Australia Pacific LNG Project

Volume 2: Gas fields

Chapter 11: Surface Water

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11. Surface water and watercourses

11.1 Introduction

11.1.1 Purpose

This chapter outlines the assessment of surface water and watercourses in the Australia Pacific LNG Project (the Project) gas fields. A number of technical studies were conducted as part of this assessment, including:

- Tenement flood assessment
- Stormwater management assessment
- Dam failure impact assessments
- Hydraulic stream flow impact assessment.

These assessments form the Surface water and watercourses technical report, which is available in Volume 5 Attachment 22.

This chapter summarises those surface water assessments, and examines potential impacts identified as a result of the Project. Mitigation and management strategies for these impacts are also discussed, as well as the potential impacts from hydrostatic test (hydrotest) water.

In the preparation of the environmental impact statement (EIS) and going forward with the Project, Australia Pacific LNG will be guided by 12 Australia Pacific LNG sustainability principles when identifying potential impacts the Project may have on water resources. In particular, the principles relevant to surface water in the gas fields provide for:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

Under these principles, surface water resources are reflected in a number of ways. Surface water is a key resource for the people and ecology of Australia. Within the operational area of the Project, surface water is used by numerous stakeholders including heavy and light industry, cities and townships, both indigenous and non-indigenous cultures and Queensland's diverse terrestrial and aquatic wildlife. To meet the demands of these stakeholders and the needs of the Project, an adaptive associated water management plan will be implemented.

Through a number of strategies, the Project will endeavour to use water efficiently and be as self sufficient as practicable for all construction and operational water requirements. Innovative design of surface water ponds and compliance with Queensland's regulatory authorities assists the Project in using associated and treated water it generates. In addition, the planned and controlled discharge of treated water back into the project area provides enhancement opportunities for all stakeholders and ecosystems.

Through a water management plan, the Project will have a clear vision for the future, and sustainable use of water acquired and generated for the life of the Project.

Section 11.6.2 of this chapter details how Australia Pacific LNG will use these surface water assessments and deliver the Project in accordance with its sustainability principles.

11.1.2 Scope of work

The scope of work for the surface water and watercourses assessments was based on the need to address the EIS terms of reference (December 2009), as set out by the Coordinator-General. Table 11.1 details these requirements.

Table 11.1 Terms of reference requirements and studies undertaken

Terms of reference section		Study	Reference
2.5.4	Stormwater drainage	Stormwater management plans	Volume 5 Attachment 22
3.4.1.2	Potential impacts and mitigation measures		
9	Environmental management plan		
3.4.1.1	Description of environmental values	Tenement flood assessment	Volume 5 Attachment 22
3.4.1.2	Potential impacts and mitigation measures		
7	Cumulative impacts		
3.4.1.2	Potential impacts and mitigation measures	Dam failure impact assessment	Volume 5 Attachment 22
3.4.1.2	Potential impacts and mitigation measures	Stream flow impact assessment	Volume 5 Attachment 22
3.4.1.2	Potential impacts and mitigation measures	Hydrotest water assessment	Volume 5 Attachment 22

In order to meet these requirements, the following scope of work was undertaken:

- Consideration was given to the relevant legislative framework
- A methodology was adopted for each technical assessment to specifically address the terms of reference
- Descriptions of the existing environment and environmental values were prepared
- Potential impacts upon these environmental values were then identified
- Mitigation measures for these potential impacts were then proposed where required
- A risk assessment, incorporating the sustainability principles, was conducted that factored in both potential impacts and mitigation measures.

11.1.3 Legislative framework

Key policies and legislation that needs to be considered in relation to surface water are shown in Table 11.2. This table is not exhaustive and lists the main aspects considered as part of this assessment.

Table 11.2 Relevant policy and legislation

Policy or legislation	Description	Relevance
Water Act 2000	The *Water Act 2000* provides for the sustainable management of water and other resources. The Act regulates the use and allocation of water through water resource plans.	The supply of associated water to third party users may require a water licence under this Act, where water will be supplied to outside of the tenements. Under this Act, a water licence is required for all operations not related to activities authorised under the *Petroleum and Gas (Production and Safety) Act 2004* that will interfere with surface water or watercourses.
The Water Supply (Safety and Reliability) Act 2008	The *Water Supply (Safety and Reliability) Act 2008* aims to provide for the safety and reliability of water supply.	The *Water Supply (Safety and Reliability) Act 2008* sets out the way in which dams are defined and regulated. The legislation puts the onus on particular dam owners to asses the impacts of dam failure by way of completing a 'dam failure impact assessment' if the dam meets criteria requiring assessment. The result of this assessment determines if the dam is referable under the Act. If the dam is classified as referable, the chief executive of the Department of Environment and Resource Management (DERM) is responsible for the regulation of the referable dams in Queensland. If a dam contains hazardous waste it is not a referable dam, and will be governed by the provisions of the *Environmental Protection Act 1994* (EP Act) instead of the *Water Supply Act.* The Water Supply Act requires that an owner of water infrastructure for the supply of water services be registered as a service provider. It is possible that should associated water be supplied to a third party via pipeline that such registration may be required.
Sustainable Planning Act 2009	The *Sustainable Planning Act 2009* provides the framework for Queensland's planning and development assessment system.	Schedule 4 of the Sustainable Planning Regulation 2009 provides that development for petroleum activities is exempt from assessment against a planning scheme. A development permit may be required under *Sustainable Planning Act 2009* for development that is assessable against a planning scheme and for which the

Policy or legislation	Description	Relevance
		petroleum activities exemption does not apply, or if the development is made assessable under Schedule 3 of the Sustainable Planning Regulation 2009, such as development that is operational work for taking or interfering with water or waterway barrier works.
Environmental Protection Act 1994 and Environmental Protection Regulation 2008	The *Environmental Protection Act 1994* (EP Act) aims to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes. The Act regulates environmentally relevant activities and outlines procedures for environmental assessment.	The Act requires a project of this nature to operate under an Environmental Authority (Petroleum Activities). Associated water is considered a regulated waste under the *Environmental Protection Regulation 2008* (EP Reg). Generally, the storage, treatment or disposal of regulated waste is an 'environmentally relevant activity', subject to exceptions. The environmental authority approvals process will involve an examination of environmentally relevant activities that are petroleum activities. For any of these activities that are not petroleum activities, a development approval may be required. If associated water is treated in accordance with the conditions of a general or specific beneficial use approval, it will no longer be considered 'waste' and will not trigger environmentally relevant activities for dealing with waste/regulated waste. The disposal of hydrotest water is to be undertaken in accordance with the conditions set out in a permit issued by DERM under an environmental authority (petroleum activities), under the provisions of the Act.
Environmental Protection (Water) Policy 2009	The purpose of the Environmental Protection (Water) Policy 2009 is to achieve the object of the EP Act in relation to Queensland waters. The object of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.	Section 6 of this policy describes the environmental values of waters to be enhanced or protected under the Policy, and Section 7 outlines the indicators and water quality guidelines for environmental values. The direct release of waste water to waters is regulated according to Section 13 of the Policy; a four step hierarchy of preferred procedures. The last (fourth) step stipulates that if waste water treatment and recycling does not, or is not likely to, eliminate the release of waste water or contaminants to waters, the following options must be evaluated (in order of priority):

Policy or legislation	Description	Relevance
		(i) appropriate treatment and release to waste facility or sewer (ii) appropriate treatment and release to land (iii) appropriate treatment and release to surface waters or groundwater.
Environmental Protection (Waste Management) Regulation 2000 (Waste Regulation) and Operational Policy – Management of water produced in association with petroleum activities (associated water)	The DERM 'Management of water produced in association with petroleum activities (associated water)' operational policy (formerly the EPA operational policy) promotes the beneficial use of associated water in accordance with the Environmental Protection (Waste Management) Policy 2000 (EPP Waste).	The operational policy applies to new applications for non-code compliant environmental authorities (petroleum activities). An application for a non-code compliant authority must demonstrate a suitable method for managing associated water. The Policy identifies a number of preferred management options (injection, direct use without treatment, treated water use) and non-preferred management options (disposal via evaporation ponds, injection after surface storage or into better quality groundwater, discharge to surface waters). Attached to the operational policy is the general approval for beneficial use of associated water issued under the Waste Regulation. Where associated water produced during the Project is used in accordance with the conditions of the general approval, the associated water will no longer be considered 'waste' and may be reused for specific purposes outlined in the general approval. Alternatively, the Waste Regulation provides that applications may be made for specific approval for the beneficial use of associated water.
Murray Darling Basin Agreement	Under the Commonwealth *Water Act 2007*, the Murray Darling Basin Authority is the entity responsible for the management of water within this Basin and to this end is charged with the responsibility to prepare 'The Basin Plan' by 2011. The Basin Plan is to address the following issues: • Limits on surface and ground water that can be taken • Identifying risks to Basin water resources (e.g. climate change) • A water quality and salinity management plan	The Project's gas fields are predominantly located within the Murray Darling Basin and drain to the Condamine River. The Project includes release of associated water to the Condamine River. To release water into the Murray Darling Basin, compliance with current Murray Darling Basin Authority policies and State water resource plans is required.

Policy or legislation	Description	Relevance
	• An environmental watering plan to optimise environmental outcomes • Matters addressed by Queensland water resource plans (e.g. water entitlement, environmental flow objectives) • Rules for trading of water rights. Water-sharing arrangements that are provided for in existing water resource plans will remain in place until these plans cease, as outlined in the transitional arrangements set out in the Commonwealth Water Act. Under the former Murray Darling Basin Commission (MDBC), a Basin Salinity Management Strategy for the Basin was put in place. This strategy established targets for river salinity for each tributary valley.	
Department of Infrastructure and Planning discussion paper - Management of water produced from coal seam gas production	The government is yet to finalise its policy related to the disposal and aggregation of coal seam gas (CSG) water, and is in the process of working with industry and community groups to shape the final policy framework. The CSG Associated Water Management policy is being developed to provide guidance on managing and disposing of CSG associated water. The draft policy responds to concerns about the current industry practice of using evaporation ponds to deal with associated water, especially with the long-term legacy of the salt stored in the evaporation ponds.	Australia Pacific LNG will manage associated water through their adaptive associated water management plan. The Plan is discussed in Volume 2 Chapter 12. Management options of the associated water are defined in the plan, including the option to discharge to watercourses. This is summarised in this chapter, and discussed in detail in Volume 5 Attachment 22.

Policy or legislation	Description	Relevance
Water Act 2000 - State Water Resource and Resource Operations Plans	Under the *Water Act 2000*, Water Resource Plans (WRPs) have been developed to define the availability and allocation of water and to ensure the sustainable management of water in Queensland. The objectives of the WRPs are to balance the needs of humans and the environment in a sustainable manner. Resource Operations Plans (ROPs) are developed to implement the outcomes and strategies contained within the WRP. The ROPs detail the day-to-day sharing and management of water within the system such that it meets the objective outlined in the WRP.	The proposed discharge locations fall within the bounds of three water resource planning catchments and are likely to be influenced by the following WRPs and ROPs: • Water Resource (Condamine and Balonne) Plan 2004 and Condamine and Balonne Resource Operations Plan 2008 • Water Resource (Fitzroy Basin) Plan 1999 and Fitzroy Basin Resource Operations Plan amended 2009 • Water Resource (Border Rivers) Plan 2003 and Border Rivers Resource Operations Plan 2008. While the water resource planning process is primarily focused on the maintenance of flow within the systems and the management of extractions, the WRPs do outline performance indicators and environmental flow objectives throughout the river system.

11.2 Methodology

11.2.1 Flooding

An assessment of regional flood characteristics, both existing (pre-Project) and potential impacts as a result of project infrastructure (base development case) has been undertaken across the tenement areas. Various infrastructure sites are proposed throughout the tenement areas. This includes wellheads, gas and water pipeline gathering systems, gas processing facilities (GPFs), water treatment facilities (WTFs), water storage facilities and telecommunication towers. Analysis of the contributing catchments and major watercourses within the tenement areas was undertaken using the latest industry practices and modelling packages.

Hydrology and hydraulic models were developed to assess the potential impacts of the Project to flooding. Eight separate hydrologic models were created for use in this investigation using the XP-RAFTS software package. Hydrological analysis was undertaken to determine peak flow rates for each catchment which contributes to the tenement areas. Model parameters were derived from various data sources including Australian Rainfall and Runoff (Pilgrim and Institute of Engineers 2001), orthophoto imagery, and site records. The eight separate hydrological models were used to calculate inflow hydrographs for the 10, 20, 100 and 500 year average recurrence interval (ARI) design rainfall events.

The overall upstream study area covers a significant number of creeks and river systems. Most of these have had only limited numerical modelling-based flooding investigations conducted, if at all. As such, a series of nine separate one dimensional/two dimensional hydrodynamic flood models were prepared using the TUFLOW software modelling package. This produced a detailed representation of flood behaviour within the major watercourses in the tenement areas. This was performed for both the existing environment and base development cases.

These models were developed using the latest photogrammetric topographic data collected for this study, supplied by Australia Pacific LNG. Model parameters were derived from various data sources including orthophoto imagery supplied by Australia Pacific LNG and site inspection. Regional scale hydraulic structures were incorporated in the respective models where appropriate by way of one dimensional insert or two dimensional flow constriction. These hydraulic models were simulated for the 10, 20, 100 and 500 year ARI design rainfall events, with hydrograph inputs extracted from the hydrologic models.

The Project's base development case was assessed, and the following assumptions were made for the flood assessment:

- Where proposed major infrastructure is predominately within the existing floodplain, then the full site area has been assessed as being filled above the 100-year ARI flood event
- Where sites marginally cover susceptible inundated areas of watercourses, it has been recommended that infrastructure be located within the site and outside of the inundated area
- Where locating major infrastructure outside areas of inundation is not possible, it is recommended that the overall infrastructure area be slightly relocated to avoid areas susceptible to inundation from watercourses
- No fill or flood immunity has been assumed for access roads

- All road crossings of waterways have been assumed as causeway crossings which are commonly used across the area.

As part of this investigation, a number of sensitivity analyses were also undertaken on all of the hydraulic models. These sensitivity analyses were aimed at determining the possible effects that changes might have on catchment responses and predicted flood levels. These include changes to land use as well as increased rainfall intensity as a result of climate change.

11.2.2 Water quality

This chapter summarises the potential impacts to water quality from stormwater only. Assessments of the existing water quality and aquatic ecology, and the potential impacts of the Project on these instream aspects, are addressed in Volume 2 Chapter 9. Potential impacts from the Project on water quality are also assessed in Volume 2 Chapter 9. Stormwater management has been assessed for the construction and ongoing operation of the GPFs and WTFs throughout the gas fields.

The proposed sites for the remaining major infrastructure are much larger than those facilities require. The exact locations of major infrastructure within the sites are yet to be determined and will be based on the outcomes of the detailed design.

As such, the stormwater assessment has focused on the two types of facilities proposed, and calculations of the contaminant load associated with each type. The findings of this assessment have then been applied to each proposed site. Potential risks specific to each site, and the corresponding treatments required for each, were then identified.

11.2.3 Stream flow

The potential impacts to stream flow, as a result of the proposed discharge of treated associated water to watercourses, were identified and assessed through a hydraulic stream flow assessment given in Volume 5 Attachment 22. These impacts are also examined in the aquatic ecology assessment Volume 2 Chapter 9.

11.2.4 Dam failure

The potential impacts from dam failure were identified and assessed through a dam failure impact assessment. Analyses of the proposed dam structures have been carried out in accordance with DERM and the former EPA guidelines (Department of Natural Resources and Mines 2002; EPA 2002a, 2002b, 2008). These guidelines define what a hazardous dam is, if the dam contains hazardous waste, and the methodology required for carrying out a dam failure assessment.

11.3 Existing environment

11.3.1 Condamine River catchment

The Condamine River is a major tributary of the Darling River, located in the upper Murray-Darling catchment. The catchment area of the Condamine River is approximately 25,000km^2 (before it becomes the Balonne River immediately downstream of Dogwood Creek). Its boundaries to the east and north are formed by the Great Dividing Range (approximately 1,400m above sea level) near Toowoomba and Warwick. Its southern boundaries comprise the much lower Herries Range (approximately 800m ASL). The western boundaries comprise the Dogwood Creek subcatchment, which includes Tchanning and Dulacca Creeks. These flow into the Condamine River where it becomes the Balonne River. Yuleba Creek joins the Balonne River from the north, downstream of where the Condamine River becomes the Balonne River.

The existing water infrastructure within or in close vicinity to the gas fields includes:

- Chinchilla and Warra weirs (Condamine River)
- Chinchilla Town Weir (Charley's Creek)
- Brigalow Creek Weir (Brigalow Creek)
- Wallumbilla Weir (Wallumbilla Creek)
- Dogwood Creek and Gilmore weirs (Dogwood Creek).

In addition, there are considerable water allocations within the catchment. These include:

- A mean annual diversion above Chinchilla of around 30 to 35% of mean natural flow, including diversions for water harvesting, area 'hectare' licences, Upper Condamine and Chinchilla Weir Irrigation Projects and other demands (Condamine Catchment Management Association 1999)
- Inspection of the integrated quantity/quality river basin model (IQQM) developed by DERM as part of water resources planning in the catchment indicates that mean annual diversion from the Condamine River and its tributaries upstream of and including the Chinchilla Weir Water Supply Scheme for urban supply, rural water supply, irrigation and water harvesting is approximately 220,000ML/yr, assuming full utilisation of the current water entitlements. This is approximately 40% of the natural flow at the downstream limit of the Chinchilla Weir Water Supply Scheme.

11.3.2 Dawson River catchment

The Dawson River catchment is a subcatchment of the Fitzroy Basin. It has a total area of about 50,800km^2 and is bordered by the Auburn, Calliope, Ulam and Dee Ranges to the east. The Great Dividing Range lies to the west and south, and the Lynd and Canarvon, Expedition and Bigge Ranges to the northwest (Telfer 1995). The south-western headwaters of the Dawson River flow easterly through relatively narrow valleys until about the Nathan Gorge constriction. From there the channel alters direction, flowing north, with a gradual downstream broadening of the valley to wide alluvial plains.

Water extractions occur in this area and are controlled under the provisions of the Fitzroy Basin WRP and ROP. This area is defined in the plans as part of the Dawson Valley Water Supply Area water management area 1.

11.3.3 Border Rivers catchment

The Border Rivers catchment is located on the Queensland–New South Wales (NSW) border and covers about 50,000km^2. The south-eastern headwaters border the Great Dividing Range in NSW, whereas the north-west headwaters border the southern section of the Condamine River catchment near Millmerran. The catchment comprises several major subcatchments. These are:

- Weir River, which drains the north-eastern section of the catchment
- Macintyre River, which drains the southern part of the catchment
- Dumaresq River which drains the eastern section of the catchment
- Macintyre Brook which also drains part of the eastern section of the catchment.

11.3.4 Existing description of proposed project infrastructure areas

Descriptions of the site locations of major gas processing and water treatment facilities and their corresponding catchments, subcatchments, land use and topographic details are shown in Table 11.3.

Eight water treatment facilities are listed, including six required facilities and two alternatives, and does not include an upgrade to the Talinga site. A maximum of 23 gas processing facilities will be required across the 30 year life of the Project. While brine ponds are not listed in the table, these were assessed for dam failure and flood immunity.

11.3.5 Geomorphology characteristics

A detailed geomorphic investigation was conducted throughout the gas fields' study area, and is reported in Volume 5 Attachment 17 and Volume 2 Chapter 9. In summary, the Condamine River in the study area is generally considered to exhibit mobile and meandering characteristics. Geomorphic change in the form of in-channel ingressions (increased sediment supply and reduced bed variability) may be occurring in response to water extractions and land-use practices. Most reaches surveyed had limited channel diversity owing to sediment accumulation on the channel bed. The reaches that flow through or adjacent to the study area were generally highly disturbed.

The Dawson River catchment watercourses within the study area exhibit similar geomorphic characteristics that can relate to adjacent land clearance, water extraction and agricultural land uses. Increased erosion from waterway banks, related increased sediment loads and resultant channel ingressions and decreased geomorphic variability have been described by Telfer (1995). The National Land and Water Resource Audit (2001) states that the sediment loads of the Dawson River and its southern tributaries may be 10 to 50 times greater than those experienced prior to development.

All reaches surveyed in the Border Rivers catchment, being the Gilbert Gully area, were highly disturbed with major in-filling evident at most sites.

11.3.6 Existing hydrology

Gauging stations were used to assist in the verification of model results from the flood assessments within the tenement areas. These have been summarised in Table 11.4. Records for stream flow and river height are limited within the tenement areas with only four gauges available, with varying periods of record.

The Condamine River is the major watercourse within the gas fields' study area. As a result there is significantly more information available with respect to historical flooding and stream flow data.

The Bureau of Meterology (BOM) states: 'Records of large floods along the Condamine extend back as far as 1887 at Warwick with extensive records at several other locations on the mainstream. Major floods occur regularly, on average every two years. The worst flooding recorded occurred in 1942, 1950, 1956, 1975, 1976, 1983 (twice), 1988 and 1996. Major floods generally only occur in the first half of the year although records indicate that they may also occur in late spring' (BOM 2009).

Table 11.3 Facility location description

Facility proposed	Site	Catchment	Sub catchment	Waterways	Primary land use	Topography
Water treatment facility	WTF_MEL_01	Dawson River	Kangaroo Creek	Appletree Creek (SE) Unnamed tributary of Kangaroo Creek (NW)	Grazing Cleared, sparse trees along creeks	Undulating-hills, 50-60m change in elevation
Water treatment facility	WTF_RCK_01a	Condamine River	Yuleba Creek	Ten Mile Creek (through N) Yuleba Creek (E)	Grazing Cleared, sparse trees along creeks Forestry in headwaters	Low-undulating with steeper headwater areas
Water treatment facility	WTF_HCK_01	Condamine River	Tchanning Creek	Noonga Creek (W) Tchanning Creek (S)	Cleared grazing, forestry in upper reaches	Low-undulating
Water treatment facility	WTF_BYM_01	Condamine River	Dulacca Creek	Seven Mile Creek (E) Dulacca Creek (W)	Cropping, grazing, cleared	Very low slope
Water treatment facility	WTF_WOL_01	Dawson River	Woleebee Creek	Unnamed tributary of Woleebee Creek (N) Woleebee Creek (W)	Grazing, cleared	Low-undulating, hills in headwaters
Water treatment facility	WTF_CON_01	Condamine River	Condamine River	Unnamed tributary of Condamine River (S through site)	Cleared grazing, irrigated pasture, cropping	Very low slope
Water treatment facility	WTF_GIL_01a	Border Rivers	Weir River	Unnamed tributary of Weir River (E and W) Weir River (S)	Cleared grazing, forestry	Low undulating (no contours)

Facility proposed	Site	Catchment	Sub catchment	Waterways	Primary land use	Topography
Water treatment facility	WTF_GIL_01	Border Rivers	Weir River	Cattle Creek (W)	Cleared grazing	Low undulating (no contours)
Gas processing facility	GPF_MUG_06	Condamine River	Yuleba Creek Blythe Creek	Cattle Creek (SW - distance) Unnamed tributary of Yuleba Creek (N – from site) Coxon Creek (W – from site)	Grazing Cleared land	Low, undulating land
Gas processing facility	GPF_COM_03a	Dawson River	Horse Creek (Main and West Branches)	Horse Creek West Branch (N) Unnamed tributary of Horse Creek Main Branch (S)	Plantation forestry (top of catchment only), grazing (cleared)	Undulating-hills, 50-60m change in elevation
Gas processing facility	GPF_RCK_04a	Condamine River	Yuleba Creek	Ten Mile Creek (N) Yuleba Creek (E) Unnamed tributary of Yuleba Creek (S)	Grazing Cleared, sparse trees along creeks Forestry in headwaters	Low-undulating with steeper headwater areas
Gas processing facility	GPF_LUK_02a	Condamine River	Yuleba Creek	MacNally Creek (NW)	Grazing, plantation forestry	Low-undulating, 30-40m change in elevation
Gas processing facility	GPF_HCK_01a	Condamine River	Tchanning Creek	Clark Creek (W)	Grazing (cleared), Forestry in head waters	Low-undulating

Facility proposed	Site	Catchment	Sub catchment	Waterways	Primary land use	Topography
Gas processing facility	GPF_NGA_02	Condamine River	Tchanning Creek	Unnamed tributary of Tchanning Creek (N) Tchanning Creek (N)	Forestry, grazing	Undulating
Gas processing facility	GPF_BYM_03	Condamine River	Dulacca Creek	Seven Mile Creek (E) Dulacca Creek (W)	Cropping, grazing, cleared	Very low slope
Gas processing facility	GPF_WOL_01	Dawson River	Woleebee Creek	Unnamed tributary of Ramyard Creek (W) Unnamed tributary of Woleebee Creek (E)	Grazing, cleared	Undulating-hills
Gas processing facility	GPF_CAR_01a	Condamine River	Dogwood Creek	Wallan Creek (E)	Grazing, cleared	Very low slope
Gas processing facility	GPF_CAS_05	Condamine River	Dulacca Creek	Range Creek (W)	Forested, cleared grazing	Very low undulating
Gas processing facility	GPF_DAL_01b	Condamine River	Dogwood Creek	Unnamed tributary of Eleven Mile Creek (E)	Forestry, some grazing	Undulating
Gas processing facility	GPF_CNN_04	Condamine River	Dogwood Creek	Unnamed tributary of Dogwood Creek (N) Unnamed tributary of	Township of Miles, grazing, forestry, gas fields (eastern headwaters)	Low-undulating

Facility proposed	Site	Catchment	Sub catchment	Waterways	Primary land use	Topography
				Columboola Creek (S)		
Gas processing facility	GPF_CON_02b	Condamine River	Condamine River	Unnamed tributary of Condamine River (S through site)	Cleared grazing, irrigated pasture, cropping	Very low slope
Gas processing facility	GPF_CON_01b	Condamine River	Condamine River	Unnamed tributary of Condamine River (N) Unnamed tributary of Cooloomala Creek (S)	Cleared grazing, forestry in headwaters	Very low slope
Gas processing facility	GPF_CNS_03	Condamine River	Condamine River	Unnamed tributary of Cooloomala Creek (W) Unnamed tributary of Cobbareena Creek (E)	Cleared grazing, forestry in headwaters	Flat-low slope
Gas processing facility	GPF_OAN_04	Condamine River	Condamine River	Unnamed tributary of Condamine River (N)	Cleared irrigated pastures, cropping	Flat
Gas processing facility	GPF_ORA_03b	Condamine River	Wieambilla Creek	Unnamed tributary of Nine Mile Creek (NW)	Forestry in headwaters, grazing in basin	Undulating at headwaters, flat-low slope in basin
Gas processing facility	GPF_KIA_01a	Condamine River	Kogan Creek	Unnamed tributary of Kogan Creek (W and N)	Forested, grazing	Undulating (no contours)
Gas processing facility	GPF_GIL_02	Border Rivers	Weir River	Unnamed tributary of Weir River (E and W)	Cleared grazing, forestry	Low undulating (no contours)

Facility proposed	Site	Catchment	Sub catchment	Waterways	Primary land use	Topography
				Weir River (S)		
Gas processing facility	GPF_WAA_03	Border Rivers	Weir River	Teatree Gully (S)	Forested	Undulating (no contours)
Gas processing facility	GPF_WAA_04	Border Rivers	Weir River	Unnamed tributary of Jib Creek (NE)	Cleared grazing, irrigated pasture, forestry at mid-reaches	Low undulating (no contours)
Gas processing facility	GPF_ZIG_05	Border Rivers	Paddy Creek	Unnamed tributaries of Paddy Creek (N and S)	Forestry (mid-reaches), some cleared grazing (headwaters)	Low undulating (no contours)
Gas processing facility	GPF_ZIG_06	Border Rivers	Western Creek	Scrubby Creek (N)	Forestry	Undulating-hills (no contours)

Table 11.4 Gauging data available in the study area

Owner	Details	Location
Department of Environment and Resource Management	Station ID: 422202B - Commissioned: 1949	Dogwood Creek – Gil Weir
Bureau of Meteorology	Flood warning river height station: 042049 Commissioned: 1974 (Earlier commissioning from 1945 – 1950 as a gauging station)	Dogwood Creek – Miles
Department of Environment and Resource Management	Station ID: 422308C - Commissioned: 1955	Condamine River – Chinchilla Weir
Bureau of Meteorology	Flood warning river height station: 042048 Commissioned: 1922	Condamine River – Crawford Bridge, Condamine

Table 11.5 summarises the flood history and the flood river heights of the more significant recent floods recorded in close proximity to the tenement areas.

Table 11.5 Historical flood level data for tenement area (BOM 2009)

River height station	February 1942 (m)	Jan/Feb 1956 (m)	February 1976 (m)	May 1983 (m)	May 1996 (m)	February 2001 (m)	January 2004 (m)
Chinchilla Weir	–	13.87	13.90	13.51	13.32	3.44	7.41
Condamine Town	14.25	14.14	12.74	14.05	13.40	3.60	5.20

Design rainfall event modelling was undertaken for the 10, 20, 100 and 500 year ARI design events. Storms with rainfall durations from 60 minutes to 72 hours were simulated for the four design events for each of the catchments to determine critical storm durations at key locations. The peak flow rates predicted by the various XP-RAFTS hydrologic models at the downstream tenement boundaries are summarised in Table 11.6.

Table 11.6 Peak design storm flows at downstream tenement boundaries

Waterway name	Catchment area (km^2)	Predicted peak flow at downstream tenement boundary			
		10-year ARI (m^3/s)	20-year ARI (m^3/s)	100-year ARI (m^3/s)	500-year ARI (m^3/s)
Horse Creek	956	250	341	582	870
Yuleba Creek	584	225	321	573	904
Weir River	687	238	343	627	1,010
Western Creek	811	221	320	598	977
Dogwood Creek	3,665	558	790	1,424	1,719

Dulacca Creek	576	176	250	435	713
Tchanning Creek	779	316	454	770	1,244
Woleebee Creek	490	290	390	642	930
Condamine River	24,916	2,116	2,337	4,716	5,664
Kogan Creek	202	153	291	362	550

11.3.7 Existing flooding

Existing environment case modelling predicts varying degrees of inundation within the tenement areas. Areas of significant inundation were typically adjacent to watercourses with large contributing catchments and high flow rates (such as Dogwood Creek and the Condamine River), or where poorly defined waterways with expansive floodplains were evident.

Causeways or natural crossings of watercourses are dominant throughout the gas fields. As such, most local roads are predicted to be inundated at waterway crossings due to the crossing style. Some major road corridors including the Warrego Highway and Leichardt Highway were also predicted to be inundated in the 10-year ARI rainfall event or greater, at a number of locations.

11.3.8 Existing water quality

An assessment of water quality throughout the gas fields' area was conducted and is reported in Volume 2 Chapter 9 and Volume 5 Attachment 17. Existing water quality within the gas fields is generally in a degraded condition, with a rating of moderate to poor. Typically, the water contains high levels of elevated nutrients, turbidity, suspended solids and metals. Many sites throughout the region are ephemeral, meaning the streams have significant periods of low or no flow throughout the year.

11.3.9 Existing stream flow

As noted in Section 11.3.6, records for stream flow and river height are limited within the tenement areas with only four gauges available, with varying periods of record (Table 11.4). There are also a number of stream flow gauges located on watercourses that flow through the tenements. These are listed in Table 11.7

Table 11.7 Streamflow gauges located outside the tenements

Location	Gauge reference	Adopted middle thread distance (km)	Catchment area (km^2)	Data availability
Balonne River at St. George	422201E	227.2	75,370	1971 to 2009
Balonne River at Surat	422220A	405.9	47,251	2004 to 2009
Balonne River at Weribone	422213A	357.8	51,540	1969 to 2009
Condamine River at Bedarra	422344A	659.0	24,344	2007 to 2009
Condamine River at	422325A	537.5	28,930	1966 to 2009

Location	Gauge reference	Adopted middle thread distance (km)	Catchment area (km^2)	Data availability
Cotswold				
Yuleba Creek at Forestry Station	422219A	34.4	1,475	1972 to 2009
Weir River at Gunn Bridge	416204A	237.9	4,423	1999 to 2009

A statistical analysis of stream flow records provides support to the characterisation of watercourses within the study area as ephemeral. Flow exceedance analysis conducted for the Condamine River at Chinchilla indicates a significant trend in decreasing flow. It also shows increasing probabilities of 'no flow' conditions from the 1950s to present.

The statistical analysis of flows from the mid 1950s to the time of construction of the Chinchilla Weir in 1972-73 indicates that the flow pattern consisted of no flow conditions 5% of the time. However, the long-term statistical analysis indicates no flow conditions progressively increased and occurred approximately 20% of the recorded period. No flow conditions occurred approximately 25% of the time following construction of the Chinchilla Weir. The construction of the weir has likely moved the downstream reach of the river from an intermittent system to ephemeral in nature.

As stream flow records are not available for other watercourses within the study area, a calibrated runoff model was used to predict the long-term runoff from selected catchments within the study area. A simulated long-term flow series was produced for the watercourses where a proposed discharge from a water treatment facility is located. The analysis of this synthetic flow series indicated that these tributaries are likely to exist under no flow conditions for between 55% and 70% of the time.

Based on the historical stream flow records, the majority of flow within the Condamine River occurs during the summer and autumn period. An average of 45% of the flow occurs in the summer season (December to February) and 30% of the average annual flows occur in autumn (March to June). The remaining 25% of the average annual flows occur in the winter and spring seasons (July to November). It is expected that the seasonal variation observed at the Condamine River will be consistent across the watercourses within the study area.

11.4 Potential impacts

The overall risks of potential impacts to surface water were assessed in the following categories: flooding, stormwater, dam failure and stream flow. The extents of these potential impacts were also assessed. The following section describes the potential impacts identified from the assessments.

11.4.1 Flooding

A review of the conceptual locations of the proposed major infrastructure areas showed that the majority are predicted to be free from regional flooding for all the assessed rainfall events (10, 20, 100, 500 year ARI design rainfall events). Eleven proposed major infrastructure sites were predicted to be located within the existing regional flood extents. These are detailed in the Volume 5 Attachment 22, and are shown in Table 11.8. The predicted inundation was generally at the edge of these proposed major infrastructure locations. Therefore, potential impacts may be easily mitigated by siting of the major infrastructure within each of these eleven areas outside of the inundation extents or employment of other site mitigation measures determined when preparing the layout of infrastructure within the designated areas. However, at three locations (WTF_RCK_01a, BP_RCK_01a and WTF_CON_01), there are local tributaries that flow through the middle of the proposed infrastructure areas. The extent of possible inundation will be considered for these sites when preparing the layout of major infrastructure within the designated areas. This will assist in avoiding or minimising impacts from flooding.

Table 11.8 Major infrastructure locations within modelled flood extents

Infrastructure type	Infrastructure name	Rainfall event in which regional flood inundation occurs*
Water treatment facility	WTF_MEL_01	10-year ARI
Brine pond	BP_MEL_01	10-year ARI
Water transfer station	WTS_COM_04	10-year ARI
Water treatment facility	WTF_RCK_01a	10-year ARI
Brine pond	BP_RCK_01a	10-year ARI
Water transfer station	WTS_PHS_07	10-year ARI
Gas processing facility	GPF_HCK_01a	500-year ARI
Water treatment facility	WTF_CON_01	10-year ARI
Gas processing facility	GPF_CON_02b	10-year ARI
Water transfer station	WTS_TAL_00	10-year ARI
Gas processing facility	GPF_WAA_03	10-year ARI

* Denotes smaller rainfall events than the 10-year ARI event were not assessed as part of this investigation.

Although gas well locations are yet to be confirmed, it is envisaged that a number of wells will be located within the flood extents of the major waterways investigated as part of this study. Appropriate well designs to deal with possible inundation at these locations will be required.

The 2D hydraulic model used for the analysis of the existing environment case was modified to produce the base development case for the Talinga/Orana and Condabri model. This was done to enable assessment of the base development case by representing proposed major infrastructure sites located within the regional flood extents that were considered capable of causing changes to flood behaviour in the surrounding areas.

All other hydraulic models (developed to assess the existing environment case) were not modified and simulated for the base development case because:

- The proposed major infrastructure locations were shown to be well outside the flood extents for all of the modelled rainfall events, meaning there will be no predicted impacts on regional flood behaviour
- There was only minor/partial intrusion into flood extents from proposed major infrastructure sites and it was noted slight re-alignment/re-positioning of the proposed location will eliminate any impact on flood behaviour.

The proposed location of WTS_TAL_00 shows it to be completely within the existing environment case flood extents. Major infrastructure may be able to be relocated to higher ground, outside of the flood extent. Nevertheless, possible impacts on regional flood levels on surrounding areas potentially resulting from the construction of WTS_TAL_00 in its proposed location were simulated. The pad location was filled above the 100-year ARI flood level in the hydraulic model and was simulated with the 100-year ARI storm event for both regional and local flood scenarios. Modelling results revealed that there were negligible changes to flood levels across the Talinga/Orana and Condabri modelling area for both scenarios. As such, modelling results predict the filling of the WTS_TAL_00 pad location will have negligible impact on peak flood levels within the Condamine River system and its flood plain.

Table 11.8 summarises all the major infrastructure locations that are predicted to be inundated in some way with the respective rainfall event in which the inundation will occur. It should be noted that this inundation is related to tributary (local and regional) flooding, and that local storm effects (from overland flow/sheet flow) have not been investigated as part of this study.

Summary of impacts of flooding

Table 11.9 shows the risks and potential impacts of the facilities as a result of flooding.

Table 11.9 Flooding risks and possible impacts

Potential risk	Possible cause(s)	Possible consequence
Damage to property Risk of injury or death	Placement of fill/cut in the floodplain Incorrect sizing or construction type of structures Other changes to flow regimes from development (such as creek diversions)	Increase in inundation extents or velocities
Damage to environment	Changes to natural flow regimes as a result of construction	Erosion of watercourses and increased turbidity of waterways

Generally, major infrastructure within each delineated infrastructure area will be located outside of flood inundation extents. Alternatively, re-alignment of infrastructure areas will be considered to avoid impacts on natural flow regimes or raising in areas that will have negligible impacts on overland flow characteristics.

The flood assessment has demonstrated that impacts from proposed infrastructure across the tenements, on flood levels and flow behaviour, will be minimised and contained within the tenement areas. There are several options for mitigating any potential impacts.

This assessment has demonstrated that impacts will be minimised and contained within the project area. It is reasonable to assume that other similar projects that may occur near the Australia Pacific LNG Project will adopt a similar position with respect to minimising impacts on flooding. That is, it is likely major infrastructure will also be located outside of the regional flood extents. Furthermore, without conceptual layouts for other projects, it is not possible to definitively predict cumulative impacts on flooding. Therefore, cumulative impacts from other developments have not been assessed as part of this study.

None of the assessed fill areas were predicted to result in significant impacts to surrounding areas. No additional inundation (higher flood levels) was predicted to occur as a result of the proposed infrastructure. Therefore, it is predicted the Project will not produce significant impacts on flooding based on the current base development case. Further, the Project is not predicted to contribute to cumulative impacts from development in the area.

11.4.2 Water quality

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was used to assess the performance of the proposed stormwater quality infrastructure for the gas processing and water treatment facilities. MUSIC modelling assessed the runoff volume and sediments only, as nutrients are not expected to increase as a result of the facilities. Details of the model are discussed in Volume 5 Attachment 22.

The MUSIC modelling predicted:

- Under the current, undeveloped conditions, existing sediment load export and runoff volumes are small, due to the pervious nature of the site
- Unmitigated development was shown to increase sediment export and runoff volumes significantly
- The proposed swales and sediment basins will remove more than 85% of the suspended solids from the generated runoff of the proposed facilities once developed
- Sediment export loads are significantly lower than those for existing conditions for the GPFs and no change from existing conditions for the WTFs
- The impervious areas within the facilities will increase the volume of runoff discharged, but this is considered minor in terms of the catchment area. Onsite surface water management and surface water runoff is addressed in the technical report in Volume 5 Attachment 22 and in the environmental management plan in Volume 2 Chapter 24.

While MUSIC conceptualises the pollutant reduction of sediments, nutrients and flow, it does not calculate hydrocarbon removal. Hydrocarbon based products are stored at major facility sites such as fuel, lubricating oils and in waste products like filters and rags. These products will be stored in accordance with appropriate regulations and managed through the environmental management plan.

Though possible, it is unlikely that significant quantities of hydrocarbon will interact with surface water runoff from a major facility. Sediment basins and swales have the capacity to trap hydrocarbons. The management of stormwater infrastructure is addressed in the environmental management plans in Volume 2 Chapter 24.

Summary of impacts to water quality

Table 11.10 shows the risks and potential impacts of the facilities in relation to stormwater management.

Table 11.10 Stormwater risks and possible impacts

Potential risk	Possible cause(s)	Possible consequence
Damage to watercourses Loss of habitat	Increased runoff scouring sediment from site	Sedimentation of watercourses
Chemicals or hydrocarbons entering watercourses	Spills at the facility	Degradation of aquatic habitat and water quality
Increase runoff from the site into receiving watercourses	Increased impervious areas	Scour/erosion within the watercourses, loss of aquatic habitat
Contamination of runoff from	Runoff from upstream catchment	Increased volumes of contaminated

Potential risk	Possible cause(s)	Possible consequence
upstream	entering the facility area and mixing with contaminated stormwater	stormwater to treat and mitigate

It is considered the proposed facilities will not significantly increase the pollutant loads in the natural drainage lines once appropriate stormwater mitigation devices are installed. While there may be an increase in the volume of runoff from each proposed site, this represents only a minor portion of the overall accumulated catchment runoff. Investigation of using proposed sediment ponds to reduce the peak flow from the site to pre-developed flows has indicated that these could be used for this purpose.

11.4.3 Stream flow

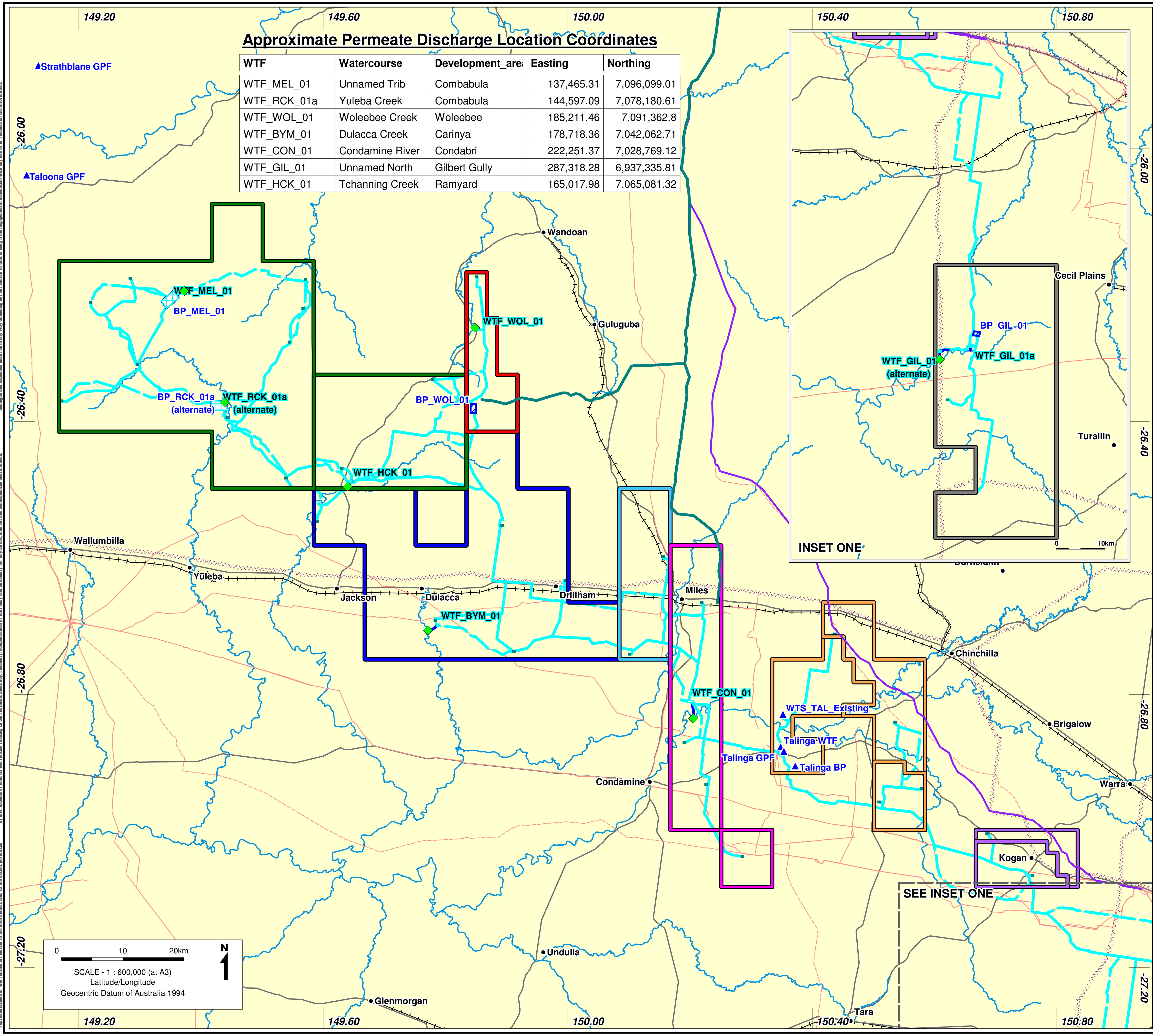
It is proposed treated associated water could be released to watercourses within the study area. Detail of the proposed adaptive associated water management plan is discussed in Volume 2 Chapter 12. Releases could be to either a watercourse in close proximity to the water treatment facilities, or as an aggregated release to the Condamine River. Several possible release locations have been identified and are shown in Figure 11.1. These are:

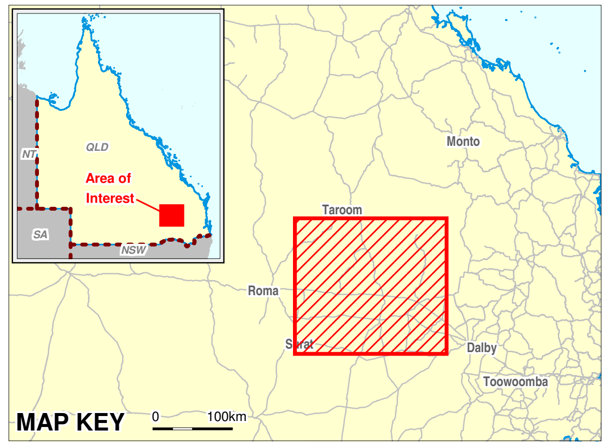
- Condamine River (Condamine-Balonne catchment)
- Yuleba Creek (Condamine-Balonne catchment)
- Tchanning Creek (Condamine-Balonne catchment)
- Dulacca Creek (Condamine-Balonne catchment)
- Woleebee Creek (Fitzroy Basin catchment)
- Unnamed tributary of Kangaroo Creek (Fitzroy Basin catchment)
- Unnamed tributary of Weir River (Border Rivers catchment).

A number of potential impacts to these watercourses as a result of discharges have been identified. These include changes to the natural flow regime and resulting impacts on aquatic ecology, changes in water quality and the resulting impacts on aquatic ecology, alteration to the hydraulic and geomorphic characteristics of the watercourse (including bank and channel stability and sediment transport) and impacts to downstream users (including licensed water users and the environment). Potential impacts on aquatic ecology are discussed in Volume 2 Chapter 9.

Approximate Permeate Discharge Location Coordinates

WTF	Watercourse	Development_are:	Easting	Northing
WTF_MEL_01	Unnamed Trib	Combabula	137,465.31	7,096,099.01
WTF_RCK_01a	Yuleba Creek	Combabula	144,597.09	7,078,180.61
WTF_WOL_01	Woleebee Creek	Woleebee	185,211.46	7,091,362.8
WTF_BYM_01	Dulacca Creek	Carinya	178,718.36	7,042,062.71
WTF_CON_01	Condamine River	Condabri	222,251.37	7,028,769.12
WTF_GIL_01	Unnamed North	Gilbert Gully	287,318.28	6,937,335.81
WTF_HCK_01	Tchanning Creek	Ramyard	165,017.98	7,065,081.32





LEGEND

- Town
- Existing infrastructure
- Major drainage
- Road
- Railway
- Pipeline licence (Application)
- Pipeline licence (Granted)
- High voltage above ground powerlines

Walloons Gas Fields Development Areas

- Talinga / Orana
- Combabula / Ramyard
- Dalwogan
- Woleebee
- Kainama
- Carinya
- Gilbert Gully
- Condabri

Proposed Infrastructure

- Permeate discharge location
- Water transfer station
- Water transfer pipelines
- Water treatment facility
- Alternative water transfer pipelines
- Brine pond
- Proposed Surat to Gladstone pipeline
- Gas pipeline route

Source Information

Pipelines
Commonwealth of Australia (Geoscience Australia) 2009
Department of Mines and Energy, MERLIN Mining Tenures system and Database (MTDB) 2009
Gas pipeline route, Proposed infrastructure
Supplied by Origin Energy on 03/11/2009

AUSTRALIA PACIFIC LNG PROJECT

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Figure 11.1 - Proposed Discharge Locations

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Flow regime

The potential for discharges to impact on the natural flow regime was assessed by the characterisation of flow patterns at each of the proposed discharge locations. Discharge regimes which will minimise these potential impacts were then developed. The characterisation of natural flow regimes was undertaken by either the statistical analysis of historic stream flow records or the production and analysis of a synthetic stream flow record using a calibrated runoff model for the discharge location catchment.

The statistical analysis focused on two aspects. A flow exceedance analysis was undertaken to determine the range of daily flows likely to occur in the watercourse and the statistical likelihood of these flows occurring in a given period. A seasonal flow variation was also undertaken to determine the flow pattern that is likely to occur in the watercourse over a year. The likely change to these natural flow patterns as a result of additional discharge to the system was identified.

The modelling concluded that the watercourses at all the proposed discharge locations are non-perennial (intermittent or ephemeral) in nature, with no flow periods extending between 5% and 70% of the simulated time. The Condamine River at Chinchilla shows a significant trend in decreasing flow and increasing probabilities of no flow conditions from the 1950s to present. The statistical analysis of flows from mid 1950s to the construction of the Chinchilla Weir in 1972-73 indicates that the flow pattern consisted of no flow conditions 5% of the time.

The long-term statistical analysis, but indicated that no flow conditions occurred 20% of the recorded period. Post the construction of Chinchilla Weir recorded no flow periods occur approximately 25% of the time. This indicates that the system, while a non-perennial downstream of Chinchilla Weir, may have shifted from intermittent to ephemeral in nature as a result of the construction of the weir. Simulated long-term flow series, analysed for the other discharge locations, indicated that these tributaries are likely to exist under no flow conditions for between 55% and 70% of the time.

The watercourses were also shown to be dominated by summer and autumn flows with 45% and 30% of flows occurring in the summer and autumn months respectively.

Hydraulic capacity

There is the potential for the hydraulic and geomorphic characteristics of the watercourse to be altered by the addition of flows to a watercourse. This was assessed via the construction of localised one dimensional hydraulic models at the proposed discharge locations. Incremental changes in key hydraulic parameters that may occur as a result of the additional discharges to the systems were also assessed. The model results were able to predict the capacity of the watercourses to cater for the additional discharges.

All watercourses were estimated to exhibit low velocity, stream power and stream stress, at all discharge locations, under normal flow conditions up to bank full. It is concluded that at all proposed locations the watercourses had the hydraulic capacity to accept the addition of treated associated water discharges. If discharge occurred under normal flow conditions, up to bank full, there was unlikely to be a significant alteration of the geomorphic characteristics of the watercourse.

Discharge which alters the hydrologic regime beyond the natural conditions in the stream often results in geomorphic changes that may include bank erosion, sedimentation and associated ecological impacts. It is noted that the hydrologic conditions in all assessed watercourses may be different to that of the natural conditions (due to land use and impacts of water resource development in the catchment) and return of the hydrologic regime to a pre-development condition can be seen as beneficial.

The analysis of flow regimes in the region indicate that the watercourses are ephemeral in nature and that there are significant periods of no or low flow. A constant discharge of any magnitude will alter this natural regime for between 5% and 70% of the year depending on the discharge location. Discharges will be timed to limit discharge during low flow periods, primarily in the late winter and spring seasons, therefore any potential impact to the natural flow patterns will be minimised.

Preliminary hydraulic modelling indicates that all the watercourses that were identified have the potential and hydraulic capacity to accept additional flows up to bankfull with minor risk of alteration to the hydraulic and geomorphic characteristics of the reach. However, due to the significant hydraulic capacity of the Condamine River and the lower observed periods of low or no flow, a discharge to the Condamine River has been selected as the preferred option over discharges to the other identified tributaries. The potential hydraulic impacts are greatest if discharges occur during low or no flow conditions. These impacts are less significant as base flow conditions within the watercourse during release increase up to bankfull conditions.

Downstream users

The potential impacts of additional discharges to the watercourses on downstream users were assessed quantitatively. This was done through the identification of downstream users (both licensed water users and environmental receptors including Narran Lakes). An assessment of the potential losses of the additional water from the system due to transmission was also taken into consideration.

This analysis was focused on users within the Condamine-Balonne catchment. Small discharges may occur to tributaries in the headwaters of the Border Rivers and Fitzroy Basin catchments. However, as the volumes of discharge to these catchments remain uncertain, impacts on downstream users were not assessed at this point. Any potential impact of future inclusion of releases to the Border Rivers and Fitzroy Basin in the adaptive associated water management plan for the Project will be considered at that time and adequately addressed through regulatory process for licensing.

In the assessment of potential impacts, possible discharge regimes were proposed which will provide varying levels of risk to the environment and downstream users. These regimes took into consideration factors such as:

- Potential impacts on the aquatic and riparian ecosystems
- The potential impact of the duration of discharges to the watercourses, that is, whether the scheme is proposed over a short term (3 years) or long term (30 years or project life)
- Potential impacts on downstream users (including increased availability of water)
- Planning and legislative constraints
- Storage and discharge infrastructure requirements.

Surface water users are well documented within the Condamine-Balonne system due to water resource planning that has been undertaken in recent years in accordance with the *Water Act 2000*. These users are managed within four regulated water supply schemes, four water management areas where supplies are un-supplemented, and by way of water licences issued for harvesting overland flow.

Reporting undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) on water availability within the Condamine-Balonne catchment notes that the current relative level of use for the entire region is extremely high, with 55% of the average available surface water in the Condamine-Balonne system diverted for use. This is compared with other Queensland catchments where generally only 10 to 40% of available water is diverted for use.

The high level of use in the Condamine-Balonne has significantly reduced end-of-system flows in the Condamine-Balonne system. In the Queensland, part of the Condamine Balonne medium security and town water supplies are both highly utilised – 97% of available Queensland medium security is used and 89% of the available Queensland town water supply water is used (CSIRO 2008). Therefore, additional water that is made available to users in this region may provide benefits for water security.

The Project's proposed discharge location on the Condamine River is located just downstream of the Chinchilla Weir Water Supply Scheme (WSS), within an unregulated reach of the Condamine River. As such, water users upstream of the Chinchilla Weir Water Supply scheme area will not be influenced by discharges. Based on the Condamine and Balonne ROP, the un-supplemented water allocations downstream of the proposed discharge location and upstream of the St George Water Supply Scheme total approximately 51.5 Gigalitres/year (GL/year).

An additional 0.6GL/year and 6.4GL/year of un-supplemented water allocations is predicted for the Yuleba and Tchanning Creeks, respectively. These users on Yuleba and Tchanning Creeks may receive increased flows due to releases from the proposed water treatment facilities WTF_RCK_01 and WTF_HCK01, respectively.

If, on average, the utilisation of the un-supplemented water allocations is 34% (as reported by the CSIRO in the water availability report for the region), that is only 34% of the un-supplemented water allocations are being accessed, then up to an additional 66% of the un-supplemented water allocation volumes on average or 13,178ML/year may be able to be accessed by licensed users within the reach of the Condamine River. This is dependent upon the correct discharge regime being utilised between the discharge location and the upstream extent of the St George Water Supply Scheme (WSS). This is a broad approximation of the quantities that may be available.

Access was provided to the IQQM model which was constructed as part of the water resource planning process for the Condamine River to model the river system. This model includes all current licensed users and best estimates of losses from the system.

Inspection of the IQQM model developed by DERM for the mid Condamine River as part of the water resource planning activities indicates that irrigators (in model zone CBU-04) located downstream of the upstream Condamine River discharge location (Talinga WTF) but still within the Chinchilla Weir WSS have a combined water allocation of 726ML/annum.

IQQM modelling indicates that the supply to this group of irrigators will be improved with discharge to the river at the Talinga WTF discharge location. With a constant continuing discharge of 50 ML/day at Talinga, the IQQM model results indicate (for the simulation period 1922 to 1995) that the mean annual diversions to this group will increase from 606Ml/yr to 783ML/yr (an increase of 29%). The reliability of supply to this group (as measured by the supplemented annual volume probability) will increase from 83.5% to 107.5%.

Users with stock and domestic licences along the river downstream of Chinchilla Weir to Weribone will also have improved supplies. The modelling indicates diversions to this group will increase by approximately 40%.

Significant volumes of water are lost from the Condamine-Balonne river system in transmission losses and surface–groundwater interactions. A portion of discharges to the river system will be similarly lost from the system via these mechanisms.

CSIRO (2008) estimated that in the reach of the Condamine River between the Chinchilla gauge and the Cotswold gauge there are between 24GL/year (modelled) and 54GL/year (accounted) of unspecified or unattributed losses from the system. Similarly, between Cotswold and the Balonne River (Weribone) the unspecified and unattributed losses averaged 51GL/year and 155GL/year respectively. From Weribone to St George the unspecified and unattributed losses averaged 36GL/year and 120GL/year respectively.

Within the Condamine-Balonne ROP, an allowance is made in the calculation of water allocations (both medium and high priority) within the Chinchilla Weir WSS for transmission losses of 50% of the release volume.

Surface–groundwater interactions have an impact on the losses observed within a river system. Groundwater extraction can have a significant influence on the volumes of water that may be lost from a river system. The CSIRO (2008) study categorised reaches of the Condamine-Balonne system as 'losing' or 'gaining' reaches with respect to surface–groundwater connectivity. A gaining reach means that inflows to the river system exceed losses by extraction, transmission and evaporation and to groundwater.

The CSIRO classified the reach from Chinchilla to Cotswold as a losing reach, Cotswold to Weribone as a gaining reach, and Weribone to St George and neither a gaining nor a losing reach. From this information it is unclear as to whether significant net losses of additional discharge to groundwater in this reach of the Condamine-Balonne are likely. CSIRO (2008) also concluded that while there was a modelled 10GL/year loss to groundwater within the region, there will be a minor impact on stream flow overall, and on end-of-system flows.

From this information on transmission losses and groundwater–surface water interactions, it is unclear as to the likely proportion of additional discharges to the system that may be lost due to these factors. The IQQM model developed within the ROP framework incorporates the best estimates of losses from the system. Assessment of additional discharges within this model will provide the best indication of the likely volumes of discharges lost from the system.

Due to the complex triggers and operating rules associated with the unsupplemented water allocations within this reach of the Condamine-Balonne system the ability of these users to access water is best assessed using the IQQM model developed for the system. DERM has provided access to this model and the results of the analysis are provided in Volume 5 Attachment 23.

IQQM modelling has been undertaken to determine a range of discharge regimes that will comply with the conditions of the Condamine-Balonne ROP and minimise the potential impact of flow regimes. The simplest discharge regime modelled includes a constant continual discharge at either of the two Condamine River discharge locations. It was determined that a constant continual daily discharge of 65ML/d (23,725ML/year) could be released from the downstream Condamine River discharge location and comply with the requirements of the ROP for environmental flow objectives and water allocation security objectives, which are designed to ensure acceptable environmental and water security outcomes.

Additional discharge scenarios were also tested which complied with the requirements of the ROP, but also minimised changes to the flow regime by taking into account flow variability and moving flow conditions towards the ROP pre-development flow condition. The IQQM modelling indicates that the release of water under all discharge scenarios, which are within the acceptable parameters of the ROP at either of the proposed discharge locations on the Condamine River, will improve the reliability of supply to stock and domestic users, Condamine Town Water Supply and some supplemented irrigation users from the Chinchilla Water Supply Scheme. These users will benefit from releases.

The IQQM modelling also notes that improvements to the supply for users from the St George WSS may also result but this has not been quantified at this stage. The IQQM model supplied for use by the DERM extends only to the upstream extent of the ponded area of Beardmore Dam. An IQQM model was not available beyond this location.

If flows did reach Beardmore Dam (the controlling structure within the St George WSS) then flows will be controlled under the provisions of the supply scheme. Flows will then be released as per the conditions of the ROP.

The CSIRO (2008) provided as assessment of the impact of water resource development has had on the nationally important wetlands on the Balonne River floodplain. It concluded that the average period between flood events to these wetlands had increased by about five months and had reduced the average flood volume by nearly 22% (CSIRO, 2008, p.ii). The study notes that 'the number of years in which Back and Clear lakes (part of the Narran Lake Nature Reserve Ramsar site) provide optimal waterbird feeding habitat has been reduced by over 60% and the number of years in which Narran Lakes provides optimal waterbird feeding habitat has been reduced by more than 50%. Overall, water resource development has greatly reduced the contribution the Narran Lakes system is able to make to the status of the lakes' waterbird population.'(CSIRO, 2008, p.ii)

This assessment tends to indicate that the addition of discharges of appropriate timing and quality may improve the hydrologic condition of the Narran Lakes system.

Summary of impacts to stream flow

The potential impacts resulting from discharges of treated associated water on stream flow and downstream users are summarised in Table 11.11 .

Table 11.11 Stream flow risks and possible impacts

Potential risk	Possible cause(s)	Possible consequence
Damage to Environment	Changes to natural flow regimes	Erosion of watercourses and increased turbidity of waterways Changes to aquatic ecology
Damage to Environment	Discharge beyond the hydraulic capacity of waterways	Hydraulic and geomorphic changes to waterways
Impact to downstream water users (including the environment)	Addition of flows to the system	Increase in water availability to downstream users Improved hydrologic condition of Narran Lakes

The Condamine River has been assessed to have a greater hydraulic capacity than the tributaries located in close proximity to the proposed water treatment facilities. In addition, the tributaries have conditions of low or no flow conditions for greater periods of the year. Hence, any discharges to the tributaries will include additional management measures to ensure any potential impacts to the watercourses are minimised.

A discharge regime has been developed that minimises the potential for negative impacts to the waterways. This regime has been based around either a release rate factored to correlate with variations in seasonal flows observed within the Condamine River and the tributaries or release triggered by watercourse flows. The addition of flows to the Condamine River up to a maximum limit (under either a constant release rate or a variable release rate) has been demonstrated through IQQM modelling to meet the environmental flow objectives of the WRP for the river, and returns the flow in the river toward pre-development flow conditions. However, the adoption of a discharge regime which is variable in release rate and correlated to the seasonal variation in flow will minimise the potential for any negative impacts on the waterways, with the added benefit of returning the flow regime in this reach of the Condamine River to better mimic pre-development conditions. The maximum release rates have been based on IQQM model outputs.

The minimum impact discharge regime is assessed as consisting of no release during periods of 'no natural flow' just upstream of the discharge location for up to 30% of the water year. The no natural flow condition was determined to occur when the flow in the Condamine River just upstream of the Talinga discharge location is less than the minimum flow of 6ML/day. This minimum flow condition removes the impact of releases to supplemented users from the Chinchilla Weir from the assessment. IQQM modelling indicates that up to 100ML/day could be released from the Talinga discharge location under this regime to meet the requirements of the ROP and resulting in flows within this reach of the Condamine River that will generally mimic the pre-development flow regime.

The design of discharge infrastructure will be done in such a way that localised velocity and scour is minimised, and appropriate mixing of discharge with natural flows is achieved. An ongoing program of monitoring will be developed. This will include regular inspections of discharge locations, cross-section surveys, as well as monitoring of aquatic and riparian ecosystems. Investigation and implementation of alternative disposal/beneficial uses will be undertaken within the adaptive water management strategy for the Project.

11.4.4 Dam failure

Each proposed water storage infrastructure item was reviewed to determine if the dam is hazardous and/or contains hazardous waste. This included both water treatment facility feed ponds and brine pond storages. The corresponding design criteria to be applied to the dams, based on the hazard rating was documented including the mandatory reporting level (MRL) and design storage allowance (DSL).

Breach characteristics and breach hydrographs were determined for each of the seven water treatment facilities (including the Talinga site upgrade and two alternate sites) and four brine pond locations (including Talinga upgrade and one alternate site).

Six of the eight one dimensional/two dimensional TUFLOW hydraulic models, developed as part of the regional flooding investigation of the tenement areas, were modified for use in this investigation. A description of these models is provided in Volume 5 Attachment 22.

The models were modified to remove design rainfall inputs. Inflow locations representing hypothetical dam breaches were derived and model areas refined. The hydrographs representing the hypothetical dam breaches for each feed and brine pond were then applied to the 2D model domains. This was done by way of direct application of the failure hydrograph to the appropriate location of the infrastructure area.

Model results showed that simulated dam breaches resulted in inundation of areas immediately downstream of the storage location. The closest watercourses to the failure locations were also predicted to be inundated. Brine ponds were shown to create the largest areas of inundation due to their total storage volumes and associated hypothetical failure peak flow rates.

Generally, potential failure of storages is not predicted to impact any residential dwellings. At only one location, approximately 700m south of the WTF associated water feed pond (WTF_Con_01), inundation of less than 100mm deep is predicted to occur. This residential dwelling is owned by Australia Pacific LNG. At this location velocities are low (less than 0.5m/s), and at a depth of less than 100mm there is not considered to be a 'population at risk' as outlined in the DERM Guidelines for failure impact of water dams (DERM 2002). Therefore, mitigation is not required at this location.

At this stage, sequential failure simulations were not considered appropriate as the exact locations of the ponds are yet to be determined. Typically water storages were situated in discrete locations where the sequential failure of dams could not occur. However, brine pond failure simulations were undertaken based in the total capacity of all cells proposed for each proposed infrastructure location. This was considered a conservative approach. Final locations of ponds will be determined during the front end engineering and design phase of the Project.

Determining the hazards associated with the various storage facilities within the gas fields tenements has resulted in classification of a hazard rating for each storage facility. This provides Australia Pacific LNG with set performance criteria with respect to storage design requirements. When storage locations are finalised, this hazard rating will be revisited and finalised. Based on the final hazard rating of the dams, Australia Pacific LNG will comply with the relevant environmental authority conditions that apply.

Summary of impacts of dam failure

The potential impacts resulting from dam failure are identified in Table 11.12 .

Table 11.12 Dam failure risks and possible impacts

Potential risk	Possible cause(s)	Possible consequence
Damage to property Risk of injury or death	Placement of fill/cut in the floodplain Incorrect sizing or construction type of structures Other changes to flow regimes from development (i.e. creek diversions)	Increase in inundation extents or velocities from dam failure
Damage to environment	Changes to natural flow regimes as a result of construction	Erosion of watercourses and increased turbidity of waterways from dam failure

The assessment shows there is an extremely low risk for loss or harm to human life due to failure of the storages at the proposed locations. Only one residential dwelling is impacted from the potential dam failure, and this dwelling is owned by Australia Pacific LNG. Possible impacts of dam failures on built infrastructure were considered (general economic loss). Due to the locations of the dams, scope for economic loss as a result of a hypothetical dam breach was limited.

A potential hazardous impact from hypothetical dam failures of the proposed transfer, feed and brine ponds is environmental harm. This is a result of the chemical and physical properties of the brine and associated water. Environmental harm from dam failure is discussed in Volume 5 Attachment 17.

11.4.5 Hydrotest water

When a section of high pressure pipeline is completed, it will be hydrostatically pressure tested (hydrotesting). This will establish if there are any leaks in the section, as well as confirm the pipeline's capability to operate at the maximum allowable operating pressure. The associated gas and water gathering pipelines may be pneumatically tested.

Due to the coverage of the pipeline networks and the vicinity to water resources, it is expected that a combination of water sources will need to be explored.

To avoid contamination of the pipe material, the preferable water sources are:

- Treated water from existing Australia Pacific LNG CSG field treatment plants
- Re-used water from other test section
- Commercial suppliers
- Water from landowners or local watercourses/rivers
- Untreated CSG water.

A small number of holding ponds are anticipated along the pipeline routes to accumulate hydrotest water. These ponds will be approximately 20ML in capacity. The holding ponds will provide sufficient freeboard (space above normal level) to allow for storage of direct rainfall. The ponds will be restored and rehabilitated after testing is complete.

Depending on the source and quality of water used for hydrotesting, additives may be required. These could include biocides, oxygen scavengers and corrosion inhibitors that remove biological organisms and reduce corrosion potential during testing.

The use of additives in hydrotest water will be minimised. Where practical, hydrotest water will be reused to reduce the amount required to be managed.

The potential impacts resulting from the disposal of hydrotest water are contamination of surface waterways and/or groundwater contamination and soil erosion, scour and sedimentation of surface watercourses.

Research undertaken on the disposal of water used for hydrostatic testing of pipelines (CSIRO Manufacturing and Infrastructure Technology (CMIT) 2005) has revealed the following:

- The hydrotest water contains contaminants that may require treatment prior to disposal
- The contaminants for new pipelines are mainly due to mill scale breakdown and unreacted additives and their reaction products
- The contaminant levels are generally not toxic
- Appropriate treatment of the hydrotest water is required prior to disposal
- The characteristics of the disposal site play a role in determining the treatment required
- Special planning is required when biocides are used and when the source water itself presents a disposal problem
- The discharge of hydrotest water is a one-off event and this should be considered when evaluating the potential environmental impact.

The disposal of hydrotest water is to be undertaken in accordance with the conditions set out by DERM under an environmental authority (petroleum activities) in accordance with the EP Act. The release of hydrotest water to land is to be carried out in a manner that ensures:

- Vegetation is not damaged
- Soil erosion and soil structure damage is avoided
- No surface ponding of released water occurs

- The quality of groundwater is not adversely affected
- No release of water to any surface waters occurs.

It is anticipated that the environmental authority will specify that hydrotest water is to be released to land for disposal and that the land disposal area must be located more than 100m from the nearest watercourse. A hydrotest water management plan must also be submitted at least four weeks prior to a discharge event.

Summary of impacts of hydrotest water

The potential impacts resulting from the use of hydrotest water are identified in Table 11.13 .

Table 11.13 Hydrotest risks and possible impacts

Potential risk	Possible cause(s)	Possible consequence
Surface water/groundwater contamination	Uncontrolled release Pond leakage	Possible contamination of groundwater by hydrotest chemicals or by imported test water of different quality to local ground/surface water Residual toxicity impacting flora and fauna
Erosion	Discharge of water Sourcing of water from waterways	Impacts to flora and fauna Erosion of creek bed during extraction Erosion of soil, creek from discharge

The assessment shows that there is limited potential for contamination of surface or groundwater as a result of hydrotesting activities, if appropriately sized and constructed ponds are used to manage hydrotest waters, suitable chemicals are used and monitoring prior to discharge is completed. The potential for hydrotest waters to cause erosion of waterways on discharge will be mitigated using erosion control measures and the suitable location of pumps to avoid vegetation and minimise erosion.

11.5 Mitigation and management

The development of mitigation and management measures has been formed by the assessment of potential impacts to environmental values, as well as incorporating best practice sustainability principles. The causes of these potential impacts were also assessed in order to develop the most appropriate strategies for their mitigation and management.

11.5.1 Flooding

Australia Pacific LNG will mitigate and manage the potential risk of damage to property or the risk of injury or death persons due to flooding by:

- Locating major infrastructure, where practicable, outside of the existing environment flood inundation extents and not over tributaries and flow paths
- Appropriate design of major infrastructure located within flood extents by way of fill or using waterway structures (culverts, bridges) to minimise the risk of inundation or damage due to flooding.

Major infrastructure will be located outside of the existing flood extents where practicable to minimise potential for damage to the environment by changing natural flow regimes and causing erosion in waterways. Appropriate stream protection works will be employed during construction activities as described in the environmental management plan.

11.5.2 Water quality

The facilities have no discharge point identified as the individual sites and layouts are not finalised, and site access has been restricted. Many of the creeks within the vicinity or the proposed facilities are ephemeral or intermittent, and therefore baseline sampling is unable to be taken at all sites. However, once the sites are finalised during the design phase, each discharge location will have a target of 80% reduction in total suspended sediments and no visible sheen (oils) within the stormwater released from a site. Due to the nature of the facilities, it is not expected that nutrient generation from the site will increase significantly. Any nutrients exported from the site that are bound to the sediments will be removed from the system when the sediment basins are cleaned.

With appropriate control measures in place, potential stormwater impacts for the facilities will be mitigated. The risks from water quality will be minimised through:

- Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines
- Utilise sediment basins to capture runoff and release slowly to avoid scour and erosion from increased runoff
- Storage of fuel and chemicals in accordance with relevant regulations and guidelines. Storage and fuel transfer facilities will be controlled to reduce spillage and mitigation measures such as bunding, secondary containment will be implemented where practicable
- Divert upstream runoff around major facilities and implement erosion and sediment management practices in accordance with the Queensland Guidelines for sediment and erosion control.

Section 6.2.4 of Volume 5 Attachment 22 details the design criteria of stormwater mitigation techniques based on a generic design for a water treatment facility and a gas processing facility. Based on the generic facilities, detention volumes, concept design and capacity for stormwater basins and swales have been calculated. However, as the final location and layout of each individual facility is to be finalised, a definitive design for stormwater mitigation has not been undertaken. Once the facility designs and locations are finalised, site-specific modelling and design can be conducted. Additionally, for those facilities where it is deemed necessary, diversion channels or bunds will be designed to prevent overland flow entering the facility and, potentially be contaminated.

Sediment basins will be designed to hold the runoff in a 1 year ARI 24-hour duration rainfall event. Runoff volumes greater than this capacity will spill from the basin via a spillway and enter the receiving environment. The facilities will also incorporate diversion channels or bunds to divert overland flow from external areas around the site.

Potential impacts of extreme rainfall events may include:

- The mobilisation of sediments from the surrounding landscape, as for a natural event, that may enter the facility should the diversion channels or walls be overtopped or breached
- Bunded areas within the facilities that are segregated from the stormwater management areas may become filled by excessive rainfall and overtop or breach the bund walls. This poses a risk

of discharging contaminants into the receiving environment, however the volume of water likely in an extreme event will result in the contaminants being significantly diluted and pose minimal risk,

- Stormwater basins, channels, and/or swales may become damaged as a result of higher velocities or prolonged discharges.

The spillway outlets on the sediment basins will discharge the peak flows for the critical duration 100 years ARI storm event and the embankments will be constructed with compacted material and grassed to minimise the risk of erosion if overtopped. Therefore, the sediment basins should be able to withstand extreme rainfall events without significant structural damage.

Areas within the facility that are considered at high risk of becoming a source for stormwater contaminants, such as chemicals or hydrocarbon spills (i.e. chemical storage areas), are proposed to be bunded off from the remainder of the facility, and treated via a trade waste mechanism. The design of the collection, treatment and disposal will be carried out as part of the detailed design of each facility.

11.5.3 Stream flow

The risks from stream discharge will be minimised through:

- Discharge treated water in a manner that meets environmental flow objectives and mimics pre-development stream flows, where practicable (recognising the practicalities and timing of establishing beneficial use).
- Construction of appropriate stream protection at discharge locations
- Ongoing monitoring of downstream reaches
- Continued investigation and implementation of alternative beneficial use and disposal options.

Discharges also potentially carry the risk of impacting downstream users of the waterways. These impacts may be managed through the adoption of appropriate release regimes. This will allow maximum volumes of water to be available at correct times for use downstream.

11.5.4 Hydrotest water

The risk associated with hydrotest water will be minimised through:

- Designing with an appropriate freeboard above storage capacity at all temporary hydrotest dams
- Selecting biocide and oxygen scavengers (if necessary) which can be neutralised, are biodegradable, or do not bio-accumulate in the soil
- Monitoring of hydrotest water and receiving water quality
- Discharging hydrotest water in compliance with all regulatory and landholder requirements
- Minimising the chemical treatment required for water uses or select chemical additives that are least harmful to the environment
- Disposing of hydrotest water in compliance with an approved hydrotest water management plan prepared in accordance with the environmental authority (petroleum activities) issued by DERM under the provisions of the EP Act.

The risk of erosion caused by hydrotesting activities will be minimised through:

- Constructing erosion control measures at discharge locations
- Locating suction pumps to avoid significant vegetation and minimise disturbance to vegetation
- Locating suction pumps above the watercourse bed to minimise erosion
- Including fish screens on intakes
- Ensuring the capacity of holding ponds provides sufficient freeboard to allow for additional rainwater, and are designed in accordance with appropriate Queensland guidelines and regulations.

11.5.5 Dam failure

The risk of dam failure will be mitigated by:

- Designing project surface water storage systems to appropriate standards, and relevant conditions and minimising the potential for impact on residences
- Incorporating appropriate mitigation measures if there is potential risk to property
- Ensuring the capacity of holding ponds provides sufficient freeboard to allow for additional rainwater, and are designed in accordance with appropriate Queensland guidelines and regulations.

11.6 Conclusions

The construction and operation of the gas fields is expected to cause minimal impacts to surface water with respect to:

- Flooding behaviour
- Water quality from stormwater runoff
- Discharge of associated water
- Dam failure to residential dwellings and other infrastructure.

The flood assessment has demonstrated that impacts from proposed infrastructure across the tenements on flood levels and flow behaviour will be minimised and contained within the tenement areas. Generally, major infrastructure within each delineated infrastructure area will be located outside of flood inundation extents. Alternatively, re-alignment of infrastructure areas will be considered to avoid impacts on natural flow regimes or filling in areas that will have negligible impacts on overland flow characteristics.

Stormwater from the proposed facilities will not significantly increase the pollutant loads in the natural drainage lines with appropriate stormwater mitigation devices installed. Sediment ponds can be used to accommodate the increase in the volume of runoff from each proposed site,

Assessment of the hydraulic characteristics of the proposed treated water discharge locations indicates that all locations have the hydraulic capacity to accept additional flows, but the Condamine River is the preferred discharge location. IQQM modelling has demonstrated that the project can discharge to the Condamine River and comply with the requirements of the ROP for environmental flow objectives and water allocation security objectives under a range of discharge regimes.

Model results indicated that reliability of supply to downstream users is increased with discharge which complies with the ROP. A discharge regime consisting of up to 100ML/d released from the upstream Condamine River discharge location, with discharge ceasing for up to 30% of the water year under no natural flow conditions. This was found to mimic the natural flow variability and return flow conditions toward pre-development conditions within the Condamine River. This regime is selected as a low impact regime.

The assessment of dam failure shows there is an extremely low risk for loss or harm to human life due to failure of the storages at the proposed locations. Only one residential dwelling is impacted from the potential dam failure, and this is owned by Australia Pacific LNG.

11.6.1 Assessment outcomes

A summary of the environmental values, sustainability principles, potential impacts and mitigation measures is shown in Table 11.14 . The risk level following application of mitigation measures is also given.

Table 11.14 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
Life, health and wellbeing of people. Diversity of ecological processes and associated ecosystems.	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas.	Scour/erosion/ sedimentation within the watercourses and floodplains.	Changes to natural flow regimes as a result of construction (temporary). Changes to flow regimes from development (for example creek diversions). Increased runoff scouring sediment from site.	Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines. Appropriate design (including factor of safety, flood immunity and site selection). Utilise sediment basins to capture runoff and release slowly to avoid scour and erosion from increased runoff.	Low
Land use capability, having regard to economic considerations.		Damage to infrastructure, crops, injury to stock from flooding and dam failure.	Placement of fill/cut in the floodplain. Incorrect sizing or construction type of structures. Dam Failure.	Locating major infrastructure where practicable outside of the existing environment flood inundation extents and not over tributaries and flow paths. Appropriate design (including factor of safety, flood immunity and site selection). Design project surface water storage systems to appropriate standards, and relevant conditions and to minimise the potential for impact on residences. Ensuring capacity of surface water holding ponds provide sufficient freeboard to allow for additional rainwater, and are designed in accordance with appropriate Queensland	Low

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
				guidelines and regulations. Incorporate appropriate mitigation measures for dam failure if there is potential risk to property.	
		Damage to riparian areas from filling for infrastructure.	Placement of fill/cut in the floodplain.	Locating major infrastructure where practicable outside of the existing environment flood inundation extents and not over tributaries and flow paths. Appropriate design of major infrastructure located within flood extents by way of fill or use of waterway structures (culverts, bridges) to minimise the risk of inundation or damage due to flooding.	Low
		Loss of/degradation of aquatic habitat and water quality.	Placement of fill/cut in the floodplain. Changes to natural flow regimes as a result of construction (temporary). Changes to flow regimes from development (for example creek diversions). Increased impervious areas. Increased runoff scouring sediment from site. Spills at facilities. Runoff from upstream catchment entering the facility area and mixing with contaminated stormwater.	Locating major infrastructure where practicable outside of the existing environment flood inundation extents and not over tributaries and flow paths. Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines. Utilise sediment basins to capture runoff and release slowly to avoid scour and erosion from increased runoff. Storage of fuel and chemicals will be stored in accordance with relevant regulations and	Low

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
			Hydrotest water release.	guidelines. Storage and fuel transfer facilities will be controlled to reduce spillage and mitigation measures such as bunding, secondary containment will be implemented where practicable. Designing with an appropriate freeboard above storage capacity at all temporary hydrotest dams. Selecting biocide and oxygen scavenger (if necessary) which can be neutralised, are biodegradable, or do not bio-accumulate in the soil. Monitoring of hydrotest water and receiving water quality. Discharging hydrotest and trench water in compliance with all regulatory and landholder requirements. Minimising the chemical treatment required for water uses or select chemical additives that are least harmful to the environment. Constructing erosion control measures at discharge locations. Holding ponds capacity provides sufficient freeboard to allow for additional rainwater, and is	

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
				designed in accordance with appropriate Queensland guidelines and regulations.	
Management of finite resources.	Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.	Sedimentation of watercourses.	Changes to natural flow regimes as a result of construction (temporary). Changes to flow regimes from development (for example creek diversions). Uncontrolled release. Discharge of water. Increased runoff scouring sediment from site.	Divert upstream runoff around major facilities and implement erosion and sediment management practices in accordance with the Queensland Guidelines for Sediment and Erosion Control. Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines. Discharge treated water in a manner that meets environmental flow objectives and mimics pre-development stream flows where practicable (recognising the practicalities and timing of establishing beneficial use). Construction of appropriate stream protection at discharge locations. Ongoing monitoring of downstream reaches. Continued investigation and implementation of alternative beneficial use and disposal options. Appropriate design (including factor of safety, flood immunity and site selection).	Low
		Loss of/degradation of	Changes to natural flow regimes as a result of construction (temporary).	Divert upstream runoff around facility and implement erosion and sediment management	Low

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
		aquatic habitat and water quality.	Changes to flow regimes from development (for example creek diversions). Uncontrolled release. Discharge of water. Sourcing of Water from waterways. Increased runoff scouring sediment from site. Spills at the facility.	practices in accordance with the Queensland Guidelines for Sediment and Erosion Control. Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines. Discharge treated water in a manner that meets environmental flow objectives and mimics pre-development stream flows where practicable (recognising the practicalities and timing of establishing beneficial use). Construction of appropriate stream protection at discharge locations. Ongoing monitoring of downstream reaches. Continued investigation and implementation of alternative beneficial use and disposal options. Appropriate design (including factor of safety, flood immunity and site selection). Minimising the chemical treatment required for water uses or select chemical additives that are least harmful to the environment.	
		Increased volumes of contaminated stormwater to	Runoff from upstream catchment entering the facility area and mixing with contaminated stormwater.	Facilities which require sediment basins or swales will be designed in accordance with appropriate regulations and guidelines.	Low

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
		treat and mitigate.		Storage of fuel and chemicals will be stored in accordance with relevant regulations and guidelines. Storage and fuel transfer facilities will be controlled to reduce spillage and mitigation measures such as bunding, secondary containment will be implemented where practicable. Divert upstream runoff around major facilities and implement erosion and sediment.	
		Changes to natural flow regime.	Changes to flow regimes from development (for example creek diversions). Changes to natural flow regimes as a result of construction (temporary). Discharge of water. Sourcing of Water from waterways.	Locating major infrastructure where practicable outside of the existing environment flood inundation extents and not over tributaries and flow paths. Appropriate design of major infrastructure located within flood extents by way of fill or use of waterway structures (culverts, bridges) to minimise the risk of inundation or damage due to flooding. Discharge in a manner that meets environmental flow objectives and mimics pre-development stream flows where practicable (recognising the practicalities and timing of establishing beneficial use). Construction of appropriate stream protection at discharge locations.	Low

Environmental values	Sustainability principles	Potential impact	Possible causes	Mitigation and management measures	Residual risk level
				Ongoing monitoring of downstream reaches. Continued investigation and implementation of alternative beneficial use and disposal options.	
		Contamination of stock water.	Uncontrolled release. Pond Leakage. Discharge of water. Spills at the facility. Dam failure.	Appropriate design (including factor of safety, flood immunity and site selection). The storage of hazardous materials, fuel and industrial or process chemicals in accordance with applicable federal, state and regional council requirements, to prevent spills or unintentional releases to surface water. Minimising the chemical treatment required for water uses or select chemical additives that are least harmful to the environment. Ensuring capacity of surface water holding ponds provide sufficient freeboard to allow for additional rainwater, and are designed in accordance with appropriate Queensland guidelines and regulations.	Low

11.6.2 Commitments

To manage potential impacts of tenement flooding, Australia Pacific LNG will:

- Avoid placement of major infrastructure in existing flood extents where practicable
- Avoid placement of project infrastructure over tributaries and flow paths where practicable
- Incorporate appropriate design measures where infrastructure is located within flood extents (such as wellhead facilities).

To manage potential impacts to water quality, Australia Pacific LNG will install and maintain stormwater mitigation devices to reduce the potential impacts of storm events on the facilities and receiving environment.

To manage potential impacts of treated water discharge to stream flow, Australia Pacific LNG will:

- Discharge in a manner that meets environmental flow objectives and mimics pre-development stream flows where practicable (recognising the practicalities and timing of establishing beneficial use)
- Design discharge infrastructure such that localised velocity and scour is minimised and appropriate mixing of discharge is achieved
- Conduct ongoing monitoring for water quality at selected locations of the gas fields where significant project activity is undertaken during operations.

To manage potential impacts of hydrotest water, Australia Pacific LNG will:

- Test the quality of the hydrotest water prior to release
- Discharge hydrotest water in compliance with all regulatory requirements and consult landholders about opportunities for reuse.

To manage potential impacts of dam failure, Australia Pacific LNG will:

- Design project surface water storage systems to appropriate standards, and relevant conditions and to minimise the potential for impact on residences
- Incorporate appropriate mitigation measures if there is potential risk to property.

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