such the discharge rates, timing, frequency and duration of CSG water releases that will be considered as part of the EA application process will address a number of variables including stream flows, stream water quality and CSG water quality. As an overarching objective, discharge of treated or untreated CSG water is considered appropriate only where disposal to receiving watercourses will not significantly impact the environmental values of the aquatic environment, in line with legislative requirements.

In the case of uncontrolled releases of CSG water the magnitude and significance of impacts would depend on the quality of CSG water released and the flows of the receiving environment. Magnitude of impact relates to the severity of the impact or consequences, whereas the significance of impact relates to importance or materiality of the potential impact. These impacts have been assessed to range from low to moderate (see Section 8.6).

8.6 Impact Assessment

The impact assessment for CSG water release scenarios on the Isaac River is summarised in Table 8-6, whereas Table 8-7 provides a summary of the impacts that potentially remain in association with the proposed Project activities, after the management and mitigation measures previously described above are applied.

Table 8-6 Impact Assessment for CSG Water Release Scenarios on the Isaac River

CSG Water Release Scenario	Contributing factor	Potential impacts	Magnitude of Impact	Significance of Impact
Uncontrolled release of *untreated* CSG water	Flooding (dams over capacity; inundation of infrastructure)	Slight increase in receiving environment salinity, although unlikely to exceed receiving environment 80th percentile value of 428 µS/cm as Isaac River flows will likely be at greater than 75th percentile flow volume for flooding to occur.	Low	Low
	Dam failure	• During periods of low flow, sudden release of large volumes of moderately saline water will impact the baseline salinity and the natural flow regime; • Potential inundation of riparian margins and floodplain areas not usually inundated during dry season; • Transport of large quantities of sediment and large woody debris downstream; and • During periods of high flow, there may be a slight increase in salinity within the receiving environment, however it is unlikely to exceed Isaac River 80th percentile value of 428 µS/cm.	High	High
	WTF operational emergency	Similar impacts to those listed above for dam failure, but of lower magnitude and significance.	Moderate	Moderate
Uncontrolled release of *treated* CSG water	Flooding (dams over capacity; inundation of infrastructure)	Possible decrease in salinity within receiving environment (due to dilution), depending on the EC of the receiving environment during flood. Some impact may be evident to hydrology and geomorphology, with an increase in water level and discharge depending on extent of flood.	Low	Low
	Dam failure	• During periods of low flow, sudden release of large volumes will be outside of the natural flow regime; • Potential inundation of riparian margins and floodplain areas not usually inundated during dry season; slight exacerbation of high water level during wet season. Mobilisation and transport of large quantities of sediment and large woody debris downstream.	Moderate	Moderate
	WTF operational emergency	Similar impacts to those listed above for dam failure, but of lower magnitude and significance.	Low	Low

CSG Water Release Scenario	Contributing factor	Potential impacts	Magnitude of Impact	Significance of Impact
Uncontrolled release of both *treated and untreated* CSG water	Flooding (dams over capacity; inundation of infrastructure)	Potential water quality impacts resulting from combined sources (higher salinity of treated CSG water, combined with large volumes of both streams) could be difficult to interpret. However during periods of significant rain events overspills are likely to be quickly diluted in the receiving environment.	Low	Low
	Dam failure	This event is considered to be highly unlikely (i.e. for one or more dams to fail on site at the same time), however if it did occur there may be the following impacts: • During periods of low flow, sudden release of large volumes will be outside of the natural flow regime. • Potential inundation of riparian margins and floodplain areas not usually inundated during dry season; slight exacerbation of high water level during wet season. Mobilisation and transport of large quantities of sediment and large woody debris downstream.	High	High
	WTF operational emergency	This event is considered to have a higher probability of occurrence than for dam failure in the same scenario. It is more likely to be able to be moderated or controlled using emergency procedures. However, the same impacts as listed for dam failure (above) would apply, albeit at a reduced extent.	Moderate	Moderate
Controlled release of *untreated* CSG water	Release according to EA conditions (where beneficial use is not appropriate/available)	Insignificant impacts to the stream hydrology and water quality would be expected.	Low	Low to negligible
Controlled release of *treated* CSG water	Release according to EA conditions (where beneficial use is not appropriate/available)	Insignificant impacts to the stream hydrology and water quality would be expected.	Low	Low to negligible

Table 8-7 Residual Impacts to Surface Water Potentially Arising from Project Activities

Project Component	Associated potential impacts	Applicable Mitigation Measures	Residual Impact	Magnitude of Residual Impact	Significance of Residual Impact
Drainage areas	• Alteration of flows and flow paths; • Erosion and sediment mobilisation; • Improper disposal of wastes from construction and operations activities; and • Potential release of contaminants to watercourses (adverse effects on surface water quality).	Mitigation measures outlined in the Surface Water Technical Report (Appendix N, Sections 9.2.1, 9.2.2 and 9.2.3) of the EIS still apply.	Potential release of sediment and contaminated water to overland flows paths if management controls fail (for example, sediment fence is washed away or vandalised).	Low	Low
Production wells	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation.	Mitigation measures outlined in the Surface Water Technical Report (Appendix N, Sections 9.2.2.1, 9.2.2.2 and 9.2.2.3) of the EIS still apply.	Potential localised impact to surface water quality if engineering/management control options fail (potential for larger volume of sediment to be mobilised from multi-well pads, on a local scale only).	Low	Low to negligible
Gas compression infrastructure	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation.	Mitigation measures outlined in the Surface Water Technical Report (Appendix N, Sections 9.2.1.1 to 9.1.2.4, and 9.2.2) of the EIS) still apply.	Potential localised impact to surface water quality in surface water catchments containing FCFs, if engineering/management control options fail (potential for larger volume of sediment to be mobilised from FCFs with increased area).	Low	Low to negligible

Project Component	Associated potential impacts	Applicable Mitigation Measures	Residual Impact	Magnitude of Residual Impact	Significance of Residual Impact
WTFs	• Controlled release of treated and in certain instances untreated) CSG water to surface watercourses (potential adverse effects on surface water quality); • Uncontrolled release of contaminated water to grade and/or watercourses due to spills (from water gathering lines; trucks transporting wastewater and treated water from water transfer stations); and • Reduced risk of adverse impacts to water quality, with fewer discharge points (a function of having fewer WTFs).	Mitigation measures outlined in the Surface Water Technical Report (Appendix N, Sections 9.2.1.1 to 9.1.2.4, and 9.2.2) of the EIS still apply. Any releases from WTFs to the receiving environment are detailed in the Surface Water Technical Report (Appendix N, Section 9.2.2.4) of the EIS and the Surface Water Technical Report (Appendix F, Sections 9.1 and 9.2) of the SREIS.	Potential impact to surface water hydrology in the event of uncontrolled releases (where it is not possible to control the volume released, such as in an emergency); and The impact to surface water quality, hydrology and geomorphology is dependent on actual rate and quality of CSG water discharge and flow in the Isaac River main channel. The likelihood of this event occurring is very low.	Moderate	Moderate
Linear infrastructure (e.g. roads and pipelines)	• Alteration of flows and flow paths; and • Erosion and sediment mobilisation	Mitigation measures outlined in the Surface Water Technical Report (Appendix N, Sections 9.2.2.1, 9.2.2.2 and 9.2.2.3) of the EIS still apply.	Potential localised impact to surface water quality if engineering/management control options fail.	Low	Low to negligible

Arrow committed to implement a number of avoidance, mitigation and management measures to reduce impacts on values in the project development area as outlined in the impact assessment tables above. The full list of commitments pertaining to surface water as presented in the EIS are listed in below in Table 8-8.

New and revised commitments are also presented below in Table 8-9. This update has resulted from changes made to the project description since the EIS was finalised and the decision to further clarify the intent of a commitment (e.g., through the consolidation of similar commitments to avoid inconsistent wording). A full list of all project commitments, including those that remain unchanged from the EIS, and details of those that have changed, are included in the Commitments Register (Appendix O) of this SREIS.

Table 8-8 Surface Water Commitments Presented in the EIS

Number	Commitment
B286	Watercourse crossings to be designed to minimise impacts on geomorphology and river flows.
B287	Where practical major facilities will be constructed above the 1:100 year flood level.
B288	Develop, implement and maintain a procedure to minimise the risk of drilling waste (in the form of drilling fluids and hydraulic stimulation fluids) contaminating watercourses during drilling, completion, hydraulic stimulation and workover activities.
B289	Develop, implement, and maintain a waste management plan for the disposal of wastes produced as a result of drilling activities.
B290	Develop a site-specific Erosion and Sediment Control Plan to include: • Localised erosion and sediment control and energy dissipation structures • Stabilise exposed areas.
B291	Storage and refuelling areas to be designed to minimise the ingress of stormwater.
B292	Areas of disturbed or exposed soil will be managed to reduce sediment mobilisation and erosion.
B293	Construction activities will be undertaken during the dry season where scheduling allows.
B294	Topsoil will be stockpiled away from drainage lines to reduce chances of erosion.
B295	Vegetation clearing will not be carried out during heavy rainfall.
B296	Dust suppression measures will be implemented.
B297	Vehicle wash-downs will be located away from drainage lines or watercourses.
B298	Regular inspections of pipeline and roads alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to prevent erosion from occurring or worsening.
B299	As soon as practical following pipe laying, the trench will be backfilled with excavated material, compacted and topsoil replaced and erosion controls implemented.
B300	Minimise potential impacts on surface waters through implementation of the following measures during construction of watercourse crossings: • Watercourse crossings should be timed to occur during the dry season during periods of low flow, where possible; • Construction of watercourse crossings will be conducted in the shortest possible time and in accordance with the EHP (2012a) guideline Activities in a watercourse, lake or spring carried out by an entity; • Avoid disrupting overland natural flow paths and, where avoidance is not practicable, maintain connectivity of flow in watercourses;

Number	Commitment
	• Delay clearance of stream banks until the watercourse crossing is due to be constructed, to the greatest extent practicable. Implement appropriate erosion and sediment control measures on watercourse approaches and banks and ensure prompt completion of construction; • Check for flood warnings or subscribe to flood warning services where relevant during construction of watercourse crossings; • Construct watercourse crossings in a manner that minimises sediment release to watercourses, stream bed scouring (e.g., the crossing location will be at low-velocity, straight sections, with the pipeline or road orientated as near to perpendicular to water flow as practicable), obstruction of water flows and disturbance of stream banks and riparian vegetation (i.e., the crossing location will be at a point of low velocity, and straight sections will be targeted, with the pipeline or road orientated as near to perpendicular to water flow as practicable). Avoid, where practicable, the use of rock gabions, as they are unsuited to watercourses of the region; • All crossings will be constructed and reinstated to ensure that flows are not impeded and water is not ponded by the crossing. Where the temporary damming of flows is necessary during construction then flow will be diverted where required to maintain flows and allow for fish movement; • Minimise the number of channels to be crossed; • Avoid permanent pools; • Avoid mid-channel alluvial bars and islands; • Stockpile watercourse bed material in the watercourse channel adjacent to the construction ROW only when the watercourse is dry, and site the stockpile to avoid impacts on riparian vegetation and in-stream features; • Retain coarse alluvial material from watercourse crossings for backfill armouring over the finer unconsolidated material; • Stabilise watercourse crossings as soon as possible using bedrock where available; • Rehabilitate and revegetate banks as soon as possible after construction.
B301	Where regulated dams are decommissioned and rehabilitated, their contents will be drained and disposed of at appropriately licensed waste facilities.
B302	Temporary and permanent chemical and fuel storage areas to be appropriately bunded in accordance with relevant Australian Standards (e.g. AS 1940).
B303	All transfers of fuels and chemicals will be controlled to prevent spillage outside bunded areas.
B304	Refuelling to occur in accordance with AS1940 at a distance of greater than 50 m from any watercourses.
B305	All vehicles, plant and equipment to be checked regularly for fuel tank and line failures.
B306	Bunds and sumps should be frequently drained and treated/ disposed of appropriately.
B307	Contaminants and spillages to be collected by a licensed waste collection and transport contractor for disposal at licensed facility.
B308	Contaminated soil to be removed and remediated.
B309	Spill clean-up kits in accordance with AS 1940 and AS 3780 to be located in appropriate locations, including where required inside machinery and vehicles.
B310	In the event of a spill occurring, ensure it is controlled, contained and cleaned up to prevent the mobilisation of pollutants in drainage lines or watercourses.
B311	A drilling waste management plan will be developed to ensure that drilling wastes are managed accordingly.
B312	A hydrostatic testing strategy will be developed to manage hydrotest activities.
B313	Dust suppression water quality will meet the prescribed specification prior to use so that water does not pool on the surface, or enter surface watercourses via surface runoff.

Number	Commitment
B314	Operate and maintain appropriate sediment detention measures for overland flow from disturbed areas.
B315	Undertake routine inspection and maintenance of existing erosion and sediment control measures.
B316	Design surface flows from unsealed areas to flow to adjacent grassed areas at low velocities.
B318	Hazardous chemical bunds and sumps within them should be emptied after each rainfall event to maintain capacity requirements as per AS 1940. Water and oily water from fuel and oil storage areas removed from bunds and sumps should be appropriately treated and/or disposed of appropriately.
B319	Contaminants and major spills should be collected by a licensed waste collection and transport contractor for disposal at licensed facility.
B320	Spill clean-up kits are to be located in appropriate locations, based on the risk of a spill occurring and potential volume of material that might be spilled at the particular location.
B321	Workers involved in storage, handling and management of fuels and chemicals are to receive training in spill prevention and control.
B322	Instructions on spill containment and clean-up to be available at refuelling locations and in vehicles where there is a moderate risk associated with spill events.
B323	Spills are to be contained and cleaned up as soon as practical to prevent the mobilisation of pollutants in drainage lines or watercourses.
B324	Wastewater from the vehicle wash-down should be treated and recirculated for use in the wash-down facility.
B325	Establish water quality monitoring stations upstream and downstream of discharge points to watercourses as part of a monitoring program to ensure compliance with environmental authority conditions and relevant standards.
B326	Design and construction supervision of regulated dam embankments undertaken by a suitably qualified and experienced engineer (as defined by EHP).
B327	Rapid stabilisation of constructed regulated dam embankments through the implementation of suitable erosion controls.
B328	An Effluent Irrigation Management Plan is prepared for any effluent irrigation area.
B329	Management and maintenance of the sewage treatment plant must be carried out by suitably trained and/or qualifications to ensure the effective operation of that treatment system.
B330	Monitoring of effluent discharge points and records kept for follow up management.
B331	Treated effluent from the sewage treatment plant must only be discharged for irrigation in compliance with the requirements for Class C (refer to the DERM (2005) Queensland Water Recycling Guidelines).
B332	Releases of effluent must not have any properties nor contain any organisms or other contaminants in concentrations that are capable of causing environmental harm.
B333	Treated effluent must not be released from the site to any waters or the bed and banks of any waters.
B334	Water or storm water contaminated by sewage treatment activities must not be released to any waters or the bed and banks of any waters (i.e. effluent irrigation must not occur during rainfall events).
B335	When conditions prevent the discharge of the treated effluent for irrigation (such as during or following rain events), the contaminants must be directed to an emergency / wet weather storage or alternative measures must be taken to store or lawfully dispose of effluent (such as wet weather storage or tanking off site to another treatment plant or sewer).
B336	Spill containment procedures will be implemented in response to releases of contaminated water as a consequence of pipeline failures.

Number	Commitment
B337	Implement best practice erosion and sediment control measures during decommissioning works in accordance with the requirements of the IECA (2008) Best Practice Erosion and Sediment Control manual.
B338	Separate clean water and impacted water from active and rehabilitated areas.
B339	Develop and implement a rehabilitation management plan for decommissioning which includes monitoring and maintenance of rehabilitated areas until rehabilitation is complete.
B340	Locate Project infrastructure with consideration of downstream values.
B341	Avoid permanent pools when selecting watercourse crossing points.
B342	Identify strategies to minimise CSG water surface storage and to promote increased efficiency.
B343	Ensure CSG water used for dust suppression on roads or for construction and operation activities is treated if required.
B344	Develop and continually maintain the CSG water management plan throughout the Project life to optimise the investigation and implementation of the potential CSG water management options in alignment with the overall Project development.
B345	Incorporate into an emergency response plan or water management plan procedures for the controlled discharge of CSG water.
B346	Design discharge structures to minimise erosion of the bed and banks of the receiving waterway by implementing erosion controls, including energy dissipation structures, at discharge outlets at the point of discharge.
B347	Employ beneficial use options for CSG water wherever practical.
B348	Undertake specific investigations to assess the assimilative capacity of the receiving environment at proposed discharge locations.
B349	All water for discharge from site will meet approved discharged criteria.
B350	Ensure that antiscalants or other chemicals used within the reverse osmosis process are captured within the reject waste stream.
B359	Develop the construction, design and monitoring requirements for new regulated dams (either raw water, treated water or brine dams) and determine the hazard category of the dam in accordance with the requirements of the most recent version of Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM, 2011b). Construct the dams under the supervision of a suitably qualified and experienced person in accordance with the relevant EHP schedule of conditions relating to dam design, construction, inspection and mandatory reporting requirements.
B363	Annual regulated dam inspections to be undertaken by a suitably qualified and experienced engineer (as defined by EHP).
B515	Establish overflow and operational controls in accordance with the dam operating plan.
B516	Inspect and maintain dam integrity.

Table 8-9 Revised Surface Water commitmtents

Number	Revised / New Commitment	Rationale
B295	Vegetation clearing will not be carried out during heavy rainfall unless opportunity exists to established and secure adequate erosion controls prior to rainfall	Amended to clarify intent
B301	Where regulated dams are decommissioned and rehabilitated, their contents will be managed in accordance with relevant environmental approvals.	Amended to clarify intent
B308	Contaminated soil resulting from spills to be removed and/or remediated.	Amended to clarify

Number	Revised / New Commitment	Rationale
		intent
B309	Spill clean-up kits in accordance with AS 1940 and AS 3780 to be located in appropriate locations based on the potential risk, volume and type of spill.	Combined with commitment B320 to clarify intent
B312	A hydrostatic testing strategy will be developed to manage hydrotest activities to prevent contaminants from entering watercourses.	Amended to clarify intent
B316	Design surface flows from unsealed areas to flow to any existing adjacent grassed areas at low velocities.	Amended to clarify intent
B327	Maintain stabilisation of constructed regulated dam embankments through the implementation of suitable erosion controls and/or maintenance.	Amended to clarify intent
B333	Treated effluent must not be released from the site to any waters or the bed and banks of any waters unless specifically authorised.	Amended to clarify intent
B335	When conditions prevent the discharge of the treated effluent for irrigation the contaminants must be directed to a relevant storage or alternative measures taken to dispose of effluent.	Amended to clarify intent
B338	When disposing of site dam water during decommissioning, separate clean water and impacted water for separate appropriate disposal.	Amended to clarify intent
B339	Develop and implement a rehabilitation management plan for decommissioning which includes monitoring and maintenance of rehabilitated areas until rehabilitation sign off criteria is met.	Amended to clarify intent
B344	Develop and maintain the CSG water management plan throughout the Project life.	Amended to clarify intent in line with legislative requirements
B345	Implement water management plan for proposed controlled discharge of CSG water.	Amended to clarify intent in line with legislative requirements
B348	When applying for approval to discharge, undertake specific investigations to assess the assimilative capacity of the receiving environment at proposed discharge locations.	Amended to clarify intent
B349	CSG water will be released to surface waters in accordance with discharge approved discharged criteria.	Amended to clarify intent
B359		Deleted as commitment intent is included in B355 and B363
B363	Annual regulated dam inspections to be undertaken by a suitably qualified and experienced person.	Amended to clarify intent
B516		Deleted as commitment intent is included in B491

8.7 Cumulative Impact Assessment

The results of impact assessments undertaken for both the EIS (Cumulative Impacts chapter (Section 31)) and SREIS indicated that surface water resources within the Project area had been impacted by different historic and current land uses such as agriculture, mining and urban development. The EIS determined that through the implementation of appropriate mitigation measures, the potential impacts

on surface water quality could be minimised. In addition, the set of principles for CSG water discharges developed in the SREIS study (see the Surface Water Technical Report (Appendix F)) will allow for CSG water to be discharged should this option be required, without having any significant impacts to the receiving environment. Providing that all planned developments are managed with sufficient mitigation measures and appropriate discharge strategies are implemented, significant impacts on surface water quality should not occur. It should be noted that in context of the large volumes of mine affected water that are discharged into the Isaac River by coal mines operating in the region (DERM 2009), any CSG water that may be released into the Isaac River by this Project will have an insignificant effect on the receiving environment.

8.8 Monitoring Program

A monitoring program, typically applied for projects of this nature throughout the Project duration has been identified, and is outlined in the Surface Water Technical Report (Appendix F, Section 10) of this SREIS. This program has been designed to assess the effectiveness of management and mitigation measures in protecting the surface water environmental values identified within the EIS and SREIS. It is noted that this program will be revised to target specific areas of the Project once infrastructure plans, designs and operations have been updated and finalised.