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REVISED COAL SEAM GAS WATER MONITORING AND MANAGEMENT PLAN

GLNG PROJECT

EPBC (2008/4059)

Date	Version	Author	Approver	Reason For Issue
31/07/2023	0	PK	PW/GW	Submission to Department of Climate Change, Energy, the Environment and Water. AW380796
17/10/2025	1	BW	DG	Review following the approval of the Fairview Water Release Scheme (2021/8914), refine applicability to above ground storage tanks, consistent with GFD water management plan. AW: 554165

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Declaration of accuracy

In making this declaration, I am aware that section 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed 

Full name (please print) David Gornall

Organisation (please print) Santos Ltd

Date 24/11/25

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Glossary

Acronym	Definition
AEP	Annual Exceedance Probability
AICIS	Australian Industrial Chemicals Introduction Scheme
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand guidelines for fresh and marine water quality
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AWAF	Associated Water Amendment Facility
BoM	Bureau of Meteorology
BTEX	Benzene, toluene, ethylbenzene, xylene
CRAF	Chemical Risk Assessment Framework
CSCL	Chemical Substances Control Law of Japan
CSG	Coal Seam Gas
CWMMP	Coal Seam Gas Water Monitoring and Management Plan
DETSI	Queensland Department of Environment, Tourism Science and Innovation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DSA	Design Storage Allowance
EA	Environmental Authority
EC	Electrical conductivity
ECse	Soil salinity
EOW	End of waste
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Act 1999*
ESS	Extreme Storm Storage
EV	Environmental Value
FSV	Full Supply Volume
EU SVHC	European Union Substance of Very High Concern
GAB	Great Artesian Basin
GDE	Groundwater Dependent Ecosystem
GLNG	Gladstone Liquefied Natural Gas
HCS	Hub Compressor Station
HDPE	High-Density Polyethylene
IARC	International Agency for Research on Cancer
JIF	Joint Industry Framework
LAI	Land amendment irrigation
LBO	Local Biological Objectives

Acronym	Definition
LNG	Liquefied Natural Gas
LWQO	Local water quality objectives
MNES	Matters of National Environmental Significance
MOV	Maximum Operating Volume
MRL	Mandatory Reporting Level
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
PBT	Persistent Bioaccumulative Toxic
PMST	Protected Matters Search Tool
RE	Regional Ecosystem
REMP	Receiving Environment Monitoring Program
RMMP	Resource Monitoring and Management Plan
ROC	RO concentrate
RO	Reverse osmosis
ROP	Reverse Osmosis Plant
RPEQ	Registered Professional Engineer Queensland
SAR	Sodium adsorption ratio
SEVT	Semi-evergreen vine thickets
SPER	Source-pathway-exposure-receptor
TEC	Threatened Ecological Communities
The Manual	Manual for Assessing Hazardous Categories and Hydraulic Performance of Dams
US NTP	US National Toxicology Program
WRR Act	*Waste Reduction and Recycling Act 2011*

1. Background

1.1. Introduction

The GLNG Project is located in southeast Queensland and encompasses three major components:

- 6,887 km^2 of CSG fields in Roma, Fairview and Arcadia Valley including 2,650 production wells;
- A 420-kilometre underground gas pipeline to transport the gas to Curtis Island, near Gladstone; and
- An LNG facility on Curtis Island, plus associated infrastructure.

The GLNG Project converts the CSG to LNG in preparation for export. The CSG fields in Roma, Fairview and Arcadia Valley supply the LNG facility with natural gas. This involves drilling and operating CSG wells, constructing and operating gathering systems and treatment facilities for the gas and water extracted from coal seams, and building and operating gas processing facilities.

Water is produced as part of the gas extraction process. Managing this water and its potential impacts on the environment is a key aspect of the GLNG Project. This document, the revised Coal Seam Gas Water Monitoring and Management Plan (CWMMP) addresses all the management activities associated with extracting water from coal seams for the GLNG Project. This includes stimulation of coal seams, the production, storage, transfer and treatment of the water extracted from coal seams, reuse of the water, and brine management.

1.2. Purpose and Scope

This CWMMP has been prepared to satisfy the amended conditions of approval 2008/4059 issued under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This plan specifically satisfies requirements of Condition 49A (refer Table 1). This condition relates to hydraulic fracturing (stimulation) and developing and outlining the proposed disposal, management and monitoring of coal seam gas produced water (produced water) to avoid, mitigate and manage impacts to Matters of National Environmental Significance (MNES) for the life of the GLNG Project. This includes managing potential impacts to surface and groundwater resources, EPBC threatened species and communities and EPBC migratory species.

Table 1: Condition 49A of EPBC (2008/4059) Approval

EPBC 2008/4059 Condition		Section
49A	Within 6 months from the date of approval for this variation, the approval holder must submit for the approval of the Minister a Revised Coal Seam Gas Water Monitoring and Management Plan for the project, which supersedes any other Coal Seam Gas Water Monitoring and Management Plan, and which includes at least:	-
49A a	the estimated number and the spatial distribution of boreholes where hydraulic fracturing may be necessary, an annual review of the estimate, and recording of actual use;	4.1
49A b	details of constituent components of any hydraulic fracturing agents and any other reinjected fluid(s), and their toxicity as individual substances and as total effluent toxicity and ecotoxicity, based on methods outlined in the National Water Quality Management Strategy;	4.2
49A c	an ongoing water quality and quantity surface water monitoring plan that includes at least:	-
49A ci	identification of the surface and aquatic systems to be monitored and their environmental values, water quality, and environmental characteristics, and the rationale for selection;	5
49A cii	the number and locations of monitoring sites upstream and downstream of proposed discharge of CSG water (whether treated water, amended water or raw water), including test and reference sites upstream and downstream and before and after any proposed impacts;	7.2

EPBC 2008/4059 Condition		Section
49A ciii	the frequency of the monitoring and rationale for the frequency;	7.2
49A civ	baseline data for each monitoring site for comparison of monitoring results over the life of the project;	8
49A cv	the approach to be taken to analyse the results including the methods to determine trends to indicate potential impacts;	8
49A cvi	threshold values that protect relevant MNES (such as reporting or control line values for additional investigation, more intensive management action, make good, and cease operations) at which management actions will be initiated to respond to escalating levels of risk and designed to protect water quality and the associated environmental values of surface and aquatic systems;	8
49A cvii	water treatment and amendment methods and standards;	3.2
49A cviii	water storage locations and volumes including any storage and volumes required to pilot or implement reinjection or other groundwater repressurisation techniques;	3.3
49A cix	water use or disposal options and methods (whether for beneficial use or not) including frequency, volumes, quality and environmental values documented for each receiving environment;	3.4, 3.5, 3.6, 3.7, 3.8, 3.9
49A cx	brine storage locations and volumes, and brine crystal waste management;	3.8, 3.9
49A cxi	emergency water discharges, their volumes and quality;	3.10
49A cxii	references to standards and relevant policies and guidelines;	11
49A d	mechanisms to avoid, minimise and manage risk of adverse impacts and response actions and timeframes that can be taken by the proponent if:	-
49A di	threshold values for surface water quality and water environmental values specified in the CSG WMMP are exceeded;	8
49A dii	there are any unforeseen emergency discharges; and	3.10
49A e	performance measures, annual reporting to the Department, and publication of reports on the internet.	9

1.2.1. Related management frameworks

GLNG Project activities which may pose a risk of a significant adverse impact to MNES, and the relevant management and monitoring measures for these project activities, are addressed in:

- Coal Seam Gas - Joint Industry Framework (JIF) (managing impacts to groundwater resources in the Surat Cumulative Management Area under EPBC Act approvals), endorsed by the Department of Agriculture, Water and Environment on 17 March 2021 – this is an outcomes and risk-based management framework to achieve stated environmental outcomes for relevant MNES resulting from the potential impacts of coal seam gas extraction.

All Santos management plans, protocols and frameworks required by EPBC approval 2008/4059 are available on the Santos website (www.santos.com).

1.3. Project Scope

This plan assesses risks to MNES from the management (storage and disposal) of produced water and provides management controls for activities appropriate to manage the risk identified. The plan relates to the GLNG Project CSG field area and across the lifetime of project development.

This plan may be updated over the life of the GLNG Project. The process for updating this plan is outlined in Section 10 and aligns to the requirements of Condition 59A and 60A of EPBC Approval 2008/4059.

1.4. Roles and responsibilities

All Santos personnel and contractors are responsible for facilitating compliance with this document, relevant conditions of approval. Specific roles and responsibilities associated with this document are detailed below.

Table 2: Roles and responsibilities

Role	Responsibilities
All personnel and contractors	+ Implement the document. + Report all water-related incidents and non-compliances in accordance with the plan and SMS requirements.
Operations team	+ Ensure water containment areas are operated and maintained as designed. + Delegate or conduct detailed reviews on water related incidents. + Ensure compliance with mitigation measures + Report non-compliances in accordance with the plan and SMS requirements
Emergency Response Team	+ Provide first response to emergency water incidents.
Land Access Team	+ Coordinate notifications to any affected landholders/stakeholders alongside Environmental Advisor.
Environmental Advisor	+ Contribute to site inductions regarding water-related incidents and emergencies. + Support the implementation of the CWMMP. + Monitor and report on incidents, preventative and corrective actions from the plan. + Review the CWMMP to ensure it remains current and compliant with regulations.
Irrigation Team	+ Implement and manage irrigation systems according to the CWMMP and RMMPs. + Monitor water usage and efficiency to ensure optimal irrigation practices. + Conduct regular maintenance and inspections of irrigation equipment. + Report any malfunctions or inefficiencies in the irrigation system. + Report non-compliances in accordance with the plan and SMS requirements.
Dust suppression appliers	+ Apply water directly to manage runoff impacts + Ensure compliance with mitigation measures + Report non-compliances in accordance with the plan and SMS requirements
Drilling and completions team	+ Select, design and control appropriate RDM application areas. + Monitor and manage RDM activities. + Ensure compliance with mitigation measures + Report non-compliances in accordance with the plan and SMS requirements

1.5. Training

The project has a comprehensive onboarding environmental training package, ensuring all Santos employees and contractors understand their responsibilities under the various environmental requirements, including this plan. The training includes identification of key environmental values, role-specific understanding of the plan requirements and procedures for responding to environmental incidents.

1.6. Emergency contacts and procedures

Santos manages emergencies in line with existing state Environmental Contingency and Emergency Response Plans for the project. Emergency contacts and the procedures are detailed in this document.

2. Regulatory Context

Several acts and regulations govern the management of produced water (and its derivatives) in Queensland. This includes:

- Produced water management - existing conditions for produced water management granted in Environmental Authorities issued by the Queensland Department of Environment, Tourism Science and Innovation (DETSI) under the *Environmental Protection Act 1994*, and
- Waste management – End of waste (EOW) framework, including various EOW codes, under the *Waste Reduction and Recycling Act 2011* (WRR Act).

Other legislation may apply, and further details are provided in the sections below.

2.1. Produced Water Management

Santos manages produced water in accordance with the relevant regulatory frameworks and policy, including those approvals listed above. The management strategy adopted is sufficiently flexible to accommodate changes in technology, energy sources and climatic conditions. The strategy is based on a rigorous evaluation and decision-making framework which aims to avoid, minimise and mitigate the risk of adverse impacts to environmental receptors.

The *Petroleum Act 1923* and *Petroleum and Gas (Production and Safety) Act 2004* provide that a petroleum tenure cannot be granted unless an Environmental Authority (EA) has been issued under the Queensland *Environmental Protection Act 1994* (EP Act). An EA can apply to multiple petroleum tenures.

In relation to produced water, the EA primarily deals with the management of produced water, the storage of chemicals and waste and their potential for impact to the land, surface water and groundwater quality. EA conditions specify the way in which particular produced water management activities can only be undertaken or specify the environmental outcomes that must be achieved. For example, EAs may limit the size, location and type of water management activity, as well as stipulating minimum operational requirements, monitoring requirements or reporting and notification requirements.

EA conditions for water management activities can only be granted once a proponent has presented information that describes the proposed activity, an assessment of environmental risk and a resulting management and monitoring plan commensurate to the risk identified.

Most notably, the EAs granted for the Roma, Fairview and Arcadia developments prohibit impacts to water resources (surface water and groundwater) associated with produced water management and disposal activities through specific imposed conditions.

2.2. Waste Management

DETSI regulates the management and disposal of wastes in Queensland under the provisions of the EP Act, the WRR Act, the Environmental Protection Regulation (2019) and the Waste Reduction and Recycling Regulation 2011 (WRR Regulation).

Both acts and regulations contain provisions for the assessment, classification and management of waste, including storage, transport, processing, recovery and disposal of waste. The Santos waste management

hierarchy has been developed in accordance with the management approaches detailed within the legislation and associated policies and guidelines.

To ensure the appropriate management and disposal of waste products, Santos has adopted a sustainable approach to waste management. This approach revolves around a hierarchy, which provides a guideline to target waste production and disposal. The successful implementation of the waste hierarchy principles assists Santos to:

- Minimise waste volumes and the risk of adverse impact to the environment (including MNES); and
- Improve operational efficiency and environmental performance.

The waste management hierarchy, from most preferable to least preferable, is illustrated in Figure 1.

Figure 1: Waste management hierarchy

3. CSG Water Management Activities

The following sections describe how produced water from the GLNG Project are managed. A description of the proposed storage, treatment, end use and disposal of produced water is provided. Santos aims to utilise fit-for-purpose beneficial re-use of produced water where feasible whilst avoiding the unnecessary generation of other waste (such as brine) and energy consumption while minimising the potential risk of adverse impacts to MNES.

3.1. Water gathering

Water gathering lines are typically constructed from high-density polyethylene (HDPE), which is used to limit the potential for line failure due to corrosion.

Gathering line right-of-ways are routinely inspected, and may be periodically tested, particularly prior to commissioning. However, this is not the main control for the detection of leaks, since most of the transfer pipes are buried. The principal control for leaks is material selection and pressure testing (integrity verification testing) at commissioning. Water gathering lines are low pressure pipelines which are designed and operated to comply with the relevant Petroleum Industry Codes of Practice (for example the *Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry* published by the Australian Pipelines and Gas Association).

3.1.1. Roma

Produced water from Roma is transferred to various produced water storages, or else transferred directly to water management facilities at the Roma Hub Compressor Station (HCS)-02.

The locations of water management infrastructure at Roma are presented in Table 3.

An overview of the quality of produced water that is gathered is provided in Appendix A.

3.1.2. Fairview

Produced water from Fairview South wells are typically transferred to either the Associated Water Amendment Facility 1 (AWAF1) feed buffer dam, or the Associated Water Balance Dam at the Fairview Hub 4. Produced water from Fairview North is typically wells is transferred to the AWAF2 Associated Water Dam.

The locations of water management infrastructure at Fairview are presented in Table

An overview of the quality of produced water that is gathered is provided in Appendix A.

3.1.3. Arcadia

Produced water from Arcadia wells is typically transferred to the Mount Kingsley Dam produced water storage dam, or else transferred directly to the Arcadia water management facility / reverse osmosis plant (ROP).

The locations of water management infrastructure at Arcadia are presented in Table .

An overview of the quality of produced water that is gathered is provided in Appendix A.

3.2. Water Management Treatment facilities

There are three desalination units located in Arcadia, Roma and Fairview, which include fines and sludge removal and a reverse osmosis plant (ROP) to remove most salts and organic compounds to produce desalinated water (permeate). Produced water is generally blended with permeate to achieve the required water quality objectives for the intended beneficial use of the water.

There is one AWAF located in Fairview (AWAF1) which is used to manage sodicity and alkalinity in produced water. The AWAF chemically amends produced water by dosing with sulphuric acid to neutralise the alkalinity of the water prior to in-line dosing with micronized gypsum to ameliorate the sodicity of the water. Alternatively, this can be achieved in-situ via the addition of agricultural amendments to soils.

To ensure appropriate operation and management of each water treatment facility, the following standards, plans and procedures have been developed and implemented:

- Water Treatment Plant Reliability Management Plans which provide a maintenance strategy for the inspection, monitoring of equipment, and testing with a schedule for and restoration/replacement.
- Water Treatment Plant Integrity Management Plans which provide design basis, process descriptions, plans, diagrams, damage mechanisms and related integrity management activities.
- Water Treatment Plant Training Manuals which provide comprehensive training guidelines.

3.3. Water Storages

3.3.1. Roma

Produced water is stored in water storage dams. Key attributes of the various water storage facilities are summarised in Table 2. Most of the water storage dams described in Table 2 are designed and operated as ‘regulated structures’ in accordance with the requirements of the Queensland Environmental Protection Act 1994 (EP Act).

Table 3: Produced water storages in Roma

Asset	Purpose	Dam construction	Liner composition	Leak detection type	Maximum allowable storage volume (ML)
R-HCS-02 Associated Water Dam	Produced water storage	In ground and above ground	Clay and HDPE	Leak detection layer and seepage bores	100
R-HCS-02 Desalinated Water Dam	Permeate water storage	In ground and above ground	Clay and HDPE	Seepage bores	135
Angry Jungle Dam	Produced water storage	In ground and above ground	Clay and HDPE	Seepage bores	180
Pleasant Hills Dam	Irrigation water storage	In ground and above Ground	Clay and HDPE	Seepage bores	170
Raslie Dam	Irrigation water storage	Above ground	Clay and HDPE	Seepage bores	185
Grafton Range Dam	Irrigation water storage	In ground and above ground	Clay and HDPE	ELIMS testing and seepage bores	200
Hermitage Dam*	Construction water storage	Above ground	HDPE	Seepage bores	180
Ben Bow Dam	Produced water storage	In ground and above ground	Clay and HDPE	Seepage bores	180
Treville Downs Dam*	Concentrate storage	In ground and above ground	Clay and HDPE	Seepage bores	140
Old Coxon Creek Dam*	RO Permeate	In ground and above ground	Nil	Nil	20
New Coxon Creek Dam*	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Seepage bores	170
Mount Hope Dam*	Construction water storage	In ground and above ground	Clay and HDPE	Seepage bores	120
Pickanjinnie Dam	Produced water storage	Turkeys Nest	Clay and HDPE	Seepage bores	180
Reuben Downs Dam	Produced water storage	Turkeys Nest	Clay and HDPE	Leak detection layer and seepage bores	85
Washpool Creek Dam	Produced water storage	Turkeys Nest	Clay and HDPE	Seepage bores	184

*These dams were not in use at the time of writing this plan however may be used again in future.

3.3.2. Fairview

Produced water is stored in water storage dams. Key attributes of the various water storage facilities are summarised in Table 3. Most of the water storages described in Table 3 are designed and operated as 'regulated structures' in accordance with the requirements of the Queensland EP Act.

Table 4: Produced water storages in Fairview

Asset	Purpose	Dam construction	Liner composition	Leak detection type	Maximum allowable storage volume (ML)
Fairview 77 Feed buffer dam*	Produced water storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	30
Fairview AWAF1 Feed buffer dam	Produced water storage	Turkeys Nest	Clay and HDPE	Under drainage and seepage bores	110
Fairview 82 Feed buffer dam*	Produced water storage	Turkeys Nest	Clay and HDPE	Under drainage and seepage bores	5
Fairview RM94 10ML dam (AWAF2)	Produced water storage	In ground	Clay and HDPE	Under drainage and seepage bores	12
Fairview RM94 15ML dam	Produced water storage	In ground	Clay and HDPE	Under drainage and seepage bores	20
F-HCS-04 Associated water dam	Produced water storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	205
F-HCS-04 Permeate dam	RO permeate	In ground	Clay and HDPE	Seepage bores	340
F-HCS-05 Amended water dam	Irrigation water storage	In ground and above ground	Clay and HDPE	Seepage bores	35
F-HCS-05 Associated water dam	Produced water storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	40
IR4 Dam	Irrigation water storage	In ground and above ground	Clay and HDPE	Under drainage	68
Spring Rock Dam*	Produced water storage	Turkeys Nest	Clay and HDPE	Seepage bores	200

*These dams were not in use at the time of writing this plan however may be used again in future.

3.3.3. Arcadia

The location of water storages in Arcadia are summarised in Table 4. Some produced water storages in Arcadia have been designed and are operated as 'regulated structure' in accordance with the requirements of the Queensland EP Act.

Table 5: Produced water storages in Arcadia

Asset	Purpose	Dam construction	Liner composition	Leak detection type	Maximum allowable storage volume (ML)
Mount Kingsley dam	Produced water storage	In ground and above ground	HDPE	Seepage bores	225
Permeate Dam	RO permeate storage	In ground and above ground	Clay	Nil	20

3.4. Beneficial re-use – operational purposes

Operational re-use of produced water reduces the need to source water from elsewhere. Operational re-uses may include use in construction, ground compaction, drilling and completions, or dust suppression. It occurs only on disturbed areas and/or engineered surfaces.

Water for operational re-use may be taken directly from transfer pipelines or any of the water storage facilities described in Table 2, Table 3 or Table 4 where it meets the required water quality objectives for the intended use.

3.5. Beneficial re-use – irrigation

Land amendment irrigation (LAI) describes the application of stoichiometric amounts of agricultural amendments (sulphur and gypsum) to treat the soil prior to the application of produced water. This is undertaken to manage risks to soil structure and crop health due to the quality of the produced water. Predominantly fertilised Rhodes grass and leucaena is irrigated with produced water and management activities to maintain soil salinity (ECse) within the tolerances stated within the ANZECC 2000 guidelines.

In Fairview, in addition to LAI, chemically amended produced water irrigation is also undertaken. The produced water is chemically amended by dosing with sulphuric acid to neutralise the alkalinity of the water prior to in-line dosing with micronized gypsum to ameliorate the sodicity of the water. A combination of forage crops such as Rhodes Grass and leucaena are irrigated with amended water in Fairview as well as tree plantations such as Chinchilla White Gum.

Resource Monitoring and Management Plans (RMMPs) required by the *End of Waste Code for Irrigation of Associated Water (including coal seam gas water)* (DETSI, 2025) for the various irrigation Projects (see Section 11) demonstrate how irrigated soils can be treated with agricultural amendments to manage the potential risks to soil structure and plant health.

The irrigated forage crops are grazed in-situ by beef cattle. Irrigation application rates (and, conversely, the required area of irrigation required) are determined using key soil parameters (e.g. initial soil salinity, soil depth, soil water holding capacity and hydraulic conductivity), climatic conditions and crop demand.

Irrigation forms the largest volumetric means of produced water re-use by Santos within the Roma, Fairview, and Arcadia development areas. Irrigation has been selected by Santos as it aligns with the waste management hierarchy (Figure 1) , complies with regulatory approval conditions and provides an economic benefit through grazing, the main land use in the broader region.

Beneficial re-use via irrigation avoids the generation of additional waste and consumption of energy that would otherwise be required for alternate re-use options which can be both energy intensive and generate waste that must be managed.

The areas are also described in the sub-sections immediately below.

3.5.1. Roma

Roma produced water can be distributed to the following LAI areas with a maximum application rate of 10 ML/ha/yr for pivot irrigation areas:

- Belbri East Irrigation Area;

- Pleasant Hills Irrigation Area;
- Roleen Irrigation Area;
- Tantatton Irrigation Area; and
- The Bend South Irrigation Area.

These areas are all operated by Santos in accordance with the Queensland Government's End of Waste Code and site specific RMMPs. Roma LAI water quality limits are detailed in Table 5.

Table 6: Roma LAI Water Quality Limits

Quality Characteristic	Irrigation Water Quality Limits
Electrical conductivity (EC)	5,000 µs/cm
pH	6.0 – 10.0
Sodium adsorption ratio (SAR) for heavy soils	180
Aluminium	20 mg/L
Arsenic	2.0 mg/L
Boron	6.0 mg/L
Cadmium	0.05 mg/L
Chromium	1 mg/L
Cobalt	0.1 mg/L
Copper	5 mg/L
Fluoride	6 mg/L
Iron	10 mg/L
Lithium	2.5 mg/L
Lead	5 mg/L
Manganese	10 mg/L
Mercury	0.002 mg/L
Molybdenum	0.05 mg/L
Nickel	2 mg/L
Zinc	5 mg/L

3.5.2. Fairview

Fairview produced water can either be irrigated via LAI or amended and irrigated via drip irrigation.

Fairview produced water can be distributed to the following LAI areas with a maximum application rate of 10 ML/ha/yr for pivot irrigation:

- IR3 pivot irrigation area;
- IR4 pivot irrigation area; and
- IR8 pivot irrigation area.

Amended produced water can be distributed to the following irrigation areas with a maximum application rate of 2.5 ML/ha/yr for drip irrigation areas and 10 ML/ha/yr for pivot irrigation areas:

- IR5 (1) drip irrigation area;
- IR5 (2) pivot irrigation area;

- IR6 (1) drip and pivot irrigation area;
- IR6 (2) drip and pivot irrigation areas;
- IR6 (3) pivot irrigation area; and
- IR7 drip irrigation area.

These areas are all operated by Santos in accordance with the Queensland Government's End of Waste Code and site specific RMMPs. Irrigation water quality limits are detailed in Table 6 and Table 7.

Table 7: Fairview LAI Irrigation Water Quality Limits

Quality Characteristic	Irrigation Water Quality Limits
Electrical conductivity (EC)	5,000 µs/cm
pH	6.0 – 10.0
Sodium adsorption ratio (SAR) for heavy soils	180
Aluminium	20 mg/L
Arsenic	2.0 mg/L
Boron	6.0 mg/L
Cadmium	0.05 mg/L
Chromium	1 mg/L
Cobalt	0.1 mg/L
Copper	5 mg/L
Fluoride	6 mg/L
Iron	10 mg/L
Lithium	2.5 mg/L
Lead	5 mg/L
Manganese	10 mg/L
Mercury	0.002 mg/L
Molybdenum	0.05 mg/L
Nickel	2 mg/L
Zinc	5 mg/L

Table 8: Fairview Amended Irrigation Water Quality Limits

Quality Characteristic	Irrigation Water Quality Limits
Electrical conductivity (EC)	4,500 µs/cm
pH	4.5 – 8.5
Sodium adsorption ratio (SAR) for heavy soils	30
Aluminium	20 mg/L
Arsenic	2.0 mg/L
Boron	6.0 mg/L
Cadmium	0.05 mg/L
Chromium	1 mg/L

Quality Characteristic	Irrigation Water Quality Limits
Cobalt	0.1 mg/L
Copper	5 mg/L
Fluoride	6 mg/L
Iron	10 mg/L
Lithium	2.5 mg/L
Lead	5 mg/L
Manganese	10 mg/L
Mercury	0.002 mg/L
Molybdenum	0.05 mg/L
Nickel	2 mg/L
Zinc	5 mg/L

3.5.3. Arcadia

Arcadia produced water is utilised at the Bottle Tree LAI area with a maximum application rate of 8 ML/ha/yr for pivot irrigation area.

Bottle Tree irrigation area is operated by Santos in accordance with the Queensland Government's End of Waste Code and site specific RMMP. Arcadia LAI water quality limits are detailed in Table 8.

Table 9: Arcadia LAI Irrigation Water Quality Limits

Quality Characteristic	Irrigation Water Quality Limits
Electrical conductivity (EC)	5,000 µs/cm
pH	6.0 – 10.0
Sodium adsorption ratio (SAR) for heavy soils	180
Aluminium	20 mg/L
Arsenic	2.0 mg/L
Boron	6.0 mg/L
Cadmium	0.05 mg/L
Chromium	1 mg/L
Cobalt	0.1 mg/L
Copper	5 mg/L
Fluoride	6 mg/L
Iron	10 mg/L
Lithium	2.5 mg/L
Lead	5 mg/L
Manganese	10 mg/L
Mercury	0.002 mg/L
Molybdenum	0.05 mg/L
Nickel	2 mg/L

Quality Characteristic	Irrigation Water Quality Limits
Zinc	5 mg/L

3.6. Release to Watercourses

In the Fairview field, up to 18 ML/day of desalinated produced water (permeate) (refer to Appendix B, Conditions of approval- EPBC Notification of Approval EPBC ref 2021/8914) (up to a maximum of 6,570 ML per year) can be released to the Dawson River in accordance with approval conditions. The desalinated produced water is pumped from the ROP2 Desalinated Water Dam via a 5.3 km pipeline to a release point located at the upper limit of an ephemeral drainage feature. From there:

- The desalinated produced water is released to a fenced, rock-lined outlet at the head of an ephemeral drainage feature via a diffuser. The ephemeral drainage feature has been partially rock-armoured in selected areas of identified higher potential erosion for protection from scouring.
- The released desalinated produced water flows for 2.9 km down an ephemeral drainage feature before discharging into a waterhole (an oxbow lake).
- The waterhole is a semi-permanent water body estimated to have a volume of approximately 500 ML. The waterhole naturally discharges via a 2.2 km watercourse which discharges into the Dawson River midway between “Dawson’s Bend” and “Yebna Crossing”.

3.7. Aquifer re-injection

There are currently no plans for the reinjection of produced water from the GLNG Project.

3.8. Brine / RO concentrate storage

Brine / RO concentrate (ROC) is produced as a by-product of the ROPs at Roma, Fairview and Arcadia. This waste stream is generated where desalination (e.g. reverse osmosis) is required to facilitate beneficial reuse of water.

All of the brine/RO concentrate storage dams described in Table 10 are designed and operated as ‘regulated structures’ in accordance with the requirements of the Queensland EP Act (1994).

Table 10: Brine Storage Dams

Asset	Purpose	Dam construction	Liner composition	Leak detection type	Maximum allowable storage volume (ML)
R-HCS-02 Brine Containment Dam A	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Leak detection layer and seepage bores	324
R-HCS-02 Brine Containment Dam B	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Leak detection layer and seepage bores	321
F-HCS-04 350ML Remote Brine Dam A	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	351
F-HCS-04 350ML Remote Brine Dam B	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	359

Asset	Purpose	Dam construction	Liner composition	Leak detection type	Maximum allowable storage volume (ML)
F-HCS-04 350ML Remote Brine Dam C	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	359
F-HCS-04 350ML Remote Brine Dam D	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	358
F-HCS-04 350ML Remote Brine Dam E	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	360
Bottle Tree Brine Dam A	Brine / concentrate storage	In ground	Clay and HDPE	Under drainage and seepage bores	230
Bottle Tree Brine Dam B	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	308
Pine Ridge Dam	Brine / concentrate storage	In ground and above ground	Clay and HDPE	Under drainage and seepage bores	150

3.9. Brine and salt disposal

Ultimate management and subsequent disposal of brine and salt will be carried out in accordance with State regulatory requirements. It should be noted that the waste fluid is not classified as brine until it is concentrated up to a total dissolved solids (TDS) exceeding 40,000 mg/L as defined by the Environmental Authorities issued under the Queensland EP Act.

The waste management hierarchy (refer Figure 1) for prioritising management of brine (saline waste) includes:

- Priority 1 – brine or salt residues are treated to create useable products wherever feasible.
- Priority 2 – after assessing the feasibility of treating the brine or solid salt residues to create useable and saleable products, disposing of the brine and salt residues in accordance with strict standards that protect the environment.

The management options available can be divided into two categories; commercial salt recovery or disposal.

Commercial recovery of saleable salt product requires an assessment of a number of critical factors such as technical considerations, environmental impacts, market proximity and economic factors. Currently this option is not considered feasible due to the significant energy intensity, cost and low commercial volumes of salt. Commercial salt beneficial use options may become more economic where economies of scale can be employed.

The current preferred brine and salt management option is the storage of brine in dedicated storage ponds, followed by crystallisation and disposal in a salt repository. Four alternative salt repository options have been considered in studies undertaken by GLNG which include:

- Closure of evaporation ponds with salt in-situ;
- Purpose built salt repository;
- Road transport to purpose-built salt repository; and
- Road transport to commercial waste facility.

Further work and assessment are currently being undertaken to determine which of these options would be the preferred salt disposal option.

Brine concentration options can be used to reduce the volume of brine or to sufficiently concentrate brine to allow crystallisation of solid salt. Various technologies are available to enhance the rate of concentration. These technologies have differing energy intensity, environmental footprint, carbon footprint, technical complexity, operability and economics.

This plan does not address the management of brine or salt, other than for storage as described in Section 3.8. Additional information and developments for the management of brine and salt is provided in Santos' GLNG Brine and Salt Management Plan.

3.10. Emergency Water Discharges

Produced water, permeate and brine storages are designed to prevent the need for any emergency water discharges (i.e. spillway releases).

These storages have been designed and constructed (and certified) in accordance with the Queensland "Manual for Assessing Hazardous Categories and Hydraulic Performance of Dams" hereinafter known as "The Manual".

The storages have been designed as 'turkey nest' structures (i.e. storages that do not capture any surface water from overland flow or a drainage path) for the containment of produced water/permeate/brine. A portion of the dam storage is below existing ground level in an excavated void. Overland flows have been diverted away from the storages by diversion bunds designed to divert peak flows up to and including 0.0005 Annual Exceedance Probability (AEP) (1 in 2000 year). This design ensures that only rainfall that falls within the area of the dam embankment enters the storages.

Furthermore, the water storages are operated such that once a Maximum Operating Volume (MOV) is reached, produced water, permeate and brine flows into the storage must cease (which may require water to be diverted or producing wells to be turned down) until the volume returns to below the MOV. Above the MOV there is a Design Storage Allowance (DSA) volume available (designed to store a 100% incidental rainfall from a 3-month wet season, in accordance with The Manual) before the Full Supply Volume (FSV) (spillway level) is reached. This is designed to specifically minimise the likelihood of spillway release from regulated storages.

Above the MOV is the Mandatory Reporting Level (MRL) which is the level at which a remaining volume equivalent to the Extreme Storm Storage (ESS) allowance (short-duration, intense rainfall event). When MRL is reached, Santos must notify DETSI immediately to minimise actual or potential environmental harm.

In summary, the water storages are operated such that produced water, permeate and brine flows into a storage must cease until the volume returns to below the MOV above which there is significant "freeboard" available to store intense rainfall events for site specific wet season (3-month period over summer).

The potential for emergency water discharges (i.e. spillway releases) could only occur under exceptional circumstances, outside the normal design parameters outlined above. This residual operational risk is managed via water storage level monitoring and regular updates to the field based operational water balance models which forecast storage volumes for various operational scenarios and climatic conditions, to ensure that appropriate contingency storage is always maintained in the storages.

3.10.1. Operational Water Balance Models

Arcadia, Fairview and Roma have individual operational water balance models that cover the produced water lifecycle i.e. storage, treatment and utilisation (i.e. operational use, irrigation etc). The purpose of the water balance models is to forecast storage, treatment and utilisation capacity requirements (including identifying constraints).

The water balance models have been developed using the GoldSim simulation software. GoldSim is a decision support tool that uses Monte Carlo analyses to dynamically simulate complex systems while quantitatively addressing the variability and uncertainty inherent in all systems.

Rainfall and evaporation inputs to the water balance model are based on daily resolution long term time-series data sourced from the SILO Data Drill service, hosted by the Queensland Government DETSI. A SILO data set can be automatically generated for any point within Australia, by interpolating between historical observational data obtained from the Australian Bureau of Meteorology (BoM).

When running simulations using the water balance models, the long-term timeseries is automatically disaggregated into over 100 unique sequences equal in length to the selected simulation duration. For example,

when simulating a ten-year outlook, the first climate sequence would be Jan 1889 to Dec 1898, the second Jan 1890 to Dec 1889, and so on.

To ensure all data is used, sequences that overrun the time-series will loop back and use data from 1889 onward.

Model simulations are run on daily time steps over an identified period with one or multiple realisations. A realisation is defined as a single model run under one set of stochastically varying inputs. The purpose of the multiple realisations is to test the system under multiple climatic conditions and provide results as a probabilistic distribution. Results are reported as daily or monthly averages for the full range of climate conditions.

3.10.2. Climate Change

The Queensland Government has developed an interactive map (https://qgsp.maps.arcgis.com/apps/MapJournal/index.html?appid=1f3c05235c6a44dcb1a6faebad4683fc) to help understand the impact of climate change for specific council regions. The gas fields of GLNG are located in the Central Queensland region and is potentially subject to the following by 2050, under a modelled high emissions case:

- 1.9ºC increase in median annual temperature (1.4ºC for low emissions case);
- 8% decrease in median annual rainfall (2% for low emissions case); and,
- 7% increase in median annual evaporation (5% for low emissions case).

As the low and high emissions case forecasts a reduction in rainfall and an increase in evaporation, this results in smaller volumes in all storages; therefore, not adopting these climate change forecasts is conservative when utilising the water balance models to forecast future storage volumes and capacities.

4. Stimulation

Stimulation is employed in the oil and gas industries to improve the production efficiency of oil and gas wells (i.e. more efficient and more economical extraction of water and gas from the coal seams). Stimulation is not carried out on all CSG wells as the process is only necessary at locations with low permeability.

Stimulation is carried out as one of the last activities in the construction of a CSG well and prior to bringing the well into service. It is typically performed on the newly drilled and constructed wells; that is the CSG well that is open to specific coal seams.

Stimulation uses a mix of water, sand and minor concentrations of other fluids mixed on the surface and then injected down into the well and then through the perforations into the coal seam (refer Section 4.2). The water and sand are typically around 99% of the volumes of the stimulation fluids, the rest being the added chemical to enhance the process.

The stimulation process occurs under varying positive high hydraulic pressures (ranging from approximately 7,000 to 34,500 KPa [1000 to 5000 psi]) in order to open existing fractures in the coal matrix. The stimulation fluids are injected through perforations (holes) in the steel well casing pipe via wellhead works on the surface and coil-tube pipe down to a device which isolates the coal seam to be fractured.

After completion of the stimulation, the volumes of fluids inserted are pumped out of the well; it clears the majority of the remaining and available fluid in the well. This flow-back largely comprises the water used in the stimulation fluid mixture, degraded additives as well as coal seam water and other geo-genic constituents sourced from the target formation. The flow-back volume discharged is typically set to be 150% of the total volume of fluids injected into the well as part of the stimulation procedure. There will be a small amount of fluid liquid lost in far reaching fractures and which may never be recovered during the flow-back pumping however most of the remaining fluid left after “flow back” will be recovered during the long-term production development.

4.1. Spatial Distribution of Stimulation

The need for stimulation is subject to change and is affected by the progress of drilling and well completion activities, the availability of resources and the geology and permeability characteristics across the CSG fields.

The spatial distribution of completed stimulation locations and the scheduled stimulation locations for 2025 and 2026 are shown in Table 11.

Table 11: Stimulation Locations

Field	Completed (since 2010)	Scheduled in 2025/26
Arcadia	~420	~20
Fairview	~450	~65
Roma	~400	~26

Santos GLNG expects that approximately 70% of wells will be fractured over the field life in the Fairview and Arcadia CSG fields and approximately 50% in the Roma CSG field. However, it is important to note that all wells have the potential to be stimulated at one or more point in time as operational requirements vary.

Given the uncertainty in future stimulation locations during field development planning, the Hydraulic Fracturing Risk Assessment assumes that all gas well locations have the potential to be fractured.

Based on the process of well drilling selection, no wells are established proximal to any known structural faults or discontinuities that could lead to vertical migration of fluids and gases, especially since the purpose of stimulation is to facilitate gas recovery.

4.2. Toxicological Evaluation of Stimulation Fluid

Santos uses a tiered assessment approach to streamline the risk assessment process for stimulation fluids, hereafter referred to as the Chemical Risk Assessment Framework (CRAF) (Chemical Risk Assessment Framework (CRAF), Santos Gas Field Development Project, EPBC 2012/6615, Version 1, April 2021 (Santos 2021)). This framework aligns the chemical assessment guidance provided by National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the approach used for industrial chemicals and with Commonwealth Approval requirements. The CRAF allows for a defined and streamlined process to:

- Identify low hazard chemicals that can be addressed simply through a hazard assessment process;
- Identify higher hazard chemicals that should be assessed through completion of a quantitative risk assessment;
- Identify very high hazard chemicals that should be encouraged not to be used as part of the process;
- Identify very high hazard chemicals that cannot to be used as part of the process; and
- Incorporate the outcomes of the assessment into environmental mitigation and management controls.

This approach incorporates best practice risk assessment methodology to evaluate potential risks and effects of chemicals used during stimulation activities to environmental values and demonstrate that potential risks to environmental values have been eliminated or reduced as much as reasonably practicable.

The methods used for qualitative risk assessment, toxicological assessment and the quantitative risk assessment align with the best practices with the only difference being that assessment is completed on a chemical-specific basis.

The framework involves a two-step process:

- Step 1 – classification of chemicals; and
- Step 2 – assessment of chemicals.

In accordance with the CRAF, chemicals are classified into five Tiers (Tier 1 through 5) based on the following criteria:

- Assessment of whether chemicals are identified on chemical databases used by Australian Industrial Chemicals Introduction Scheme (AICIS) as indicators that these chemicals are of concern. These included:
  - European Union Substance of Very High Concern (EU SVHC)
  - US National Toxicology Program (US NTP) Report on Carcinogens
  - International Agency for Research on Cancer (IARC) Monographs
  - European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity

  - Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical.
  - Polymers identified as of low concern by AICIS
- Completion of a formal persistent, bioaccumulative and toxic (PBT) substances assessment (using environmental reference values contained within the categorisation guidelines) and the factors discussed in the meeting to develop the tiered framework.
- Evaluation of any other concerns associated with persistence in the environment (especially for inorganics) which is not captured in the PBT assessment but may be a consideration in the context of project activities (for example, irrigation of produced water).

A low-risk chemical is defined as a chemical that is not identified as a Persistent Bioaccumulative Toxic chemical and is not listed as a chemical of concern on the following databases:

- European Union Substance of Very High Concern (EU SVHC)
- US National Toxicology Program (US NTP) Report on Carcinogens
- International Agency for Research on Cancer (IARC) Monographs
- European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity
- Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical

A high-risk chemical is defined as a chemical that is identified as a Persistent Bioaccumulative Toxic chemical, or a chemical which exhibits toxicity of potential concern, or is listed as a chemical of concern on the following chemical databases:

- European Union Substance of Very High Concern (EU SVHC)
- US National Toxicology Program (US NTP) Report on Carcinogens
- International Agency for Research on Cancer (IARC) Monographs
- European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity
- Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical

For the purposes of this CRAF, chemicals categorised as Tier 1 or Tier 2 chemicals are designated as ‘low risk’ chemicals. Chemicals categorised as Tier 3, Tier 4 or Tier 5 chemicals are designated as ‘high risk’ chemicals.

Based on the category classification of the chemical (and its potential toxicity, persistence and bioaccumulation potential in the environment), different levels of assessment will be conducted with the most robust assessment conducted on the highest classification (Table 12).

Table 12: Risk Assessment Requirements

Tier	Risk Category	Screening Assessment and Categorisation	Toxicological Profile	Qualitative Risk Assessment	Quantitative Risk Assessment	Site Specific Assessment	Prohibited from Use on Project
1	Low Risk	X	X				
2		X	X	X			
3	High Risk	X	X	X	X		
4		X	X	X	X	X	
5		X					X

Consistent with the screening matrix in Table 12:

- Tier 1 chemicals, which are effectively low toxicity and therefore low hazard, would be subject to only the screening assessment.

- Tier 2 chemicals, in addition to the screening assessment, will be subjected to a qualitative risk assessment.
- Tier 3 and Tier 4 chemicals will be subject to an additional quantitative risk assessment with Tier 4 chemicals requiring an additional site-specific quantitative risk assessment. Site-specific risk assessment for Tier 4 chemicals will require site-specific per use approval by the Minister.
- Tier 5 chemicals will not be used, and no further discussion will be provided.

The assessment of geogenic chemicals recovered within produced water will be assessed against risk-based criteria depending on their end fate (i.e. use and/or disposal).

Toxicological profiles (risk assessment dossiers) are developed for all chemicals under the CRAF and are accessible and available on the Santos website. The toxicological profiles (dossiers) include chemical identification, physical and chemical properties, environmental fate properties, human health and environmental hazard assessments, derivation of non-cancer and cancer screening levels, a PBT assessment and regulatory status.

Several stimulation contractors will potentially be undertaking stimulation activities within Arcadia, Fairview and Roma. These contractors all have multiple fluid systems with differing chemistries. The variability in fluid systems is primarily a function of the use of either water and gel-based systems and foam and non-foam versions. In addition, vendors use different biocides, breakers and enzymes in their gel-based systems. The Toxicological Summaries for these fluid systems are provided in contractor and/or product vendor specific Appendices to the CRAF, for the individual chemical compounds.

In the assessment of potential exposure pathways and risks, only authorised operational activities are considered (i.e. activities that are authorised in the respective EA and Commonwealth Approval). Where activities are specifically precluded (e.g. release or disposal of wastes to surface or ground waters are explicitly not authorised), these are not considered in the risk assessment.

Further the qualitative risk assessment considers management plans developed as part of Commonwealth and State approvals, which have been developed to avoid, mitigate, manage and monitor potential impacts.

Based on the outcomes of the National Assessment of the Chemicals used in Coal Seam Gas in Australia (DoEE, 2017), hypothetical accidental releases associated with delivery truck rollovers, including into watercourses, represented the greatest potential risk to environmental values. Given the highly regulated nature of transportation of chemicals (at both a Commonwealth and State level), transport related scenarios and assessment will not be incorporated into the risk assessment process. However, the outcome of the assessment should be used to inform emergency response actions.

The chemical risk assessment qualitatively assesses the potential for one or more hazards associated with the chemicals used in stimulation to impact environmental values. Further, the assessment of cumulative impacts to environmental values is evaluated for Tier 3 and Tier 4 chemicals only due to their potential persistence and/or potential to bioaccumulate.

A Register of Assessed Chemicals is published and maintained on the Santos website (https://www.santos.com/about-us/corporate-governance/public-notices/).

5. MNES Receptors

A description of potential MNES receptors within the GLNG Project area and adjacent to the various irrigation areas (the main release points for produced water) is provided in the following Sections. Potential MNES receptors identified via the DCCEEW Protected Matters Search Tool (PMST) are based on generic databases held by the Commonwealth and States and are not always validated by ground surveys. Confirmation of a PMST listed species presence is indicated in each of the following sub-sections.

Table 13 summarises the potential and confirmed MNES flora species for each of the project areas.

5.1. Flora MNES listed species

5.1.1. Roma

The PMST identifies one threatened flora species with a potential to occur within Roma project area as indicated in Table .

Field surveys within the vicinity of the project disturbances and the immediate surrounds have failed to identify the presence of *H. belsoni.*

A number of different non-MNES vegetation communities are present within the project area including Blyth Creek and its tributaries that provide suitable habitat values for eight MNES threatened fauna species. These eight threatened fauna species and their corresponding distribution and known habitat uses are provided in Table .

5.1.2. Fairview

The PMST lists nine threatened flora species that may potentially occur within the Fairview project area as listed in Table .

Three of the listed PMST flora species are confirmed to occur within the Fairview project area as indicated in Table .

A number of different vegetation communities and fauna habitats are present within the project area including Dawson River and Hutton Creek. These vegetation communities provide suitable habitat values for 13 species of MNES threatened fauna species (see Table).

5.1.3. Arcadia

The PMST identifies 10 threatened flora species with potential to occur within the Arcadia project area as indicated in Table . Two of the listed PMST flora species are known to occur within the Arcadia project area as indicated in Table .

Table 13: Likely occurrence of threatened MNES flora in GLNG Project Area

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely / Confirmed occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
Homopholis belsonii	Belson's panic	V	Field surveys within the vicinity of the project disturbances and the immediate surrounds have failed to identify the presence of *H belsoni.*	L [4]	×	×
Acacia grandifolia	None	V		×	L	L
Aristida annua	None	V		×	×	L
Arthraxon hispidus	Hairy-joint grass	V		×	L	×
Bertya opponens	None	V	*Bertya opponens* - recorded during surveys as growing in mixed shrublands on the sandstone hills and escarpments within the Fairview project area.	×	L&C [5]	L
Cadellia pentastylis	Ooline	V	*Cadelia pentastylis* - occurs within the valley and in a variety of areas including open paddocks within the Arcadia project area	×	L	L&C
Daviesia discolor	None	V		×	L	L
Dichanthium queenslandicum	King Blue-grass	E		×	×	L
Dichanthium setosum	Bluegrass	V		×	×	L
Eucalyptus beaniana	Beans Ironbark	V		×	L	L
Phaius australis	Lesser Swamp Orchid	E		×	L	×
Thesium australe	Austral Toadflax, Toadflax	V		×	×	L
Xerothamnella herbacea	None	E	*Xerothamnella herbacea* - recorded during surveys to occur in the far northern areas of the Fairview project	×	L&C	L&C

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely / Confirmed occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
			area, and is recorded in riparian areas in the southern half of the Arcadia project area			
Eriocaulon carsonii	Salt Pipewort, Button Grass	E	*Eriocaulon carsonii* - is known to occur in a spring complex in the west of the project area.	✕	L&C	✕

Table notes:
1. V = vulnerable; E = endangered
2. FV is Fairview
3. AV is Arcadia.
4. L = Listed in the PMST
5. C = Confirmed during a project

5.2. Threatened ecological communities

5.2.1. Roma

Three EPBC Act Threatened Ecological Communities (TECs) occur within the project area as follows.

- Brigalow (Acacia harpophylla dominant and co-dominant) occurs in many areas within the Roma project area. This TEC is confirmed to be present in proximity to Belbri and Bend South irrigation areas.
- Weeping Myall Woodlands with the Weeping Mayall (*Acacia pendula*) as the dominant (but not sole) overstorey species with and understorey of open layer of shrubs above an open ground layer of grasses and herbs
- Semi-evergreen vine thickets (SEVT) of the Brigalow Belt (North and South) and Nandewar Bioregions Woodlands.

Whist these TECs are present with the Roma project area, they only occur in small, isolated patches and are not known to occur in the vicinity of the irrigation areas.

5.2.2. Fairview

The PMST identifies six TEC as being potentially present in the Fairview project area as follows:

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow belt South Bioregions
- Poplar Box Grassy Woodland on Alluvial Plains
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Weeping Myall Woodlands
- Brigalow (Acacia harpophylla dominant and co-dominant) and,
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.

Four TECs are confirmed to occur via survey in the Fairview project area as follows:

- RE 11.3.1 and/or 11.9.5 - Brigalow (*Acacia harpophylla* dominant and co-dominant) occurs on the undulating plains and lowlands within the Fairview project area.
- RE 11.9.4 - Semi-evergreen vine thickets (SEVT) of the Brigalow Belt (North and South) and Nandewar Bioregions TEC are predominately present on the moister south facing slopes associated with the sandstone escarpments. Both Brigalow and SEVT communities are common in Fairview and are located in close proximity to irrigation areas and water storages.
- RE 11.3.2 - Poplar Box Grassy Woodland on Alluvial Plains has been confirmed as being present and one (the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin)
- The Yebna2 spring complex, vent 534 is considered analogous with the EPBC TEC (GAB Springs) within the Fairview project area.

5.2.3. Arcadia

Field surveys conducted across the gas field have confirmed the presence of two TECs within Arcadia as:

- RE 11.3.1 and/or 11.9.5 - Brigalow (*Acacia harpophylla* dominant and co-dominant) and
- RE 11.9.4 - Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar' are present.

Both these communities are relatively common in Arcadia, and both occur in close proximity to irrigation infrastructure.

5.3. Riparian vegetation and referable wetland

5.3.1. Roma

Riparian vegetation is generally associated with Blyth Creek and its tributaries. It is mapped as Regional Ecosystem 11.3.25: River Red Gum (*Eucalyptus camaldulensis*) open forest to woodland, and is located within the Roma project area approximately:

- 2.5km south-east of Pleasant Hills irrigation areas
- 2.2km east of Belbri/Somerset irrigation areas
- 300m north of Roleen irrigation area
- 100m north-west of Bend South Irrigation area

A series of Referrable Wetlands associated with Blyth Creek and its tributaries is located approximately:

- 1.5km north-east of Bend South irrigation area
- 1km east of Pleasant Hills irrigation areas
- 800m east of Belbri/Somerset irrigation areas
- 300m north of Roleen irrigation areas.

5.3.2. Fairview

Riparian vegetation is generally associated with Hutton Creek and the Dawson River and their associated tributaries. The vegetation associated with both Hutton Creek and the Dawson River generally consists of:

- Regional Ecosystem 11.3.25: *Eucalyptus tereticornis* or *E. camaldulensis woodland* fringing drainage lines. A riparian community growing below the high banks of the Dawson River, represented by woodland to open forest of Queensland Blue Gum (*Eucalyptus tereticornis*), River Oak (*Casuarina cunninghamiana*), Rough-barked Apple (*Angophora floribunda*) and Weeping Bottlebrush (*Melaleuca viminalis*), the latter dominating on lower banks. This RE is classified as Least Concern under the Queensland Nature Conservation Act (1992) and does not contain species listed in the EPBC Protected Matters report for the Fairview area.
- Regional Ecosystem 11.3.19: Callitris glaucophylla, Corymbia spp. and/or Eucalyptus melanophloia woodland on Cainozoic alluvial plains, typically present on sandy levees above the high banks of the Dawson River that are considered to at least periodically access groundwater from shallow alluvial aquifers. The RE is listed as No Concern at present under the Nature Conservation Act (1992) and does not contain species listed in the EPBC Protected Matters report for the Fairview area.

Hutton Creek is defined by DEECCW as a permanent connected river with variable gaining (generally from the Precipice Sandstone Formation) and losing reaches in the areas immediately south of IR8 and IR1, west of IR6(1) and IR6(2), and north of IR5(1), IR5(2) and IR4. The aquatic Groundwater Dependent Ecosystem (GDE) rule generally states that the river is supported by channel alluvia connected to the Precipice Sandstone with a fresh, permanent groundwater connectivity regime.

There are four lacustrine wetlands situated along Hutton Creek and Dawson River within 5km of irrigated areas. All four wetlands are bound within the creek/riverbanks and have all been designated as derived terrestrial GDE's with low confidence.

5.3.3. Arcadia

Riparian vegetation is generally associated with the Dawson River in the south of the project area and a number of small creeks that flow north. The vegetation associated with both systems is generally Regional Ecosystem 11.3.25: River Red Gum (*Eucalyptus camaldulensis*) open forest to woodland.

There are a number of smaller ephemeral wetlands in Arcadia Valley, and these are generally associated with Regional Ecosystem 11.3.27.

5.4. Fauna MNES listed species

A number of different vegetation communities and unique fauna habitats are present within the project area including sandstone escarpments and caves, large areas of Brigalow and the Dawson River. These vegetation communities provide suitable habitat values for 13 species of MNES threatened fauna species (see Table 14).

5.5. Migratory Species

All listed EPBC Act migratory species with potential to occur within the project area can best be described as passage, or seasonal migrant, or widely distributed and common species. All listed migratory species are unlikely to be significantly impacted by the proposed wastewater management activities as these will not substantially modify, degrade, destroy, or isolate an area of important habitat for any migratory bird species and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population. In addition, the wastewater management activities are not expected to result in the direct mortality of migratory bird species.

Table 14: Likely occurrence of threatened MNES fauna in GLNG Project Area

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
Botaurus poiciloptilus	Australasian bittern	E	Heron-like waterbird inhabiting shallow vegetated wetlands with dense reeds, sedges or similar vegetation where it forages and nests (Pizzey and Knight 2010). It is found in coastal and subcoastal SE Australia including Tasmania, with the mid- to lower Murray-Darling drainage being an important population centre (Pizzey and Knight 2010, ALA 2019). It is infrequently recorded in inland southern Queensland, with no records in close proximity to the GLNG Project area (ALA 2019).	✕	✓	✓
Erythrotriorchis radiatus	Red goshawk	V	A sparsely distributed species occurring in north-eastern and northern Australia. It is a highly mobile species with a large home range; breeding habitat is in intact tall forest associated with major drainage lines, especially near permanent water bodies and where there is high avian prey diversity, but the species could potentially forage much further away from these areas (Marchant and Higgins 1993). Based on known occurrence (ALA 2019) the forested uplands of the Fitzroy and Dawson River catchments may potentially support this species.	✓	✓	✓
Geophaps scripta	Squatter pigeon	V	Occurs in southern and central eastern Australia, being almost entirely confined to Queensland. It Inhabits grassy woodlands with open areas for foraging habitat usually near a water source (Higgins and Davies 1996). There are numerous records from the adjacent Fairview gas-field (ALA 2019, Santos unpubl.).	✕	✕	✓
Rostratula australis	Australian painted snipe	E/M	Recorded over much of Australia other than the driest interior, but most frequently recorded within the Murray-Darling Basin (ALA 2019). Forages at shallow edges and adjacent vegetated margins of freshwater wetlands (DoEE 2019b) and is able to use both artificial and natural ephemeral and permanent wetlands (Marchant and Higgins 1993).	✓	✓	✓

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
Turnix melanogaster	Black-breasted button-quail	V	This bird lives in drier rainforest types (including SEVT), Brigalow shrubby open forest and littoral shrublands from about Byfield, central Qld south to the Northern Rivers area of NSW, where it forages in deep leaf litter (Smith and Mathieson 2012). The species is recorded at Palmgrove NP, *ca*. 80km northeast of the site and within a large tract of intact vegetation extending north and east from the Expedition Range (ALA 2019).	✓	✓	✓
Furina dunmalli	Dunmall's snake	V	This snake is almost endemic to southern-central Queensland, having been also reported in the far north of NSW. Occupies woodlands and open forests; may be reliant on presence of abundant fallen woody debris (Hobson 2012). The species has been recorded from the nearby Arcadia Valley (BOOBOOK unpubl. data).	✗	✓	✓
Denisonia maculata	Ornamental snake	V	This snake is endemic to Queensland. It occurs in lowlands associated with the Dawson and Fitzroy catchments (DoEE 2019b). Known southern distribution limit is approximately Lake Nuga Nuga, ca. 80 km northwest (ALA 2019). Lives in woodland and grassland with cracking clay soils, usually in close proximity to wet or seasonally wet areas e.g. billabongs, gilgais, floodplains, riparian corridors (DoEE 2019b).	✓	✓	✓
Delma torquata	Collared delma	V	This lizard is endemic to sub-coastal and inland southern Queensland. Occupies a range of eucalypt woodlands and open forests; lives under surface rock and large woody debris (Wilson 2015). The Site is within the species' potential range with several records from locations north-west of Roma (ALA 2019).	✗	✓	✓
Egernia rugosa	Yakka skink	V	This lizard is endemic to inland southern Queensland, where it lives in a range of woodland and open forests dominated by *Eucalyptus, Acacia* and *Callitris* spp.; also grassland with regrowth trees (DoEE 2019b). Requires suitable soils for burrows or shelters in sinkholes, abandoned rabbit warrens or large fallen/piled woody material (Eddie 2012). There are	✓	✓	✓

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
			historical records of the species from the Arcadia Valley, *ca*. 30km northwest (ALA 2019).			
Chalinolobus dwyeri	Large-eared pied bat	V	This species occurs in inland to coastal areas of New South Wales and Queensland (ALA 2019). All known occurrences of this species are within or near forested landscapes with relatively high relief (DoEE 2019b). The species may be present in uplands with appropriate geology (usually sandstone) providing essential habitat (caves, crevices, holes) and associated foraging habitat. The species is known from Expedition Range NP and Belington Hut SF (ALA 2019).	✓	✕	✕
Nyctophilus corbeni	South-eastern long-eared bat	V	The distribution and habitat preferences of this species are very poorly known but it has been reported from a wide variety of dry woodland and open forest types in south central Queensland (Reardon 2012). The species has been recorded in the Expedition Range, with a record within 40km of the Site (ALA 2019).	✕	L&C	✕
Dasyurus hallucatus	Northern quoll	E	Formerly widespread in south-central Queensland this species has declined markedly and is now confined to rugged and remote areas throughout its distribution (Burnett 2012). Forested uplands with high relief and/or containing abundant rock outcrops may support the species. The nearest recent records are from the Carnarvon Range (ALA 2019).	✕	L&C	✓
Phascolarctos cinereus	Koala	V	Occurs in coastal and inland areas from South Australia to northern Queensland. This species requires eucalypt woodland and forest habitat with suitable food trees (primarily *Eucalyptus* spp.) (DoEE 2017b). Woodlands containing food trees in riparian/alluvial areas are particularly favoured (Melzer *et al*. 2014). The Site is within the known range of the species (ALA 2019). Potential food trees occurring within the Site include *Eucalyptus tereticornis*, *E. camaldulensis, E. populnea, E. melanophloia, E. major* and *E. crebra.*	✕	✓	✓
Maccullochella peelii	Murray cod	V	In Queensland naturally occurring populations of this species are confined to permanent water in riverine environments in	✓	✓	✓

Species	Common Name	EPBC Act Status [1]	Distribution and Known Habitat Use	Likely occurrence in GLNG Project Areas		
				Roma	FV [2]	AV [3]
			the Condamine, Maranoa-Balonne, Weir, Moonie and Macintyre River catchments (Lintermans 2007).			
Rheodytes leukops	Fitzroy river turtle	V	The species is confined to the Fitzroy and Dawson River catchments of Queensland where it requires permanent water in riverine environments, preferentially foraging in shallow, well-oxygenated riffles (Limpus *et al*. 2011).	✕	✕	✓
Elsaya albagula	Southern Snapping Turtle, White-throated snapping turtle	CE	Confirmed sightings in the Dawson River within the Fairview project area.			

Table notes:
1. V = vulnerable; E = endangered
2. FV is Fairview
3. AV is Arcadia.
4. L = Listed in the PMST
5. C = Confirmed during a project

5.6. Groundwater resources

5.6.1. Roma

There are several water supply bores registered within the State of Queensland that are in proximity to Santos' produced water management activities in the Roma area.

The hydrogeological units underlying the various water management areas varies, with formations generally dipping from north-east to south-west, with the older formations outcropping in the north-east. The Roleen area is underlain by outcropping units of the Mooga Sandstone. The Bend South, Belbri/Somerset and Pleasant Hills areas are all underlain by the Bungil Formation.

The Mooga Sandstone is the shallowest aquifer unit beneath the irrigation areas. In the broader region, groundwater from this aquifer is used for town water supply, stock watering and domestic use and bore yields range widely up to 35 L/s. However, locally, the unit is close to outcrop and the water resource is not consistently present, particularly in more northern areas. Groundwater level in the Mooga Sandstone aquifer is shallowest at the location of the Bend South irrigation area where the groundwater level is 20m below the pivots, and locally intersects ground surface and supports watercourse springs in Blyth Creek. The intersection of groundwater only supports permanent pools of water, not permanent flowing water, which suggests the intersection does not result in significant aquifer discharge.

The Orallo Sandstone is minor aquifer. Where groundwater is present it can support small scale stock and domestic uses.

Water supply bores in the local area are typically stock and domestic bores that access the Gubberamunda Sandstone which provides higher yielding fresh to brackish water supplies suitable for stock watering.

Groundwater flow directions in all formations are generally expected to be towards the south and south-west, i.e. down dip and towards the areas of lower elevation within the Surat Basin.

The nearest water supply bore constructed in the Mooga Sandstone is RN38337 is located about 800m north-west of Pivot 6.

The closest spring comprises the Barton spring complex. This complex comprises two discharge vent springs located approximately 30km north-east of the Roleen irrigation area. The spring source aquifer for Barton Spring complex is understood to be the Gubberamunda Sandstone (OGIA, 2016).

As described above, watercourse springs (aquatic GDEs) are noted along Blythe Creek (OGIA, 2016), at a distance of approximately 100m from the Bend South irrigation area. The spring source aquifer for Blythe Creek is understood to be the Mooga Sandstone.

5.6.2. Fairview

At Fairview all of the Surat Basin geological units dip to the south towards the deeper parts of the Surat Basin (such as the Mimosa Syncline). The Westgrove Sandstone generally underlies the irrigation areas on the central flat-lying parts of the elevated plateaus. This formation acts as a regional aquitard.

The Boxvale Sandstone proudly outcrops along the peripheries of the irrigated plateaus and formed the resistive layer against erosion of the escarpment. There are large swathes of Boxvale Sandstone outcrop across the escarpment, with permeable quartzose beds and regular fracturing and jointing patterns allowing for effective recharge along the escarpment ridges and gullies. This preferential recharge mechanism was recognised by Kellett et al. (2003) as one of the key components of GAB recharge, and far more effective than diffuse recharge to the water table. The Boxvale Sandstone dips to the south and groundwater in this formation flows away from the Hutton River valley downstream receptors.

The lower Evergreen aquitard lies beneath the Boxvale Sandstone and allowed for significant erosion during the formation of the incised valleys. This aquitard provides resistance to vertical flow between the Boxvale Sandstone and the deeper Precipice Sandstone aquifer.

The Precipice Sandstone lies at the base of the valley and is the source aquifer for several discharge springs along the Hutton Creek floodplain (down-gradient of the irrigation areas). The Precipice Sandstone also provides base flow to Hutton Creek. Generally, groundwater within this regional aquifer flows from northwest to southeast with a strong convergence of flow along the Dawson River near a number of Precipice Sandstone spring vents.

There are 55 existing, registered, sub-artesian (i.e. non-artesian) water supply bores in the immediate extents of the irrigation areas and up to 5km down-gradient of the irrigation areas. Seventeen bores are directly tapping the Boxvale Sandstone where it crops out along the plateaus. A majority of the remaining bores are situated along the precipice Sandstone/Evergreen Formation geological contact and are likely to either be Precipice Sandstone bores or deeper bores that intersect the Bandanna Formation.

There are sixteen spring vents along the floodplains of Hutton Creek and Dawson River within 5 km of all Fairview irrigation areas. Fifteen of the springs have a permanent connection with the Precipice Sandstone (via surficial alluvia in places), and all sixteen are known aquatic GDEs (highest confidence based on local expert knowledge supported by field studies).

5.6.3. Arcadia

The Bowen Basin is a north-south oriented sedimentary basin of Permo-Triassic age predominately consisting of layered siltstones, sandstones, mudstones and shales. Basement rocks consist of Devonian to Carboniferous age strata including the Timbury Hills Formation and volcanic rocks (e.g. Roma Granite) (URS, 2011).

In the Arcadia Valley, the Rewan Group (a regional tight aquitard) outcrops and the GAB formations of the upper Bowen Basin (Moolayember Formation and Clematis Sandstone) are the prominent formations forming the steep cliffs of the Expedition Range. The lowest three formations of the Surat Basin sequence, the Precipice Sandstone, the Evergreen Formation and Hutton Sandstone are not present.

The Clematis Sandstone is the primary aquifer in the region and is hydraulically disconnected from the Arcadia Valley where the Bottle Tree Irrigation Area occurs. Quaternary Colluvium comprises the surface geology of the Bottle Tree Irrigation Area. The Quaternary Colluvium consists of clay, silt, sand and gravel and is a flood-plain alluvium system with shallow groundwater present.

5.7. Watercourses (Dawson River)

The desalinated water (permeate) release to the Dawson River occurs within a reach of the Dawson River that is fed by springs associated with the Precipice Sandstone formation. Inflow of spring water from the Precipice Sandstone results in perennial flow conditions within the Dawson River that in turn supports an aquatic GDE utilising alluvial sediments within and adjacent the Dawson River.

Springs are typically located either on the banks or at a relatively short distance away from the Dawson River, where they connect via spring discharge channels. While the spring flows contribute to riverine GDE values, their conservation ranking is generally relatively low (Category 2: wetland vegetation without isolated populations) (Qld Herbarium 2021). Due to the spring inflow and baseflow from the Precipice Sandstone, the Dawson River supports a permanent, though variably flowing, freshwater riverine wetland GDE within the proposed action area (DES 2021b).

The topography, habitat values, flora and fauna of this reach of the river are well described (e.g., AECOM 2012, FRC environmental 2019, Boobook 2021a)). An inventory of 14 native fishes; 6 turtle species, including the critically endangered White-throated Snapping Turtle (Elsey albagula) and vulnerable Fitzroy River Turtle (Rheodytes leukops); Platypus (Ornithorhynchus anatinus); and a diverse aquatic macroinvertebrate community is known to exist within the in-stream aquatic GDE habitat, where perennial flow occurs (Boobook, 2021).

6. MNES Risk Assessment

Santos have developed the CRAF to review and assess the potential risks from both geogenic (naturally occurring) chemicals and additive chemicals used in the drilling, appraisal or treatment phases of water management. The objective of the CRAF is to demonstrate that potential risks to MNES (including beneficial uses) associated with the chemicals used in coal seam gas operations have been eliminated or reduced as much as is reasonably practicable.

The CRAF assesses potential risk to MNES based on the review of the following:

- A **source** of produced water containing a hazardous chemical / contaminant[1] (the hazard)
- An MNES **receptor**(s)
- A valid **pathway** – for the source water to reach the MNES receptor(s)
- An **exposure mechanism** for uptake of a hazardous contaminant by the MNES receptor

If any one of the above source-pathway-exposure-receptor (SPER) is missing, then there is no risk to MNES. For example, if there is either no source, no MNES present, no pathway, or no exposure mechanism present then there can be no risk of adverse impact to MNES.

Based on the SPER review and CRAF process the potential exposure is categorised as either:

- **Complete exposure** – when a source, a migration pathway, an exposure for exposure and a potential receptor are present.
- **Incomplete exposure** – when any one or more of the four elements (source, pathway, exposure mechanism and receptor) that make a complete exposure pathway are not present.
- **Insignificant / low probability exposure** – where the potential risks are limited due to attenuation, fate and transport mechanisms, infrequent exposure occurrence, and / or minimal projected chemical concentrations at the point of exposure (i.e. there is no hazard).

For MNES values to be included in the risk assessment process there must be:

- the potential for MNES values to be present (receptor) and an exposure pathway to the chemical additive(s) from an authorised activity, or
- the potential for MNES values to be present (receptor) and an exposure pathway to media (soils or water resources (surface or groundwater)) affected by an authorised activity.

For a non-MNES value(s) to be included in the risk assessment there must be:

- an MNES water resource (surface water and / or groundwater) affected or potentially affected by chemical additive(s) from an authorised gas extraction activity, and
- a complete or potentially complete exposure pathway to the non-MNES receptor.

The following sections describe the potential sources, MNES receptors and pathways.

6.1. Produced water – Hazards

Produced water from each development area in the GLNG Project is gathered and transferred to water management facilities. Based on the activities described in Section 3, the following produced water sources have been identified:

- Water stored in storage dams listed in Table 2, Table 3 and Table 4.
- Water in pipelines as described in Section 3.1.
- Water applied to irrigation areas described in Section 3.5.
- Water applied to engineered surfaces during construction and dust suppression.
- Desalinated water (permeate) releases to surface waters described in Section 3.6.

[1] The Queensland *Environmental Protection Act (1994)* defines a hazardous contaminant as: a contaminant, other than an item of explosive ordnance, that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause serious or material environmental harm because of—
(a) its quantity, concentration, acute or chronic toxic effects, carcinogenicity, teratogenicity, mutagenicity, corrosiveness, explosiveness, radioactivity or flammability; or
(b) its physical, chemical or infectious characteristics.

6.1.1. Conceptual Exposure Model

The following section describes potential migration pathways or mechanisms for produced water that may facilitate an exposure to a receptor (if present). These migration mechanisms will be carried into the exposure assessment below.

6.1.1.1. Water Storages

Water storages are engineered structures with liners (refer to Table 2, Table 3, Table 4) designed to contain produced water in accordance with State Environmental Authority requirements. Potential pathways, exposure mechanisms and receptors are summarised in Table .

Table 15: Potential pathways, exposure mechanisms and receptors for Water Storage sources

Pathway	Exposure Mechanism	Receptor
Subsurface vertical migration beneath the dam	Groundwater discharge to surface soil (discharge zone) and direct uptake by roots of flora Groundwater discharge to watercourse (ephemeral &/or perennial) and uptake by fauna & flora Direct discharge following failure to watercourse (ephemeral &/or perennial) and uptake by fauna & flora	Shallow groundwater aquifer Adjacent and down gradient flora and fauna Adjacent and down gradient flora and fauna – including MNES if present and mapped
Subsurface horizontal migration along a zone of lower permeability beneath the dam		
Surface flow or run-off down topographic gradient from a failure to contain (walls of the storage or over topping)		

For the purpose of this assessment all above migration pathways will be considered potentially complete.

6.1.1.2. Water Pipelines

Water pipelines are pressurised transport conduits to convey water from one location to another. They are buried (except at surface facilities). Given that pipelines are buried and under pressure, should releases occur, the water moves from an area of high pressure to low pressure via the path of least resistance. This results in the water migrating to the surface whereby it can undertake surface flow. Should the release volume / rate be limited then the expression of water may be visible as a wetted area.

Potential pathways, exposure mechanisms and receptors for a water pipeline source are summarised in Table .

Table 16: Potential pathways, exposure mechanisms and receptors for Water Storage sources

Pathway	Exposure Mechanism	Receptor
Subsurface vertical migration beneath the pipeline	Groundwater discharge to surface soil (discharge zone) and direct uptake by roots of flora Groundwater discharge to watercourse (ephemeral &/or perennial) and uptake by fauna & flora Direct discharge following failure to watercourse (ephemeral &/or perennial) and uptake by fauna & flora	Shallow groundwater aquifer Adjacent and down gradient flora and fauna Adjacent and down gradient flora and fauna – including MNES if present and mapped
Subsurface horizontal migration along a zone of lower permeability beneath the pipeline		
Surface flow or run-off down topographic gradient from a pipeline failure		

For the purpose of this assessment all above migration pathways will be considered potentially complete.

6.1.1.3. Irrigation

Irrigation aims to apply water in balance with crop demand in consideration of infiltration capacity, climatic conditions and soil quality objectives. Potential pathways, exposure mechanisms and receptors for an irrigation source are summarised in Table .

Table 17: Potential pathways, exposure mechanisms and receptors for an Irrigation Source

Pathway	Exposure Mechanism	Receptor
Subsurface vertical migration beneath the irrigation area (where application is greater than flora uptake – i.e. unbalanced irrigation)	Groundwater discharge to surface soil (discharge zone) and direct uptake by roots of flora Groundwater discharge to watercourse (ephemeral &/or perennial) and uptake by fauna & flora Direct discharge to watercourse (ephemeral &/or perennial) and uptake by fauna & flora	Shallow groundwater aquifer Adjacent and down gradient flora and fauna– including MNES if present and mapped Adjacent and down gradient flora and fauna – including MNES if present and mapped
Subsurface horizontal migration along a zone of lower permeability beneath the irrigation area (where application is greater than flora uptake)		
Surface flow or run-off down topographic gradient from an irrigation where irrigation rate is greater than soil and crop capacity		

For the purpose of this assessment all above migration pathways will be considered as potentially complete under conditions where the application rate may not be balanced and thus generating excess water to migrate either via groundwater or as surface runoff. Irrigation rates are required to be balanced to maintain optimal soil conditions for crop and tree growth and over application of irrigation water is unlikely due to saturated soil conditions damaging crops.

6.1.1.4. Construction and dust suppression

Dust suppression aims to minimise dust generation during construction activities at a given location and / or during vehicle movements between locations. Water is applied to the surface using spray equipment. In accordance with Environmental Authority conditions no pooling or run-off is permitted during dust suppression activities, limiting the applicable pathway, exposure mechanism and receptor to that summarised in Table .

Table 18: Potential pathways, exposure mechanisms and receptors for a Dust Suppression Source

Pathway	Exposure Mechanism	Receptor
Surface flow or run-off down topographic gradient from a dust suppression area	Indirect secondary discharge to watercourse (ephemeral &/or perennial) and uptake by fauna & flora	Surface flow or run-off down topographic gradient from a dust suppression area

However, given the short duration of the activity and that no pooling of water is authorised, subsurface vertical or horizontal migrations are not considered a complete migration pathway and will not be considered further.

Although surface run-off is also not authorised under the State EA, it will be retained as a potentially complete migration pathway for the purpose of the assessment due to the potential proximity of MNES to dust suppression activities.

6.2. Stimulation – Hazards

Based on the activities described in Section 4, the following sources have been identified:

- Unrecoverable stimulation fluid liquid lost in far reaching fractures.
- Water applied to irrigation areas described in Section 3.5.
- Water applied to engineered surfaces during construction and dust suppression.

6.2.1. Conceptual Exposure Model

The following section describes potential migration pathways or mechanisms for stimulation fluid that may facilitate an exposure to a receptor (if present). These migration mechanisms will be carried into the exposure assessment below.

It is assumed that stimulation fluid may remain in the coal seam following fracturing. Exposure may occur if chemicals in the residual fluid migrate down gradient in the coal seam and into a natural spring or water supply bore in close vertical proximity to the coal seam. However, migration of organic fracturing fluid chemicals in the coal seams is strongly attenuated by sorption to the carbon in the coal. In addition, the zone of stimulation is less than 100 m, and all aquifers are identified within and beyond this zone.

6.3. Potential complete exposure pathways

Source, migration pathway and receptor assessments have identified the specific potential pathways in each development area that have the potential to transmit produced water sources to MNES receptors. The sub-sections below describe those potentially complete exposure pathways for each relevant project activity.

Where a source, receptor and a potentially complete or incomplete exposure pathway is identified, then further assessment is undertaken to determine whether there is a risk of significant adverse impact to a MNES receptor. Mitigation measures are then identified to manage such risk.

Monitoring actions are then assigned to assess the effectiveness of mitigation controls and assign triggers for further actions as required.

Both monitoring and management actions are described in the following sections.

6.3.1. Irrigation activities

Potential migration pathways, exposure mechanisms and potential receptors for irrigation activities are indicated in Table . Potentially complete pathways are detailed in the sections below.

6.3.1.1. Roma

At Roma, the potentially complete pathways associated with irrigation activities include:

- Brigalow TEC – Some minor areas of Brigalow TEC occur down topographic gradient of the Bend South Pivot and west of the Roleen Pivots. In accordance with regulatory approvals, irrigation application rates must be managed to ensure irrigation water infiltrates the ground and the risk of run-off is minimised. However, for this purpose of this assessment the exposure pathway is considered as potentially complete.
- Blyth Creek and associated wetlands located ~100m from the Bend South Irrigation area. Given the presence of drainage features in proximity to the irrigation area, this pathway is considered as potentially complete.
- The Mooga Sandstone aquifer located approximately 20m below the Bend South irrigation area. Given the duration of irrigation activities and the vertical distance to the water table, this pathway is considered as potentially complete.

6.3.1.2. Fairview

At Fairview, the potentially complete pathways associated with irrigation activities include:

- Vegetation mapped as RE 11.9.4 Semi-evergreen vine thicket or Acacia harpophylla with a semi-evergreen vine thicket understorey on fine-grained sedimentary rocks within close proximity and downgradient of the IR8 and IR4 irrigation pivots. In accordance with regulatory approvals, irrigation application rates must be managed to ensure irrigation water infiltrates the ground and the risk of run-off is minimised. However, for this purpose of this assessment the exposure pathway is considered as potentially complete.
- Springs (aquatic GDEs) associated with Hutton Creek – the source aquifer (Precipice Sandstone) is hydraulically isolated from the irrigation areas through the presence of the Evergreen aquitard. This exposure pathway is incomplete.
- Hutton Creek and associated wetlands – irrigated water runoff is considered a potentially compete exposure pathways to Hutton Creek in the areas down-gradient of the irrigated plateaus.
- Boxvale Sandstone aquifer, located on the peripheries of the irrigated areas along the escarpment ridgelines. The strong fracture networks observed in outcrop indicates that this pathway is potentially complete.

- Precipice Sandstone aquifer, present along the base of the Hutton Creek valley floor. As described above, this aquifer is hydraulically isolated from the irrigation areas through the presence of the Evergreen aquitard. This exposure pathway is incomplete.

6.3.1.3. Arcadia

At Arcadia, the potentially complete pathways associated with the Bottle Tree Irrigation Area include:

- Some minor areas of Brigalow TEC occur 2 km west and down gradient of the Bottle Tree irrigation area. Given the distance to this TEC, the exposure pathway is incomplete.
- The nearest spring occurs approximately 16km to the west of the irrigation area. This permanent spring (705-Spring Creek) is sourced from the Clematis Sandstone, which is hydraulically isolated from the irrigation area by the Rewan Formation. This exposure pathway is incomplete.
- There are no GAB or Bowen Basin aquifers in hydraulic connection with the Bottle Tree Irrigation Area. This exposure pathway is incomplete.
- There is one existing water supply bore within 5km of the site (RN158164) which taps the Rewan Formation aquitard. There are four Santos dam seepage monitoring bores that tap the Rewan Formation aquitard to the northeast of the irrigation area. Given that the Rewan Formation is a tight regional aquitard (OGIA, 2019), this exposure pathway is incomplete.
- There are no surface spring ecosystems, watercourse springs, or subterranean GDE areas within 5km of the irrigation area. This exposure pathway is incomplete.

6.3.2. Dust suppression and construction activities

6.3.2.1. Roma

At Roma, the potentially complete pathways associated with dust suppression and construction activities include:

- Brigalow TEC – A potentially complete exposure pathway may exist should engineered surfaces, construction or dust suppression activities occur in proximity to a TEC. Location selection would be in accordance with the Constraints Planning Protocol.
- Blyth Creek - Given the presence of drainage features, this pathway is considered as potentially complete.
- The Mooga Sandstone aquifer – given depth to groundwater, limited duration and typical volume of application, this pathway is not considered complete.

6.3.2.2. Fairview

At Fairview, the potentially complete pathways associated with dust suppression and construction activities include:

- Springs associated with Hutton Creek – the source aquifer (Precipice Sandstone) is hydraulically isolated from roads and construction areas situated on the elevated plateaus through the presence of the Evergreen aquitard. This exposure pathway is incomplete.
- Hutton Creek and associated wetlands – given the presence of drainage features this is considered as a potentially complete exposure pathway to Hutton Creek.
- Precipice Sandstone aquifer, present along the base of the Hutton Creek valley floor. As described above, this aquifer is hydraulically isolated from the elevated development areas through the presence of the Evergreen aquitard. This exposure pathway is incomplete.

6.3.2.3. Arcadia

At Arcadia, the potentially complete pathways associated with dust suppression and construction activities include:

- There are terrestrial GDEs situated within select locations of the Arcadia Valley. These are Quaternary alluvial aquifers with a fresh, intermittent groundwater connectivity regime. Given the presence of drainage features this considered a potentially complete exposure pathway to these terrestrial GDEs.

- There are two threatened flora species are known to occur within the project area and on Bottle Tree property. Ooline (Cadelia pentastylis) and Xerothamnella (Xerothamnella herbacea) occurs within select locations the valley including riparian areas. Given the presence of drainage features this is considered a potentially complete exposure pathway.
- Brigalow and the TEC 'Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar' are present within select locations of Arcadia. Given the presence of drainage features this is considered a potentially complete exposure pathway.

6.4. Releases to Watercourses – Fairview

As described in Section 3.6, to release desalinated water (permeate) to the Dawson River, the water travels through a number of steps:

- a water pipeline transfers the desalinated water to an outlet diffuser release point located at the upper limit of an ephemeral drainage feature.
- down a partially rock armoured ephemeral drainage feature before discharging into a waterhole.
- From the waterhole, naturally discharging via a watercourse into the Dawson River.

The complete exposure pathways associated with desalinated releases to surface water are to aquatic ecosystems of the Dawson River which includes MNES freshwater turtles. Since released desalinated water and produced water would become part of the regional surface water (i.e., Dawson River water quality and flow), aquatic ecological species (including MNES freshwater turtles) within Dawson River downstream of the release point are considered potential receptors.

Potential pathways, exposure mechanisms and receptors for desalinated water releases are summarised in Table .

Table 19: Potential pathways, exposure mechanisms and receptors for Authorised releases treated water

Pathway	Exposure Mechanism	Receptor
Surface flow or run-off down topographic gradient	Direct uptake from water column via respiration (gills and cloacal respiration), ingestion, and dermal contact by aquatic organisms via gills (and cloacal respiration) including macrobenthos and shallow alluvial stygofauna. Indirect uptake from water column via food ingestion. Direct uptake by partially and fully immersed and suspended flora. Direct ingestion by stock animals Direct and indirect ingestion by human consumers	Riparian flora and fauna– including GDE, MNES and stygofauna if present and mapped within area Shallow alluvial aquifers and geological aquifers (where permeability is sufficient or piezometric pressure allows) Agricultural stock drinking directly from water storages or rivers, or from abstracted water from watercourses or shallow alluvial aquifers (where a licensed bore is present) Human consumers of surface water or shallow alluvial groundwater for potable and domestic uses
Baseflow loss to hyporheic zone and shallow alluvial and geological aquifers		
Baseflow loss to hyporheic zone and/or shallow alluvial aquifer and subsurface horizontal migration in shallow aquifer along a zone of lower permeability		
Vertical migration to shallow geology	Vertical migration to shallow geological units where permeability and/or fracture flow permits or groundwater piezometric pressure allows	

For the purpose of this assessment all above migration pathways will be considered as complete. Desalinated water is required to meet drinking water standards under the State Environmental Authority.

7. Measures to Avoid, Mitigate and Manage Adverse Impact

Section 7.1 outlines Santos GLNG's constraints planning process. This describes how the planning process which locates project activities, including those related to the production, storage and disposal of CSG produced water during the life of the project, avoids adverse impact to ecologically sensitive areas. Ecologically sensitive areas include habitats that may support EPBC threatened species, EPBC migratory species and EPBC communities.

- Section 7.2 provides information specific to the production, storage and disposal of produced water during the life of the project at Roma, Arcadia and Fairview. In summary, that section:
  - Describes the various mechanisms and processes by which an adverse impact to a water resource may occur without adequate management controls in place as a result of various actions;
  - References the existing documentation that provides further information on how the risk of adverse impact has been assessed; and
  - Provides a justification for the measures that will be implemented to avoid, mitigate and manage impacts to surface and groundwater resources.

7.1. Constraints to development

All project activities listed in Section 3 have considered hazards to groundwater resources, EPBC threatened species, EPBC migratory species and EPBC communities. For these hazards to pose a risk to MNES, a source, a migration pathway, a mechanism of exposure and a MNES receptor must be present.

The Santos GLNG constraints planning process follows the approved Environmental Protocol for Constraints Planning and Field Development (available on the Santos website). Constraints planning provides a mechanism for avoidance and then minimisation of potential risks MNES through location selection, without the need for further mitigation or management.

The need for additional mitigation and management of activities in the following location section is determined after the application of the avoidance measures based on the evaluation of exposure pathways to an MNES receptor.

7.2. Determination of measures

This section provides information specific to the storage and disposal of produced water during the life of the GLNG project at Roma, Fairview and Arcadia. These focus on avoiding uncontrolled releases of water and the planned discharges of treated produced water to surface water.

Section 6, Table to Table 23 present a summary of the potential produced water management actions which without management controls in place, may pose a significant risk of adverse impact to MNES including water resources. It describes the various mechanisms and processes by which water may be released.

Table to Table 23 then reference supporting documentation that can provide further information on how the risk of significant adverse impact has been assessed. The supporting documents justify the proposed measures that will be implemented to avoid, mitigate and manage impacts to MNES receptors.

7.2.1. Water storages

The storage dams described in Table 2, Table 3 and Table 4 include the following controls and monitoring requirements:

- Mandatory hydraulic performance engineering standards as defined by the Queensland Government to manage containment;
- Leak detection systems and / or seepage monitoring bores to demonstrate containment and to the risk of seepage to both groundwater and the surface environment;
- Annual engineering inspections by a Registered Professional Engineer Queensland (RPEQ) to demonstrate that the dam is performing as designed; and

- Maximum operating limits and mandatory reporting limits to manage the risk over topping.

Early warning, trigger thresholds and limits for detecting impact on surface water and groundwater resources due to the operation of produced water storage dams are specified under the respective State Environmental Authority and provided in Section 8. A risk-based exceedance response plan is presented in Section 9.

7.2.2. Irrigation

In Queensland, criteria for irrigation water quality are defined in *End of Waste Code – Irrigation of Associated Water (including coal seam gas water)* (DETSI, 2025). This provides general approval conditions for resource producers and users issued in accordance with the Queensland Waste Reduction and Recycling Act (2011) (WRR Act). These criteria determine minimum standards that must be achieved by water management activities to avoid environmental impact and reflect the same standards that are applied to primary industries that may use any groundwater (i.e. from water bearing strata, including coal seams) for the same purpose. These criteria are adopted or derived in accordance with ANZG (2018) and ANZECC (2000).

Where a generic standard for a particular water quality parameter cannot be met, an End of Waste Code Resource Monitoring and Management Plan (RMMP) is required. An RMMP:

- is provided to the administering authority and must be certified by an independent and suitably qualified person;
- states the extent to which the water quality does not meet the generic required standard;
- states the varied water quality parameters (for the parameters that do not meet the required standards) that facilitates;
    - soil structure, stability and productive capacity can be maintained or improved;
    - toxic effects to crops do not result; and
    - yields and produce quality are maintained or improved.

RMMPs have been produced for each of the irrigation areas described in Section 3.5. Monitoring of irrigation water quality, soil structure and chemistry, crop health and soil infiltration rates is specified in that RMMP.

Deep drainage refers to the infiltration of irrigation water beneath the shallow soil layer effectively utilised by the irrigated crop. Hydrogeological risk assessments (referenced in Section 11) assess the risk of subsurface migration of irrigation water where deep drainage occurs in a respective project area. They assess that subsurface migration pathways to water resource receptors may be present such as land uses, terrestrial GDEs, aquatic GDEs, aquifers, registered water supply bores, springs (including GAB springs) and terrestrial receptors.

Hydrogeological risk assessment reports for Roma and Fairview have concluded that the risk of vertical and horizontal migration is very low and can be managed through irrigation management and monitoring. A hydrogeological risk assessment is not required for Arcadia because the presence of the Rewan Formation aquitard throughout the Arcadia Valley nullifies the migration risk of subsurface irrigation water in this area, i.e. there is no complete pathway to assess.

For irrigated areas in the Roma development, under a conservative modelled irrigation scenario, irrigation water is expected to largely remain within the vadose zone and not migrate laterally more than 50 m laterally. This can be readily demonstrated through shallow groundwater monitoring throughout the life of the project. Should irrigation water reach the water table, the water quality approximates that of the receiving environment due to the large travel time and the dilution that occurs due to rainfall infiltration over the period it takes to reach groundwater. In most irrigation areas this period is more than 1000 years. For the northern-most pivots in the Bend South Irrigation area (Pivots 4 and 5), the period it takes to reach the water table is more than 100 years.

For irrigated areas in the Fairview development, salinity modelling through the vadose zone concludes that the risk of irrigation-induced deep drainage contributing salinity to the Boxvale Sandstone aquifer is very low. The migration of dissolved salts to groundwater may take decades to hundreds of years (based on solute transport modelling), and the salt flux will be small compared to the existing salt content in the boxvale aquifer.

Although no environmental receptors are predicted to be, or at risk of being impacted, monitoring is proposed to verify the report findings, demonstrate environmental outcomes and to inform adaptive management, if required.

7.2.3. Operational re-use of coal seam water

Assessment of complete pathways for operational water beneficial re-use is presented in Section 6.3.2. The State EA specifies that dust suppression water is not permitted to be applied at a rate that pools.

To manage this risk, Santos will not undertake dust suppression activities within or adjacent to watercourses. Further, the Constraints Planning Protocol avoids project activities, including dust suppression within or adjacent to areas of wetlands, including all springs.

Early warning, trigger thresholds and limits for detecting impact on surface water (and shallow groundwater at these locations) due to the suppression of dust on roads using coal seam water are provided in Section 8. A risk-based exceedance response plan is presented in Section 9.1.

7.2.4. Releases to Watercourses

Direct releases of treated water to a watercourse only occurs in the Fairview project area from reverse osmosis plant number 2 (ROP2). Treated water releases are managed and mitigated in accordance with the EPBC 2021/8914 Notification of approval (EPBC 2021/8914, refer Appendix B). The federal approval EPBC 2021/8914 requires treated water discharged from the ROP2 to avoid harm to protected matters as a result of the action.. Releases to receiving waters is also designed to ensure the applicable Water Quality Objectives (WQOs), sediment quality objectives or biological objectives are met at the required monitoring point specified in the Receiving Environment Monitoring Program (REMP).

Operation of ROP 2 prioritises beneficial re-use of desalinated water to avoid release to receiving waters as required under the waste management hierarchy. This is achieved via redirecting desalinated water to forestry and crop irrigation (60%) or in operational activities such as dust suppression (10%) or is lost from water storages as evaporation (5%) or from treatment as brine (5%).

On average 20% of desalinated water generated in ROP2 is directed to intermittent release to the Dawson River. Release of water is triggered in line with the below operating philosophy, however, may change pending operational requirements:

1. The above beneficial re-uses are not available; and/or
2. Water levels in the desalinated water balance pond reach up to 90% to 95% design storage capacity.

Once triggered, a desalinated water release to the Dawson River occurs via:

- Transferred via a 5.3 km pipeline to a release point located at the upper limit of an ephemeral drainage feature and released to a fenced, rock-lined outlet via a diffuser;
- The released desalinated water flows for 2.9 km down topographical gradient of an ephemeral drainage feature before discharging into a waterhole. The ephemeral drainage feature has been partially rock armoured in selected areas of identified higher potential erosion for protection from scouring; and
- Will enter the waterhole, which is a semi-permanent water body estimated to have a volume of approximately 500 ML. The waterhole naturally discharges via a 2.2 km watercourse discharging into the Dawson River midway between “Dawson’s Bend” and “Yebna Crossing”.

The EPBC 2021/8914 approval limits the daily release of desalinated water to no more than 18 ML/day. Actual release rates are based on available pump capacity and have ranged between 13.5 to 18 ML/day for between 87 and 156 days per year depending on prevailing climate conditions and beneficial re-use.

The following sections describe the monitoring measures which are undertaken to assess, manage and mitigate potential impacts associated with desalinated water releases.

7.2.4.1. Monitoring Locations

The EPBC 2021/8914 approval (refer Appendix B) conditions the water quality characteristic limits for water released from ROP2 via the release pipeline connected to HCS04DWB1 monitoring location as specified in Table 20. The EPBC 2021/8914 also requires a REMP to be implemented for receiving waters “*Specifically, the REMP provides for water quality and aquatic ecological monitoring to ensure early detection of any potential direct or indirect water quality impacts to threatened aquatic species listed under the EPBC Act, that may be caused by the release of desalinated produced water”*.

The Dawson River Desalinated Release REMP (refer Appendix C) includes a number of sampling locations that includes upstream reference/control locations, and downstream assessment locations. Refer to Appendix C, Table 7.1 for a full list of locations.

Table 20: EPBC 2021/8914 Release Water Quality Compliance Location

Monitoring location Name	Longitude	Latitude
HCS04DWB1	149.090	-25.730

7.2.4.2. Monitoring Parameters and Frequency

A baseline assessment to be undertaken *"…to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised activity(ies), and must include periodic monitoring for the effects of the discharge on the receiving environment (under natural flow conditions) as a result of contaminant releases to waters from the site."*

Baseline monitoring was conducted over seven bi-annual events between August 2013 to January 2015 to establish local catchment specific reference conditions prior to the commencement of desalinated water releases in 2015.

Baseline data collected included assessment of the following:

- hydrology - water flow and depth
- geomorphology - watercourse bed and bank condition
- water quality and sediment quality
- aquatic ecosystem biological parameters including
  - macroinvertebrates communities
  - fish communities
  - threatened turtle species, and
  - zooplankton.

Collected baseline data informed local water quality objectives (LWQO) and local biological objectives (LBO) used in the Dawson River Desalinated Release REMP (refer Appendix C) based on requirements of ANZECC & ARMCANZ (2000) and ANZG (2018). Appendix C, Table 7.2 provides a summary of the REMP monitoring program including sampling frequency. Actions and responses are provided in Section 8 and 9.

Table 21: CSG water assessment methods and controls for potential impacts to MNES in Roma

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
Storage of produced water in dams	All water storages described in Table 2 and Section 3.3.	Water over-tops or leaks from dam	Overland flow to surface water resource	Change in surface water resource quality		Constraints planning protocol	- Location selection - Design in accordance with Australian Standards and State Environmental Authority conditions - Fit with water level sensor - Fit with leakage detection system
			Subsurface migration to groundwater resource	Change in ground water resource quality			
			Overland flow to flora or fauna habitat	Impact to health of flora or fauna			
Irrigation of produced water	The irrigation areas described in Section 3.5.2.	Irrigation water migrates to surface water	Overland flow of irrigation water to surface water resource	Change in surface water quality	- Water balance modelling to quantify irrigation size and inform design to manage risk of run-off (probabilistic climatic modelling and crop/water modelling, verified by suitably qualified third-party)	Constraints planning protocol End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection to ensure potential run-off is buffered by adjacent dryland cropping area - Design and control of irrigation area size and application rates to avoid run-off - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Grazing and land management practices that maintain high infiltration rates and maintain healthy plants to maximise plant water uptake
		Irrigation water migrates to a sensitive habitat	Overland flow of irrigation water to flora and / or fauna habitat	Impact to health of flora or fauna			
		Irrigation water migrates to a groundwater resource	Subsurface migration of irrigation water to groundwater resource	Change in ground water quality	- Water balance modelling and quantify size and inform design to quantify deep drainage rates - Hydrogeological risk assessment	End of Waste Code RMMPs (refer to Section 11). Irrigation Hydrogeological and Risk Assessments (refer to Section 11).	- Irrigation location selection - Design and control of irrigation area size and application rates to manage deep drainage rates - Monitoring of sub-surface migration pathways (specified in Section 6).
		Irrigation water migrates to surface water	Subsurface migration of irrigation water to surface water resource	Change in surface water quality			
		Irrigation water disperses the soil	Direct application	Impact to soil structure	- Threshold electrolyte concentration (TEC) calculation Soil chemistry modelling - Calculation of stoichiometric quantities of amendment chemicals	End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection (soil type) - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Grazing and land management practices that maintain high infiltration rates and maintain healthy plants to maximise plant water uptake
		Irrigation water disperses the soil, rainfall runoff erodes and transports sediment to a water resource	Overland flow of sediment to surface water resource	Change in surface water quality			
		Irrigation water affects crop, e.g. foliar damage, osmotic	Direct application of irrigation water	Impact to crop health - change in productivity	- Irrigation foliar studies	End of Waste Code RMMPs (refer to Section 11).	- Crop selection - Monitoring, observation and adaptive management

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
		effects or toxicity to plant health			- Soil chemistry modelling (pH, University of Queensland)		of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1])
Dust Suppression	Within all development and operational areas in the Roma area	Dust suppression water migrates to a watercourse	Direct application Run-off to adjacent area	Change in surface water quality	- Identify water resource and ecological receptors - Constraints planning protocol and location selection	Santos GLNG Upstream: Using Coal Seam Water and Liquids Management Specification	- Location selection - no direct application plus within 50m buffer of a watercourse - visual observations - no pooling of run-off
		Dust suppression water migrates to a sensitive habitat	Direct application Run-off to adjacent area	Impact to health of flora or fauna			

Table 22: CSG water assessment methods and controls for potential impacts to MNES in Fairview

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
Storage of produced water in dams	All water storages described in Table 3 and 3.3.3.	Water over-tops or leaks from dam	Overland flow to surface water resource	Change in surface water resource quality		Constraints planning protocol	- Location selection - Design in accordance with Australian Standards and State Environmental Authority conditions - Fit with water level sensor - Fit with leakage detection system
			Subsurface migration to groundwater resource	Change in ground water resource quality			
			Overland flow to flora or fauna habitat	Impact to health of flora or fauna			
Irrigation of produced water	The irrigation areas described in Section 3.5.3.	Irrigation water migrates to surface water	Overland flow of irrigation water to surface water resource	Change in surface water quality	- Water balance modelling to quantify irrigation size and inform design to manage risk of run-off (probabilistic climatic modelling and crop/water modelling, verified by suitably qualified third-party)	Constraints planning protocol End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection to ensure potential run-off is buffered by adjacent dryland cropping area - Design and control of irrigation area size and application rates to avoid run-off - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Grazing and land management practices that maintain high infiltration rates and maintain healthy plants to maximise plant water uptake
		Irrigation water migrates to a sensitive habitat	Overland flow of irrigation water to flora and / or fauna habitat	Impact to health of flora or fauna			
		Irrigation water migrates to a groundwater resource	Subsurface migration of irrigation water to groundwater resource	Change in ground water quality	- Water balance modelling and quantify size and inform design to quantify deep drainage rates - Hydrogeological risk assessment	End of Waste Code RMMPs (refer to Section 11). . Irrigation Hydrogeological and Risk Assessments (refer to Section 11).	- Irrigation location selection - Design and control of irrigation area size and application rates to manage deep drainage rates - Monitoring of sub-surface migration pathways (specified in Section 6).
		Irrigation water disperses the soil	Direct application	Impact to soil structure	- Threshold electrolyte concentration (TEC) calculation - Soil chemistry modelling - Calculation of stoichiometric quantities of amendment chemicals	End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection (soil type) - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Crop selection - Monitoring, observation and adaptive management of irrigation application rates
		Irrigation water disperses the soil, rainfall runoff erodes and transports sediment to a water resource	Overland flow of sediment to surface water resource	Change in surface water quality			
		Irrigation water affects crop, e.g. foliar damage, osmotic effects or toxicity to plant health	Direct application of irrigation water	Impact to crop health - change in productivity	- Irrigation foliar studies - Soil chemistry modelling (pH, University of Queensland)	End of Waste Code RMMPs (refer to Section 11).	

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
							to avoid run-off (see Resource Monitoring and Management Plans[1])
Dust Suppression	Within all development and operational areas in the Roma area	Dust suppression water migrates to a watercourse	Direct application Run-off to adjacent area	Change in surface water quality	- Identify water resource and ecological receptors - Constraints planning protocol and location selection	Santos GLNG Upstream: Using Coal Seam Water and Liquids Management Specification	- Location selection - no direct application plus within 50m buffer of a watercourse - visual observations - no pooling of run-off
		Dust suppression water migrates to a sensitive habitat	Direct application Run-off to adjacent area	Impact to health of flora or fauna			
Desalinated Water Release	Approved release into Dawson River	Erosion and/or inundation of turtle nesting habitat on Dawson Riverbanks	Discharge increasing base flow above natural levels	Loss of turtle habitat (potentially nest sites) through increase in river level inundating	Baseline monitoring of Dawson River and Waterhole flows. Direct measurements and assessment of releases and impacts on Dawson River flows Detailed assessment of impacts through modelling (hydrology and water quality impacts)	REMP (Appendix C) Santos monitoring results	Ongoing measurement of water release volumes at release point and monitoring changes in Dawson River, on a scheduled frequency (i.e., daily, weekly, quarterly or biannually) during release. Geomorphological and aquatic ecology assessments 2 x annually
		Sedimentation impeding turtle cloacal respiration and foraging behaviour	Discharge contains or creates elevated sediment in water column	Sediment and contaminant effects to turtle cloacal respiration and foraging behaviour: decreased efficiency in cloacal respiration	Baseline monitoring of Dawson River and Waterhole	REMP (Appendix C) Santos monitoring results	Ongoing measurement (chemistry and water release volumes) at release point and monitoring changes in Dawson River chemistry (on a scheduled frequency (i.e., daily, weekly, quarterly or biannually) during release. Geomorphological and aquatic ecology assessments 2 x annually
		Physiological impacts of geogenic and anthropogenic chemicals in the co-produced water, including detail of ecotoxicology assessments	Discharge contains elevated geogenic and anthropogenic chemicals	While turtles are air breathing, evidence indicates that water column exposure to chemicals via cloacal respiration is the most significant pathway for chemical exposure	Baseline monitoring of Dawson River and Waterhole	REMP (Appendix C) Santos monitoring results	Ongoing measurement (chemistry and water release volumes) at release point and monitoring changes in Dawson River chemistry (on a scheduled frequency (i.e., daily, weekly, quarterly or biannually) during release. Geomorphological and aquatic ecology assessments 2 x annually.

Table 23: CSG water assessment methods and controls for potential impacts to MNES in Arcadia

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
Storage of produced water in dams	All water storages described in Table 4 and 3.3.4.	Water over-tops or leaks from dam	Overland flow to surface water resource	Change in surface water resource quality		Constraints planning protocol	- Location selection - Design in accordance with Australian Standards and State Environmental Authority conditions - Fit with water level sensor - Fit with leakage detection system
			Subsurface migration to groundwater resource	Change in ground water resource quality			
			Overland flow to flora or fauna habitat	Impact to health of flora or fauna			
Irrigation of produced water	The irrigation areas described in Section 3.5.4.	Irrigation water migrates to surface water	Overland flow of irrigation water to surface water resource	Change in surface water quality	- Water balance modelling to quantify irrigation size and inform design to manage risk of run-off (probabilistic climatic modelling and crop/water modelling, verified by suitably qualified third-party)	Constraints planning protocol End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection to ensure potential run-off is buffered by adjacent dryland cropping area - Design and control of irrigation area size and application rates to avoid run-off - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Grazing and land management practices that maintain high infiltration rates and maintain healthy plants to maximise plant water uptake
		Irrigation water migrates to a sensitive habitat	Overland flow of irrigation water to flora and / or fauna habitat	Impact to health of flora or fauna			
		Irrigation water migrates to a groundwater resource	Subsurface migration of irrigation water to groundwater resource	Change in ground water quality	- Water balance modelling and quantify size and inform design to quantify deep drainage rates - Hydrogeological risk assessment	End of Waste Code RMMPs (refer to Section 11). . Irrigation Hydrogeological and Risk Assessments (refer to Section 11).	- Irrigation location selection - Design and control of irrigation area size and application rates to manage deep drainage rates - Monitoring of sub-surface migration pathways (specified in Section 6).
		Irrigation water disperses the soil	Direct application	Impact to soil structure	- Threshold electrolyte concentration (TEC) calculation - Soil chemistry modelling - Calculation of stoichiometric quantities of amendment chemicals	End of Waste Code RMMPs (refer to Section 11).	- Irrigation location selection (soil type) - Monitoring, observation and adaptive management of irrigation application rates to avoid run-off (see Resource Monitoring and Management Plans[1]) - Crop selection - Monitoring, observation and adaptive management of irrigation application rates
		Irrigation water disperses the soil, rainfall runoff erodes and transports sediment to a water resource	Overland flow of sediment to surface water resource	Change in surface water quality			
		Irrigation water affects crop, e.g. foliar damage, osmotic effects or toxicity to plant health	Direct application of irrigation water	Impact to crop health - change in productivity	- Irrigation foliar studies - Soil chemistry modelling (pH, University of Queensland)	End of Waste Code RMMPs (refer to Section 11).	

Proposed Action	Locations	Unwanted event / causal factor	Complete or potentially complete pathway to MNES receptor	Potential adverse impact	Assessment methodology	Supporting documentation	Management controls
							to avoid run-off (see Resource Monitoring and Management Plans[1])
Dust Suppression	Within all development and operational areas in the Roma area	Dust suppression water migrates to a watercourse	Direct application Run-off to adjacent area	Change in surface water quality	- Identify water resource and ecological receptors - Constraints planning protocol and location selection	Santos GLNG Upstream: Using Coal Seam Water and Liquids Management Specification	- Location selection - no direct application plus within 50m buffer of a watercourse - visual observations - no pooling of run-off
		Dust suppression water migrates to a sensitive habitat	Direct application Run-off to adjacent area	Impact to health of flora or fauna			

8. Early Warning Indicators, Trigger Thresholds and Limits for Detecting Impact

8.1. Detection of impacts from water storages and irrigation areas

Table describes the early warning indicators, triggers thresholds and limits for detecting impacts MNES within the Roma, Fairview and Arcadia project areas.

These monitoring values have been derived conservatively. For example, an exceedance of a 'limit for detecting impact' would not necessarily confer that an impact to surface water or groundwater quality and associated MNES has occurred or is likely to occur in the future. The early warning indicators, trigger thresholds and limits for detecting impact have been derived to demonstrate that the pathways to adverse impact need to be confirmed and may remain only partially or entirely incomplete.

Management responses to exceedances of trigger thresholds, as presented in Section 9, will require investigation of the potential adverse impact, relative completion of the impact pathway, and the need for possible impact mitigation or site remediation. New or modified existing management controls may also be necessary to prevent a recurrence of the trigger threshold exceedance and will be confirmed pending the application of the management response to that exceedance.

The risk-based exceedance responses which are described in Section 9 include the ability to review and revise the derivation of early warnings, trigger thresholds and limits for detecting impacts on surface and groundwater quality. This plan would be revised in accordance with Section 10 if a revision of the values is required or if a new and/or modified management control is identified as necessary.

Table 24: Proposed Early Warning, Threshold Triggers and Limits for detecting risk of impact related to management of CSG produced water across Santos GLNG

Proposed action	Unwanted event / causal factor	Migration and Exposure pathway	Potential adverse impact	Attribute to monitor	Method	Early Warning Indicator (EW) monitoring result	EW management response	Trigger Threshold (TT) monitoring result	TT management response	Limit for detecting impact
Storage of produced water in dams	Produced water over-tops or leaks from dam	Overland flow to surface water resource	Change in surface water resource quality	- Dam integrity - Dam level	- Telemetered water level readings (daily) - Inspection of leak detection system (bi-annual) - Engineering inspection of storage condition and integrity (annual)	- Water level reaches maximum operating volume(MOV) - Fluid detected in leak detection system	- Reduce volume of water stored - Fluid in leak detection system is sampled and analysed in the lab.	- Water level reaches mandatory reporting level (MRL) - Fluid analysed from leak detection system is confirmed to be produced water	- Reduce volume of water stored to safe levels - Liner repair / remedial engineering actions to reinstate integrity of liner	Water level reaches design storage limit (DSA)
		Subsurface migration to groundwater resource	Change in ground water resource quality							
		Overland flow to flora or fauna habitat	Impact to health of flora or fauna							
Land amendment irrigation of coal seam water	Irrigation water migrates to surface water	Overland flow of irrigation water to surface water resource	Change in surface water quality	- Applied irrigation volume - Land run-off	- Visual inspection of soil within the pivot, and land surface immediately adjacent to pivots (Weekly) - Measure of irrigation application volume (daily) - Refer to EMP	- Visual inspection identifies irrigation water run-off to adjacent targeted (buffer) dryland grazing areas	- Implement adaptive management (e.g. adapt irrigation volume, duration, frequency, time of day) - Continue visual monitoring to evaluate effectiveness	Visual inspection identifies: - irrigation water run-off in area outside the adjacent targeted (buffer) dryland grazing areas - changes in grazing vegetation type i.e. species adapted to wetter conditions in adjacent target (buffer) dryland areas	- Implement adaptive management (e.g. adapt irrigation volume, duration, frequency, time of day) - Increased frequency of visual monitoring to evaluate effectiveness of management - Increase extent of monitoring to include down-gradient drainage feature	Visual inspection identifies irrigation water run-off within drainage feature
	Irrigation water migrates to a sensitive habitat	Overland flow of irrigation water to flora and / or fauna habitat	Impact to health of flora or fauna							
	Irrigation water migrates to a groundwater resource	Subsurface migration of irrigation water to groundwater resource	Change in ground water quality	Groundwater along vertical migration pathway via seepage monitoring bore	Seepage detection (vertical migration pathways) via a monitoring bore located in a zone of lower permeability (i.e. >10m deep, <10m from irrigation area, or appropriate to subsurface conditions) (bi-annual)	- Groundwater detected in the monitoring bore (baseline bore condition is expected to be dry, with no groundwater present) - Monitoring bore may be used for both groundwater and surface water resource monitoring attribute and method if appropriate based on hydrogeological impact assessment.	- Continue to monitor groundwater levels in monitoring bore (biannually) - Sample groundwater and analyse for geochemical indicators (see Table 25) - Evaluate geochemical indicators via multiple lines of evidence (see Section 8.2) - Review and revise hydrogeological	Water quality analysis of seepage water verifies presence of irrigation water along pathway (see Section 8.2)	- Re-sample to confirm the result after 3 months - Report the confirmed results to the Department of Climate Change, Energy, and the Environment and Water (DCCEEW) (within 30 business days) - Review and revise hydrogeological impact assessment, if required - Assess need to implement contingency irrigation areas to	Detection of irrigation water at receptor (receptor monitoring only installed once trigger threshold exceeded) (see Table 25 and Section 8.2)
	Irrigation water migrates to surface water	Subsurface migration of irrigation water to surface water resource	Change in surface water quality	Groundwater along horizontal migration pathway via seepage monitoring bore	Seepage detection along horizontal migration pathways via multiple shallow monitoring bores (i.e. <10m deep,					

Proposed action	Unwanted event / causal factor	Migration and Exposure pathway	Potential adverse impact	Attribute to monitor	Method	Early Warning Indicator (EW) monitoring result	EW management response	Trigger Threshold (TT) monitoring result	TT management response	Limit for detecting impact
					<250m from irrigation area, or appropriate to subsurface conditions) (bi-annual).		impact assessment, if required		reduce irrigation volumes at that location - Install receptor monitoring bore(s) and commence receptor monitoring biannually (see Table 25 and Section 8.2)	
	Irrigation water disperses the soil	Direct application	Impact to soil structure	- Applied irrigation volume and water quality - Soil condition and chemistry in irrigation area	- Soil surface coring / sampling, laboratory analysis (bi-annual). - Visual inspection of soil in irrigation areas (weekly) - Refer to EMP	Visual inspection identifies soil dispersion within irrigation area	- Implement adaptive management and remedial actions (e.g. application of additional land amendment, mechanical tilling of the soil surface) - Continue visual monitoring to evaluate effectiveness	Soil surface coring / sampling and laboratory results identify surface average SAR within the irrigation area >30 and / or pH >8.4	- Implement adaptive management and remediation (e.g. application of additional amendments, and mechanical tilling of the soil surface) - Increase soil coring / sampling across irrigation area - Continue visual monitoring to evaluate effectiveness - Assess need to implement contingency irrigation areas to reduce irrigation volumes at that location	- Visual monitoring or soil surface core / sample analysis indicates significant dispersion across the irrigation area (>25% of locations)
	Irrigation water disperses the soil, rainfall runoff erodes and transports sediment to a water resource	Overland flow of sediment to surface water resource	Change in surface water quality							
	Irrigation water affects crop, e.g. foliar damage, osmotic effects or toxicity to plant health	Direct application of irrigation water	Impact to crop health	- Crop health and plant tissue condition - Soil chemistry in irrigation area	- Visual inspection of crop health (weekly) - Plant tissue sampling and laboratory analysis (annual) - Soil coring, sampling and laboratory analysis (bi-annual) - Refer to EMP	Visual inspection identifies localised indicators of plant stress	- Implement adaptive management and remedial actions (e.g. application of additional amendments, induce additional deep drainage and or alter duration, frequency or time of irrigation)	Visual inspection identifies significant indicators of plant stress (>25%)	- Investigate and identify most likely causal factor (e.g. using plant tissue results and soil sampling results) - Implement adaptive management and remediation (e.g. application of additional amendments, induce additional deep drainage and	- Visual inspection identifies significant indicators of plant stress (>50%)

Proposed action	Unwanted event / causal factor	Migration and Exposure pathway	Potential adverse impact	Attribute to monitor	Method	Early Warning Indicator (EW) monitoring result	EW management response	Trigger Threshold (TT) monitoring result	TT management response	Limit for detecting impact
									or alter duration, frequency or time of irrigation) - Assess need to implement contingency irrigation areas to reduce irrigation volumes at that location	
Dust suppression of coal seam water	Dust suppression water migrates to a watercourse	Direct application Run-off to adjacent area	Change in surface water quality	Applied surface	Visual inspection of application areas if undertaken within 200m of a watercourse.	Visual inspection - pooling or run-off	Cease application or continue application at a reduced rate.	Visual inspection – soil dispersion adjacent to roads	Assess need for and execute remediation, if required	Application of irrigation water outside of approved areas
	Dust suppression water migrates to a sensitive habitat	Direct application Run-off to adjacent area	Impact to health of flora or fauna							

Table 25: Analytes for groundwater samples collected from proposed irrigation early warning seepage bores, groundwater bores and receptor monitoring bores

Analyte	Units	Level of detection	Trigger threshold value	Indicator type
Electrical conductivity[1]	µS/cm	1	920	Receptor monitoring
Total dissolved solids (TDS)	mg/L	1	Presence of irrigation water	Geochemical Indicator / Evaluation
Major anions	mg/L	1		
Major cations	mg/L	1		
Alkalinity (bicarbonate, carbonate and total)	mg/L	1		
Aluminium*[2]	mg/L	0.01	0.027	Receptor monitoring
Boron*[2]	mg/L	0.001	0.09	
Cadmium*[2]	mg/L	0.0001	0.06	
Chromium (total)*[2]	mg/L	0.001	0.001 (0.00001)	
Copper*[2]	mg/L	0.001	0.001	
Lead*[2]	mg/L	0.001	0.001	
Manganese*[2]	mg/L	0.001	1.2	
Mercury*[2]	mg/L	0.0001	0.0001 (0.00006)	
Nickel*[2]	mg/L	0.001	0.008	
Selenium*[2]	mg/L	0.001	0.005	
BTEX[2]	µg/L	2	200	
Poly-aromatic hydrocarbons[2]	µg/L	1	2	

* Dissolved
[1] Conversion from ANZECC (*high reliability* trigger values for freshwater, Table 3.4.1)
[2] ANZECC (*high reliability* trigger values for freshwater, Table 3.4.1)

8.2. Detection of groundwater in irrigation monitoring bores

If groundwater is identified in irrigation monitoring bores, then samples will be collected and analysed for geochemical indicators show in Table . The laboratory analytical results will be assessed using geochemical evaluation methods. The purpose of this evaluation is to identify whether the sampled water comprises irrigation water or is naturally occurring in the environment using multiple lines of evidence. To achieve this, the evaluation may include analytical results from the following locations:

- Irrigation seepage bore(s);
- Background groundwater monitoring bore(s); and/or
- Other groundwater or surface water monitoring locations.

The evaluation will also consider subsurface conditions (e.g. baseline, post-baseline results and monitoring bore construction records) and the findings of the hydrogeological impact assessment. Where water is present in groundwater monitoring bores (e.g. background monitoring bores), the geochemical evaluation methods can be used to identify potentially negative changes to water quality and trends overtime. Evaluation tools used will include Stiff Plots and/or Piper Diagrams (described in sections below).

If the evaluation identifies that the water present within the monitoring bore is irrigation water, then the relevant early warning or trigger response will be initiated. If the trigger threshold management response resample confirms the presence of irrigation water along the pathway, the minister will be notified of the trigger threshold exceedance in accordance with Table 24 and Section 9.2 and receptor monitoring will commence. An environmental assessment will commence to define the receptor monitoring locations, in consideration of the subsurface conditions, and monitoring will commence biannually, post-construction of monitoring bore(s), for the receptor monitoring indicators presented in Table 25. The receptor monitoring indicators may be revised, dependent on the receptor (i.e. surface water / groundwater), in accordance with the Water Quality Management Framework (Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG), 2018).

8.2.1. Stiff plots

Similar to a Schoeller diagram, a Stiff plot can be used to compare different water quality samples and to monitor changes in water chemistry both temporally and spatially. Results are plotted in meq/L, and the polygon presented is broken up into halves. The left-hand side of the polygon plots a summary of cation data, while the right-hand side displays that of anions. As a result, these diagrams are typically used as a quick comparison of waters from different sources.

8.2.2. Piper diagram

A Piper Diagram graphically displays the nature of a water sample in terms of cations, anions and total ions, and can be used to differentiate the types of water in a given aquifer or collection of aquifers and to compare temporal, spatial and source changes (depending on zone isolation, etc.). The lower left triangle (presented on the left of the tab) summarises cations in the form of Na+ + K+, Ca2+ and Mg2+, while the lower right triangle (on the right of the display) focuses on anions in the form of SO42-, Cl- and HCO32-. The data displayed on the two cation/anion triangles are then combined, and plotted on the quadrilateral plot, displayed in the centre of the tab. Concentrations on Piper diagrams are expressed as % meq/L.

8.3. Detection of Impacts in Surface Water

Detection of potential adverse impacts to receiving waters is completed via completion of REMP monitoring as summarised in Section 7.2.4 for the elements in Appendix C, Table 7.2 and Appendix B. Assessment of collected REMP data to assess if an adverse impact is present is completed via analysis specified in Appendix F of the REMP (refer Appendix C) and is based on data analysis recommended under the ANZG (2018).

The REMP has a two-tier approach towards detecting adverse environmental impacts on the local environmental values of the aquatic ecosystem of the receiving environment, which are described in Appendix C, Section 7.1

Table 26: Proposed Early Warning, Threshold Triggers and Limits for detecting risk of impact related to management of CSG produced water across Santos GLNG

Proposed action	Unwanted event / causal factor	Migration and Exposure pathway	Potential adverse impact	Attribute to monitor	Method	Early Warning Indicator (EW) monitoring result	EW management response	Trigger Threshold (TT) monitoring result	TT management response	Limit for detecting impact
Dawson River Desalination Water Release	Erosion and/or inundation of nesting habitat; assessments	Potentially complete: release point is OUTSIDE suitable habitat for Turtles. Within the Dawson River, erosion and nest inundation are not considered a risk under baseflow conditions with actual water level increases measured at Yebna Crossing under an 18 ML/day discharge being 0.05 m	Loss of turtle habitat/nests typically 1.5 m to 2.0 m above baseflow levels	Erosion of bed and banks of river at REMP (Appendix C) monitoring locations	REMP (Appendix C) – Geomorphological assessment 2 x annually Monitoring of Dawson River levels during floods	Non-compliance with any of the local biological objectives (Table 4.6) at any receiving environment monitoring site.	REMP Tier 1: (refer Appendix C) approach would include: - a root cause review of the exceedances with appropriate corrective / preventative actions - a review of any other available information, such as non-project site specific influences, and - reporting in accordance with the FAPA EA.	Where the results of the Tier 1 approach indicate a potential impact to the receiving environment	Tier 2 (refer Appendix C) response would include: - rapidly re-sampling relevant parameters at appropriate monitoring locations to ensure the data is representative, and - response and reporting in accordance with Appendix C, Section 8.2.	6 monthly monitoring event identifies impact
	Sedimentation impeding MNES turtle cloacal respiration and foraging behaviour	Potentially Complete – desalinated water is treated and free of sediment when released	Impacts on Turtle respiration and behaviour	Elevated Sedimentation	REMP (Appendix C) – Sedimentation assessment 2 x annually	Non-compliance with any of the LWQOs for water quality (REMP, Appendix C, Section 4.4.4).	REMP Tier 1: (refer Appendix C) approach would include: - a root cause review of the exceedances with appropriate corrective / preventative actions - a review of any other available information, such as non-project site specific influences, and - reporting in accordance with the FAPA EA.	Where the results of the Tier 1 approach indicate a potential impact to the receiving environment	REMP Tier 2 (refer Appendix C) response would include: - rapidly re-sampling relevant parameters at appropriate monitoring locations to ensure the data is representative, and - response and reporting in accordance Appendix C, Section 8.2.	6 monthly monitoring event identifies impact
	Physiological impacts of geogenic and anthropogenic chemicals in the co-produced water, including detail of ecotoxicology assessments	Potentially Complete: CRAF includes risk assessment of geogenic chemicals	Turtle toxicity	Impacts on water quality above thresholds	REMP (Appendix C) – Chemical and biological assessment 2 x annually	Non-compliance with any of the local WQGs for water quality (REMP, Appendix C, Section 4.4.4)	REMP Tier 1: (refer Appendix C) approach would include: - a root cause review of the exceedances with appropriate corrective / preventative	Where the results of the Tier 1 approach indicate a potential impact to the receiving environment	REMP Tier 2 (refer Appendix C) response would include: - rapidly re-sampling relevant parameters at appropriate monitoring locations to ensure	6 monthly monitoring event identifies impact

Proposed action	Unwanted event / causal factor	Migration and Exposure pathway	Potential adverse impact	Attribute to monitor	Method	Early Warning Indicator (EW) monitoring result	EW management response	Trigger Threshold (TT) monitoring result	TT management response	Limit for detecting impact
							actions - a review of any other available information, such as non-project site specific influences, and - reporting in accordance with the FAPA EA.		the data is representative, and - response and reporting in accordance with Appendix C, Section 8.2	

9. Exceedance Response and Reporting

9.1. Risk-based exceedance responses

Monitoring and management controls will be implemented by Santos GLNG to manage and mitigate against the risks presented in Table to Table 23.

The monitoring and response approach outlined in Table 21 to Table 23, and justified below, is conservative in respect of detecting a change in the potential for impact far in advance of any impact actually occurring.

No significant impacts to MNES are expected. The proposed management responses are adaptive. If justified, re-assessment and revision of this monitoring and management plan may be required if new information becomes available that justifies a less conservative approach (see Section 10).

Table 24 presents the Early Warning and Trigger Threshold values and proposed management responses that comprise risk-based exceedance responses for the assessed project activities.

The following sections justify the risk-based approach to the monitoring and management. All monitoring requirements and frequency of monitoring are outlined in the relevant management documents, including the relevant State Environmental Authority, RMMP, Residual Drill Material Management Plan and Procedure, End of Waste Code(s) and this plan. Refer Section 11 for a list of supporting documentation.

9.1.1. Storage of produced water in dams

The risk-based exceedance response plan for the storage of produced water in water storage dams relies on water level monitoring and the monitoring of leak detection and / or seepage systems.

This design and operation of these storages adheres to relevant Australian standards or regulatory obligations imposed by the Queensland Government. The monitoring approach outlined ensures that leakage and overtopping is adequately managed. Furthermore, the location of these storages, being sited away from potential water resources, means the risk to water resources or other MNES due to a loss of containment is extremely low.

9.1.2. Irrigation

The risk-based exceedance response plan for irrigation produced water is complex. The various approaches that are shown in Table 24 are unique to the causal factor, migration pathway and potential adverse impact. The approaches are summarised and justified under the following headings:

- Adverse impacts due to over land migration
- Adverse impacts due to subsurface migration
- Adverse soil dispersion impacts
- Adverse impacts to crop health and yield.

9.1.2.1. Adverse impacts due to over-land migration

The risk-based exceedance response plan for the irrigation of produced water, in respect of the risk of produced water migration to water resources via overland flow, relies on monitoring of application rates and visual inspection of the pivot areas and its surrounds.

An observational approach to the management of irrigation water at, or immediately adjacent to the irrigation areas, will directly prevent the loss of irrigation water and risk of migration to receptors via surface run-off. This approach recognises that many factors combine to affect soil infiltration rates, for example antecedent rainfall, crop condition, temperature and humidity, and so an adaptive and observational approach to application rates is both practical and reliable.

9.1.2.2. Adverse impacts due to subsurface migration

The risk-based exceedance response plan in respect of subsurface migration of irrigation to both groundwater and surface water resources, depends on groundwater monitoring.

This approach is justified by the findings of the hydrogeological risk assessments (see Section 11). These reports show that the risk to water resources due to subsurface migration of irrigation water is low because:

- the horizontal migration pathway to surface water resources is incomplete (i.e. the rate and duration of application is not sufficient enough to allow irrigation water to migrate more than around ~50m (Roma) to ~200m (Scotia) from the irrigation areas over 30 years).
- the rate of vertical migration will be so slow that the potential impact to groundwater resource quality is mitigated by the exceedingly slow rate of release of irrigation water towards groundwater.
- the top of the first groundwater resource is encountered at depth greater than 10m at Fairview, 20m at Roma and 60m at Scotia. Groundwater aquifers are not present in the Arcadia Valley where Bottle Tree Irrigation Area occurs.

This approach is conservative in respect of managing potential impacts to water resources because:

- The detection of irrigation water along either the vertical or horizontal pathways is not expected throughout the life of the project due to irrigation design and irrigation management.
- Early detection of irrigation water in these groundwater piezometers can derive and inform adaptive management response that may result in more information becoming available that may justify an amendment to the hydrogeological impact assessment (see Table). New information that may justify an amendment of this plan might include (see Section 10):
  - a review of the hydrogeological risk assessment (e.g. validation of the modelled condition using the observed condition) and, if necessary, a revision of the risk assessment and this plan (in accordance with commitments in Section 10).
  - the installation of monitoring locations further afield, i.e. to confirm the extent that irrigation has migrated vertically or horizontally, or
  - an alteration of irrigation practices the effect of which may continue to be monitored in the currently proposed monitoring locations.

9.1.2.3. Adverse soil dispersion impacts

The risk-based exceedance response plan for irrigation in respect of adverse impacts due to soil dispersion, depends on the visual inspection and a periodic laboratory testing of the soil chemistry.

This approach is justified by the RMMPs (references provided in Section 11). These reports describe the expected attributes of both the irrigation water and the soil. They derive a methodology for ensuring the stability of the soil is maintained throughout the life of the project. The approach requires the application of established agricultural principles and practices.

9.1.2.4. Adverse impacts to crop health and yield

The risk-based exceedance response plan for irrigation in respect of adverse impacts to crop health and yield, depends on the visual inspection of the crop condition and periodic laboratory testing of plant tissue and soil chemistry.

This approach is justified by the RMMPs (full references provided in Section 11). These reports describe the expected attributes of both the irrigation water and the soil. They derive a methodology for ensuring the stability of the soil is maintained throughout the life of the project. The approach requires the application of established agricultural principles and practices.

9.1.3. Dust suppression with produced water

The risk-based exceedance response plan for the re-use of produced water for dust-suppression activities relies on observation of the application areas by the operator, and the avoidance of application in defined areas. This includes avoiding dust suppression within or adjacent to watercourses or other MNES values.

This approach is supported by the approved Environmental Protocol for Constraints Planning and Field Development.

9.1.4. Release to Watercourses

Based on the analysed data as assessed under the REMP program and considering the magnitude of an exceedance, the Dawson River Desalinated Release REMP (refer Appendix C) has a two-tier approach towards detecting and responding to adverse environmental impacts on the local EV of the aquatic ecosystem. Refer to Appendix C, Section 7.1 for tier details.

Table summarises specific outcomes or the Tier 1 and Tier 2 responses for MNES Turtles.

9.2. Timeframes for management actions and reporting

The timeframe to implement the management responses to exceedances of the early warning indicators and trigger thresholds for surface water and groundwater quality is outlined in Table . Where there is an exceedance of a limit outlined in Table this will be reported to the Minister within 10 business days.

Reporting will include an assessment of the location and severity of exceedance. Santos will cease the activity associated with the exceedance if directed in writing by the Minister and where required undertake corrective actions as directed. The activity will not recommence until the Minister has indicated it is able to in writing. Any external audits will be conducted as instructed by the Authority.

Table 27: Timeframes for management action and reporting

Monitoring result	Timeframe to management response	Reporting monitoring exceedances to minister
Early warning indicator exceeded	Within 30 business days	Annual report
Trigger threshold exceeded	Within 10 business days	Within 30 business days of monitoring event

Reporting that is required to meet Condition 49A e (refer Table 1) of the EPBC (2008/4059) approval will be submitted in the Annual Return.

10. Plan Amendment

In accordance with Conditions 59A and 60A of approval 2008/4059 issued under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Santos GLNG is required to revise this management plan when:

- Additional activity (or action) is proposed relating to the management of CSG water that would have a new and increased impact on a protected matter.
- A written request is received from the Minister requiring that the CWMMP be revised or amended.

11. Supporting documentation

- ANZECC and ARMCANZ Water Quality Guidelines, Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000
- 0007-650-PLA-0007_Environmental Protocol for Constraints Planning and Field Development – GFD (Santos, 2016)
- End of Waste Code Irrigation of Associated Water (including coal seam gas water) (ENEW07546918) Waste Reduction and Recycling Act 2011 (DETS 2025) and Resource Monitoring and Management Plans (RMMPs) required under code:
  - 1724-220-EMP-0001 RMMP: Bottle Tree Irrigation Area
  - 0027-220-EMP-0001 RMMP: AWAF1
  - 1704-220-EMP-0001 RMMP: Pleasant Hills
  - 4120-220-EMP-0001 RMMP: Kia Ora

  - 6317-220-EMP-0001 RMMP: PL 92 & PL 100 LAI / IR3,4,5(2),6(3)
  - 6367-220-EMP-0001 RMMP: IR8 LAI
  - 7601-220-EMP-0001 RMMP: RM07-03
  - 7667-220-EMP-0001 RMMP: The Bend South
  - 7667-220-EMP-0001 RMMP: Belbri East
  - 7691-220-EMP-0001 RMMP: Roleen.
  - 7608-220-EMP-0001 RMMP: Tantatton
  - Irrigation Hydrogeological and Risk Assessments:
- Santos Pleasant Hills LAI Landscape Salinity Risk Assessment. Golder, August 2016.
- Bend South Irrigation Hydrogeological Risk Assessment, Santos GLNG. Golder, July 2018
- Belbri Irrigation Hydrogeological Risk Assessment, Santos GLNG. Golder, July 2018.
- Fairview Irrigation Hydrogeological and Landscape Salinity Risk Assessment, Santos GLNG. Golder, January 2020
- Surat Underground Water Impact Report (UWIR) for the Surat Cumulative Management Area (Queensland Office of Groundwater Impact Assessment (OGIA 2021)
- Chemical Risk Assessment Framework (CRAF), Santos Gas Field Development Project, EPBC 2012/6615, Version 1, April 2021 (Santos 2021).
- Coal Seam Gas - Joint Industry Framework (JIF) - Managing impacts to groundwater resources in the Surat Cumulative Management Area under EPBC Act approvals. Endorsed by the Department of Agriculture, Water and the Environment on 17 March 2021
- Environmental Authority EPPG00928713 (Fairview Arcadia Project Area)
- Environmental Authority EPPG00898213 (Roma Shallow Gas Project Area)
- Environmental Authority EPPG00662213 (Roma Shallow Gas Project Area East)
- ST01 - Emergency and Crisis Management Procedure (Santos 2017)
- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ 2000; ANZG 2018)
- Monitoring and Sampling Manual 2009, Environmental Protection (Water) Policy 2009 (EHP 2013a)
- AS 3778.3.1 Measurement of Flow in Open Channels
- Sustainable Rivers Audit physical habitat methodology (MDBC 2004b) × Australian / New Zealand Standard AS5667.1 Water Quality – Sampling
- AS/NZ5667.12 Guidance on Sampling of Bottom Sediments × Handbook for Sediment Quality Assessment (Simpson et al. 2005)
- Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual (DNRM 2001)
- Environmental Contingency and Emergency Response Plan (0007-650-EMP-0029)

Appendix A: Coal seam water quality

Table A-28: Water quality composition of Walloon Coal Measures in the Roma Area

Analyte	Dissolved or total	Limit of detection	Min.	P10	Median	P90	Max.	Sample count
Boron (mg/L)	T	0.05	0.08	0.4	0.58	1.09	4.68	1079
Calcium (mg/L)	D	1	1	3	5	15	84	1462
Chloride (mg/L)	N/A	1	92	508.1	795	2520	4490	1462
Electrical Conductivity @ 25°C (µS/cm)	N/A	1	1300	2960	3970	8572	13100	1459
Fluoride (mg/L)	N/A	1	0.7	1.8	2.6	3.4	7.9	1089
Magnesium (mg/L)	D	1	1	1	1	4	10	1462
pH – Lab	N/A	0.01	7.84	8.35	8.63	8.832	9.23	489
Potassium (mg/L)	D	1	1	6	18	46	80	1459
Sodium (mg/L)	D	1	296	665	880	1882	3160	1459
Sodium Adsorption Ratio-	N/A	0.01	59.3	90.1	105	128	238	398
Strontium (mg/L)	T	0.001	0.574	0.9292	2.35	2.414	2.43	3
Sulfate as SO4 2 (mg/L)	D	1	1	1	1	1	28	1462
Total Dissolved Solids (Calc.) (mg/L)	T	10	845	1718	2280	3020	4760	269

Table A-29: Water quality composition of Walloon Coal Measures in the Fairview Area

Analyte	Dissolved or total	Limit of detection	Min.	P10	Median	P90	Max.	Sample count
Boron (mg/L)	T	0.05	0.05	0.79	1.41	7.67	16.1	417
Calcium (mg/L)	D	1	1	1	6	24	154	425
Chloride (mg/L)	N/A	1	1	97.6	984	2884	8140	417
Electrical Conductivity @ 25°C (µS/cm)	N/A	1	30	1880	5760	12600	27000	451
Fluoride (mg/L)	N/A	1	0.1	1.3	3.5	8.2	11.1	419
Magnesium (mg/L)	D	1	1	1	1	4	10	425
pH – Lab	N/A	0.01	6.72	7.306	8.34	8.68	9.33	169
Potassium (mg/L)	D	1	1	2.6	7	44	77	417
Sodium (mg/L)	D	1	1	444.6	1270	2894	6040	417
Sodium Adsorption Ratio-	N/A	0.01	58.3	78.35	104	203	206	26
Strontium (mg/L)	T	0.001	0.413	0.5527	1.1115	1.6703	1.81	2
Sulfate as SO4 2 (mg/L)	D	1	1	1	1	3	125	419
Total Dissolved Solids (Calc.) (mg/L)	T	10	1460	1622	2040	2632	2830	10

Table A-30: Water quality composition of Walloon Coal Measures in the Arcadia Area

Analyte	Dissolved or total	Limit of detection	Min.	P10	Median	P90	Max.	Sample count
Boron (mg/L)	T	0.05	1.79	1.842	2.135	3.576	3.74	12
Calcium (mg/L)	D	1	10	11.4	17	22.9	25	12
Chloride (mg/L)	N/A	1	1210	1354	2215	3293	4100	12
Electrical Conductivity @ 25°C (µS/cm)	N/A	1	6670	7059	8880	11360	13000	12
Fluoride (mg/L)	N/A	1	1.9	1.97	3.65	6.07	6.5	12
Magnesium (mg/L)	D	1	1	1.1	2	3.9	5	12
pH – Lab	N/A	0.01	7.58	7.636	8.23	8.651	8.71	24
Potassium (mg/L)	D	1	13	16.2	21	28.7	45	12
Sodium (mg/L)	D	1	1660	1784	2125	2652	3030	12
Sodium Adsorption Ratio-	N/A	0.01	114	120.1	131.5	143.4	148	12
Strontium (mg/L)	T	0.001	1.7	2.112	2.815	4.016	4.91	12
Sulfate as SO4 2 (mg/L)	D	1	1	1	1	1	1	12
Total Dissolved Solids (Calc.) (mg/L)	T	10	-	-	-	-	-	-

Appendix B: Conditions of approval- EPBC Notification of Approval EPBC ref 2021/8914

Please Note: For the latest version please go to the DEEEEW website (http://epbcnotices.environment.gov.au/referralslist/) and search their Referral list using reference number "2021/8914"

Australian Government
Department of Climate Change, Energy, the Environment and Water

Notification of approval

Fairview Water Release Scheme, 50 km east of Injune, Queensland (EPBC ref 2021/8914)

This decision is made under section 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Note that section 134(1A) of the EPBC Act applies to this approval. That provision provides, in general terms, that if the approval holder authorises another person to undertake any part of the Action, the approval holder must take all reasonable steps to ensure that the other person is informed of any conditions attached to this approval, and that the other person complies with any such conditions.

Approved Action

person to whom the approval is granted (approval holder)	Santos TOGA Pty Ltd
ABN of approval holder	46 077 536 871
Action	To undertake controlled releases of desalinated co-produced water from the GLNG Gas Field Development (EPBC 2016/6615) to the Dawson River and tributary water courses, 50 km east of Injune, Queensland. See EPBC Act referral 2021/8914, subject to the variation of the Action accepted by the minister under section 156B on 24 November 2022.

Approval decision

decision

My decisions on whether or not to approve the taking of the Action for the purposes of each controlling provision for the Action are as follows.

Controlling Provision	Decision
Listed threatened species and communities (section 18 and section 18A)	Approved
Coal seam gas or large coal mining development with impact on water resources (section 24D and section 24E)	Approved

period for which the approval has effect

This approval has effect until 31 March 2068.

conditions of approval

The approval is subject to conditions under the EPBC Act as set out in Annexure A.

Person authorised to make decision

name and position	Declan O'Connor-Cox Branch Head Environment Assessments Queensland Branch
signature	
date of decision	10 November 2023

Annexure A

Note: Words appearing in **bold** have the meaning assigned to them at PART C – DEFINITIONS.

Part A – Conditions specific to the Action

ACTION SPECIFICATIONS

The purpose of the following conditions is to avoid **harm** to **protected matters** as a result of the Action.

1) The approval holder must ensure that all water released as part of this Action is **desalinated water.** The approval holder must ensure that all released **desalinated water** is:

   a) within the **desalinated water quality limits**,

   b) only released from the **release point**, and

   c) released at a rate of no more than 18 megalitres (ML) per day.

RECEIVING ENVIRONMENT MONITORING AND REPORTING

The purpose of the following conditions is to avoid **harm** to **protected matters** as a result of the Action.

2) The approval holder must implement the **Receiving Environment Monitoring Program** (**REMP**) from the **commencement of the Action** until at least two calendar years following the date on which the approval holder decides that no more **desalinated water** releases as part of the Action will occur. The approval holder must notify the Department of the date of the decision that there will be no more **desalinated water** releases within 20 **business days** of the date of that decision. If the approval holder has notified the Department of the date after which no more **desalinated water** releases as part of the Action will occur, the approval holder must not release any **desalinated water** as part of the Action after that date.

3) The approval holder must, within 3 months of each anniversary of the **commencement of the Action**, provide the **department** with a written report of all monitoring undertaken in accordance with condition 2 over the 12-month period ending on the most recent anniversary of the **commencement of the Action** (the reporting period). The report must be prepared in accordance with the **REMP**. The approval holder must **publish** each report on the **website** within 60 **business days** following the end of the reporting period.

4) If a **receiving environment water quality trigger** or **sediment quality trigger** occurs, the approval holder must ensure that an **investigation** commences within 2 **business days** and is completed within 10 **business days** of the detection of the trigger, to determine whether the trigger is a result of the Action.

5) If the results of any **investigation** undertaken in accordance with condition 4 cannot demonstrate that a **receiving environment water quality trigger** or **sediment quality trigger** is not a result of the Action, the approval holder must, within 2 **business days** of completion of the **investigation**, notify the **department** in writing of the detection of the trigger and include the results of the **investigation**.

6) Within 15 **business days** of notifying the **department** in accordance with condition 5, the approval holder must submit to the **department** a report which includes the following:

a) the potential extent and severity of actual and potential **harm** to **protected matters**,

b) measures taken and/or commitments to undertake corrective actions and/or procedural changes to prevent a recurrence of the trigger and/or to remedy any actual or potential **harm** to **protected matters**, and

c) a schedule of reporting and review mechanisms to demonstrate compliance with, and success of, the commitments made.

7) If the **minister** is not satisfied with a report provided under condition 3 and/or condition 6, or if the **minister** is not satisfied that implemented corrective actions and/or procedural changes will remedy, or have remedied, any actual or potential **harm** to **protected matters**, the **minister** may direct in writing that the approval holder:

a) provide specified additional data and/or evidence,

b) implement specified corrective actions and/or procedural changes at the expense of the approval holder,

c) within a timeframe specified by the **minister**, submit to the **department**, for the **minister's** written approval, an Offset Management Plan (OMP) that details how specified residual **harm** to **protected matters** as a result of the Action will be compensated for, and/or

d) pause the taking of a specified part of the Action until the **minister** subsequently advises in writing that the approval holder may resume taking the specified part of the Action.

OFFSET REQUIREMENTS

The purpose of the following conditions is to compensate for any significant residual impact to **protected matters** as a result of the Action.

8) If the **minister** requires the approval holder to submit an OMP in accordance with condition 7c, the OMP must:

a) be prepared by a **suitably qualified expert**.

b) be prepared in accordance with the **EPBC Act Environmental Offsets Policy** and the **Environmental Management Plan Guidelines**.

c) reference the **EPBC Act** approval conditions to which the OMP refers.

d) detail the residual **harm** to **protected matters** which the OMP will compensate for.

e) demonstrate how the OMP will fully compensate for the residual **harm** on **protected matters**.

f) commit to achievable ecological outcomes for the offset and timeframes for their achievement.

g) include a table of commitments made in the OMP to achieve the environmental objectives, and a reference to exactly where these commitments are detailed in the OMP.

h) detail specific, measurable and timebound management measures to achieve the ecological outcomes.

i) include a schedule of reporting and review mechanisms to demonstrate compliance with the commitments made in the OMP.

j) include an assessment of risks relating to achieving the environmental objectives and risk management strategies and/or mitigation measures that will be applied to address identified risks.

k) detail a monitoring program, including:

i. measurable performance indicators to monitor attainment of the ecological outcomes.

ii. trigger values for corrective measures.

iii. the timing and frequency of monitoring, ensuring monitoring is capable of detecting trigger values and changes in the performance indicators.

iv. proposed corrective measures which will be undertaken, and the timing of those measures, if trigger values are reached.

l) include links to other relevant **plans** or conditions of approval, including state approval conditions.

The approval holder must implement the OMP as, and commencing when, approved by the **minister** in writing at least until the expiry date of this approval.

CHEMICAL RISK ASSESSMENT FRAMEWORK

The purpose of the following conditions is to avoid and mitigate **harm** to **protected matters** as a result of **chemicals** associated with the Action.

9) The approval holder must implement the **CRAF** at least until the expiry date of the approval.

10) The approval holder must publish the **CRAF** and **Register of Assessed Chemicals** on its **website** prior to the **commencement of the Action** and ensure the **CRAF** and **Register of Assessed Chemicals** remain published on the **website** until the expiry date of the approval.

11) The approval holder must not use a **low-risk chemical** until that **chemical's** risk assessment has been recorded in the **Register of Assessed Chemicals** and provided to the **department** as required by the **CRAF**.

12) In accordance with the **CRAF**, the approval holder must not use a **high-risk chemical** until the **minister** has approved a risk assessment for that **chemical** in writing and the risk assessment has been recorded in the **Register of Assessed Chemicals** as required by the **CRAF**.

13) The approval holder must engage a **chemical risk assessment expert** to peer review all risk assessments at least once every 5 years, commencing from the date of this approval. The peer review of all risk assessments must be completed before the end of each 5-year anniversary of the date of this approval. The peer review must include:

a) an assessment of whether all risk assessments on the **Register of Assessed Chemicals** are consistent with current scientific knowledge,

b) an evaluation of the adequacy of relevant monitoring, mitigation and management measures that have been implemented by the approval holder, and

c) an explanation of how the approval holder will address, or has addressed, any concerns raised by the peer review.

14) The approval holder must, within 60 **business days** of the completion of the peer review, submit to the **department** a signed statement by the **chemical risk assessment expert** detailing the findings of the 5-year peer review and provide evidence demonstrating how all concerns raised by the peer review have been, or will be, addressed, and when.

Part B – Administrative conditions

NOTIFICATION OF DATE OF COMMENCEMENT OF THE ACTION

15) The approval holder must notify the **department** electronically of the date of **commencement of the Action**, within 5 **business days** following **commencement of the Action**.

16) The approval holder must **commence the Action** within 5 years of the date of this approval decision.

REVISION, SUBMISSION AND PUBLICATION OF PLANS

17) The approval holder must:

a) submit all **plans** required by these conditions electronically to the **department**.

b) publish each **plan** on the **website** within 20 **business days** of the date:

i. of this approval, if the version of the **plan** to be implemented is specified in these conditions; or

ii. the **plan** is approved by the **minister** in writing, if the **plan** requires the approval of the **minister**.

iii. the approval holder is required to exclude or redact **sensitive ecological data** from **plans** published on the **website** or otherwise provided to a member of the public.

iv. keep **plans** required by these conditions published on the **website** until the expiry date of this approval.

Note: The approval holder may, at any time, apply to the **minister** for a variation to **plan** by submitting an application in accordance with the requirements of section 143A of the **EPBC Act**. If the **minister** approves a revised **plan** then, from the date specified, the approval holder must implement the revised **plan** in place of the previous version of the **plan**.

COMPLIANCE RECORDS

18) The approval holder must maintain accurate and complete **compliance records**.

19) If the **department** makes a request in writing, the approval holder must provide electronic copies of **compliance records** to the **department** within the timeframe specified in the request.

Note: **Compliance records** may be subject to audit by the **department**, or by an **independent** auditor in accordance with section 458 of the **EPBC Act**, and/or be used to verify compliance with the conditions. Summaries of the results of an audit may be published on the **department's** website or through the general media.

20) The approval holder must ensure that any **monitoring data** (including **sensitive ecological data**), surveys, maps, and other spatial and metadata required under the conditions of this approval are prepared in accordance with the *Guidelines for biological survey and mapped data*, Commonwealth of Australia 2018, or as otherwise specified by the **minister** in writing.

21) The approval holder must ensure that any **monitoring data** (including **sensitive ecological data**), surveys, maps, and other spatial and metadata required under the conditions of this approval are prepared in accordance with the *Guide to providing maps and boundary data for EPBC Act projects*, Commonwealth of Australia 2021, or as otherwise specified by the **minister** in writing.

22) The approval holder must submit all **monitoring data** (including **sensitive ecological data**), surveys, maps, other spatial and metadata and all species occurrence record data (sightings and evidence of presence) electronically to the **department** within 12 months of the approval, or as otherwise specified in these conditions or agreed to in writing by the **minister**.

ANNUAL COMPLIANCE REPORTING

23) The approval holder must, within 3 months of the anniversary of the **commencement of the Action**, prepare a **compliance report** for each 12-month period following the date of this approval, or as otherwise agreed to in writing by the **minister**.

24) The approval holder must ensure that each **compliance report** is consistent with the *Annual Compliance Report Guidelines*, Commonwealth of Australia 2014.

25) The approval holder must ensure that each **compliance report** includes:

    a) Accurate and complete details of compliance and any non-compliance with the conditions and the **plans**, and any **incidents**.

    b) A schedule of all **plans** in existence in relation to these conditions and accurate and complete details of how each **plan** is being implemented.

26) The approval holder must:

    a) Publish each **compliance report** on the **website** within 60 **business days** following the end of the 12-month period for which that **compliance report** is required.

    b) Notify the **department** electronically, within 5 **business days** of the date of publication that a **compliance report** has been published on the **website**.

    c) Provide the weblink for the **compliance report** in the notification to the **department**.

    d) Keep all published **compliance reports** required by these conditions on the **website** until the expiry date of this approval.

    e) Exclude or redact **sensitive ecological data** from **compliance reports** published on the **website** or otherwise provided to a member of the public.

    f) If **sensitive ecological data** is excluded or redacted from the published version, submit the full **compliance report** to the **department** within 5 **business days** of its publication on the **website** and notify the **department** in writing what exclusions and redactions have been made in the version published on the **website**.

Note: **Compliance reports** may be published on the **department's** website.

REPORTING NON-COMPLIANCE

27) The approval holder must notify the **department** electronically, within 2 **business days** of becoming aware of any **incident** and/or potential non-compliance and/or actual non-compliance with:

a) the conditions

b) commitments made in a **plan** which results and/or is likely to result in an increased impact to **protected matters**.

28) The approval holder must specify in the notification required by condition 27:

a) Any condition which has been or may have been breached and any commitment made in a **plan** for which condition 27b. applies.

b) A short description of the **incident** and/or potential non-compliance and/or actual non-compliance.

c) The location (including co-ordinates), date and time of the **incident** and/or potential non-compliance and/or actual non-compliance.

Note: If the exact information cannot be provided, the approval holder must provide the best information available.

29) The approval holder must provide to the **department** in writing, within 12 **business days** of becoming aware of any **incident** and/or potential non-compliance and/or actual non-compliance, as specified in condition 27, the details of that **incident** and/or potential non-compliance and/or actual non-compliance. The approval holder must specify:

a) Any corrective action or investigation which the approval holder has already taken.

b) The potential impacts of the **incident** and/or non-compliance.

c) The method and timing of any corrective action that will be undertaken by the approval holder.

INDEPENDENT AUDIT

30) The approval holder must ensure that **independent audits** of compliance with the conditions are conducted as requested in writing by the **minister**.

31) For each **independent audit**, the approval holder must:

a) Provide the name and qualifications of the nominated **independent** auditor and the draft audit criteria to the **department**.

b) Only commence the **independent audit** once the audit criteria have been approved in writing by the **department**.

c) Submit the **audit report** to the **department** for approval within the timeframe specified in the approved audit criteria.

32) The approval holder must publish the **audit report** on the **website** within 10 **business days** of receiving the **department's** approval of the **audit report** and keep the **audit report** published on the **website** until the end date of this approval.

33) Each **audit report** must be completed to the satisfaction of the **minister** and be consistent with the *Environment Protection and Biodiversity Conservation Act 1999 Independent Audit and Audit Report Guidelines*, Commonwealth of Australia 2019.

COMPLETION OF THE ACTION

34) The approval holder must notify the **department** electronically 60 **business days** prior to the expiry date of this approval, that the approval is due to expire.

35) Within 20 **business days** after the **completion of the Action**, and, in any event, before this approval expires, the approval holder must notify the **department** electronically of the date of **completion of the Action** and provide **completion data**. The approval holder must submit any spatial data that comprises **completion data** as a **shapefile**.

Part C – Definitions

In these conditions any bolded use of a word or term refers to the below definition of that word or term:

Audit report means a written report of compliance and fulfilment of the conditions attached to this approval, objectively evaluated against the audit criteria approved by the **department**.

Business day means a day that is not a Saturday, a Sunday or a public holiday in Queensland.

Chemical means any chemical element or chemical compound used in **CSG operations**.

Chemical risk assessment expert means a person with at least a postgraduate degree (or equivalent) in a suitable area (such as chemistry) and a minimum of 10 years relevant experience in **chemical** assessments.

Commence the Action or **Commencement of the Action** means the date on which the first instance of any activity associated with the Action is undertaken.

Completion data means an environmental report and spatial data clearly detailing how the conditions of this approval have been met.

Completion of the Action means the date on which all activities associated with this approval have permanently ceased and/or been completed.

Compliance records means all documentation or other material in whatever form required to demonstrate compliance with the conditions of approval (including compliance with commitments made in **plans**) in the approval holder's possession, or that are within the approval holder's power to obtain lawfully.

Compliance report means a written report of compliance with, and fulfilment of, the conditions attached to the approval.

CRAF means the *Chemical Risk Assessment Framework – Fairview Water Release Scheme EPBC 2021/8914*, 21 December 2022, EHS Support, or a subsequent revised version approved by the **minister**.

CSG means any gas extracted or escaping from any natural body of coal, generally known as coal seam gas.

CSG operations means the operation of **CSG** infrastructure including:

i. drilling of CSG wells,

ii. **hydraulic fracturing**, and

iii. treatment of **flowback** or **CSG produced water**.

CSG produced water means underground water brought to the surface of the earth, or otherwise interfered with, in connection with exploring for or producing **CSG**.

Department means the Australian Government agency responsible for administering the **EPBC Act**.

Desalinated water means co-produced water from the Santos GLNG Gas Field Development Project (EPBC 2012/6615), treated according to the procedures described in the **Preliminary Documentation**.

Desalinated water quality limits means the respective 'desalinated water quality limits' (whether maximum, minimum or confinement to a range) for each 'quality characteristic' specified in Attachment A.

Environmental Management Plan Guidelines means the *Environmental Management Plan Guidelines*, Commonwealth of Australia 2014.

EPBC Act means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

EPBC Act Environmental Offsets Policy means the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, Commonwealth of Australia 2012.

Flowback means a water-based solution which flows back to the earth's surface after completing **hydraulic fracturing**. **Flowback** may consist of **chemical** additives, mud, sand, clay and/or geogenic material.

Harm means to cause any measurable direct or indirect disturbance or deleterious change as a result of any activity associated with the Action.

High-risk chemical means a Tier 3 or Tier 4 **chemical** as classified by the **CRAF**.

Hydraulic fracturing means a well-stimulation technique in which rock is fractured by a hydraulically pressurised liquid.

Incident means any event which has the potential to, or does, **harm** any **protected matter**.

Independent means a person or firm who does not have any individual, financial*, employment* or family affiliation or any conflicting interests with the project, the approval holder or the approval holder's staff, representatives, or associated persons.

*Other than for the purpose of undertaking the role for which an independent person is required

Independent audit means an audit conducted by an **independent** and **suitably qualified person** as detailed in the *Environment Protection and Biodiversity Conservation Act 1999 Independent Audit and Audit Report Guidelines*, Commonwealth of Australia 2019.

Investigation means the specific series of steps for investigating a trigger as specified in the **REMP**, including comparison and evaluation of **monitoring data**.

Low-risk chemical means any Tier 1 or Tier 2 **chemical** as classified by the **CRAF**.

Minister means the Australian Government Minister administering the **EPBC Act**, including any delegate thereof.

Monitoring data means the data required to be recorded under the conditions of this approval.

Monitoring location means each of the sites at which parameters must be monitored in accordance with the **REMP**. The position of each **monitoring location** is described, including its coordinate data, in the **REMP** and is represented on the map at Attachment B by the green circles labelled 'Monitoring locations'.

Plan means any action management plan, framework, or strategy that the approval holder is required by these conditions to implement.

Preliminary Documentation means the *Santos Fairview Water Release Scheme Preliminary Documentation*, prepared by AECOM Australia Pty Ltd (dated 17 July 2023).

Protected matter means a matter protected under a controlling provision in Part 3 of the **EPBC Act** for which this approval has effect.

Receiving environment monitoring program (**REMP**) means the *Santos Ltd Dawson River Desalinated Release Receiving Environment Monitoring Program*, prepared by frc environmental (dated 8 November 2023), or a subsequent revised version approved by the **minister**.

Receiving environment water quality parameter means the parameters specified in the first (left-hand) column of Table 5.4 in the **REMP**.

Receiving environment water quality trigger means a monitoring result above the maximum threshold, or outside the range thresholds, specified in Table 5.4 (Local Water Quality Guidelines) of the **REMP**, applying respectively to the **waterhole monitoring locations** or the Dawson River **monitoring locations** in respect of the corresponding parameter specified in Table 5.4 of the **REMP**.

Register of Assessed Chemicals means the register of assessed **chemicals**, to be published and maintained on the **website**, as specified in Section 3.2 of the **CRAF**.

Release point means the **desalinated water** release point, represented on the map at Attachment B by the blue circle labelled 'Desalinated water release point'.

Sediment quality trigger means a monitoring result above the maximum threshold specified and highlighted in blue in Table 5.5 (Local Sediment Quality Guidelines) of the **REMP**, applying respectively to the **waterhole monitoring locations** or the Dawson River **monitoring locations** in respect of the corresponding parameter specified in Table 5.5 of the **REMP**.

Sensitive ecological data means data as defined in the *Sensitive Ecological Data – Access and Management Policy V1.0*, Commonwealth of Australia 2016.

Shapefile means location and attribute information about the Action provided in an Esri shapefile format containing:

a) '.shp', '.shx', '.dbf' files,

b) a '.prj' file which specifies the projection or geographic coordinate system used, and

c) an '.xml' metadata file that describes the shapefile for discovery and identification purposes.

Suitably qualified expert means a person who has relevant professional qualifications in writing and implementing offset management plans with knowledge of the conservation management requirements of the **protected matters**.

Suitably qualified person means a person who has professional qualifications, training, skills and/or experience related to the nominated subject matter and can give authoritative independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.

Waterhole means the floodplain oxbow lake represented on the map at Attachment B by the zone shaded solid blue labelled 'Waterhole'.

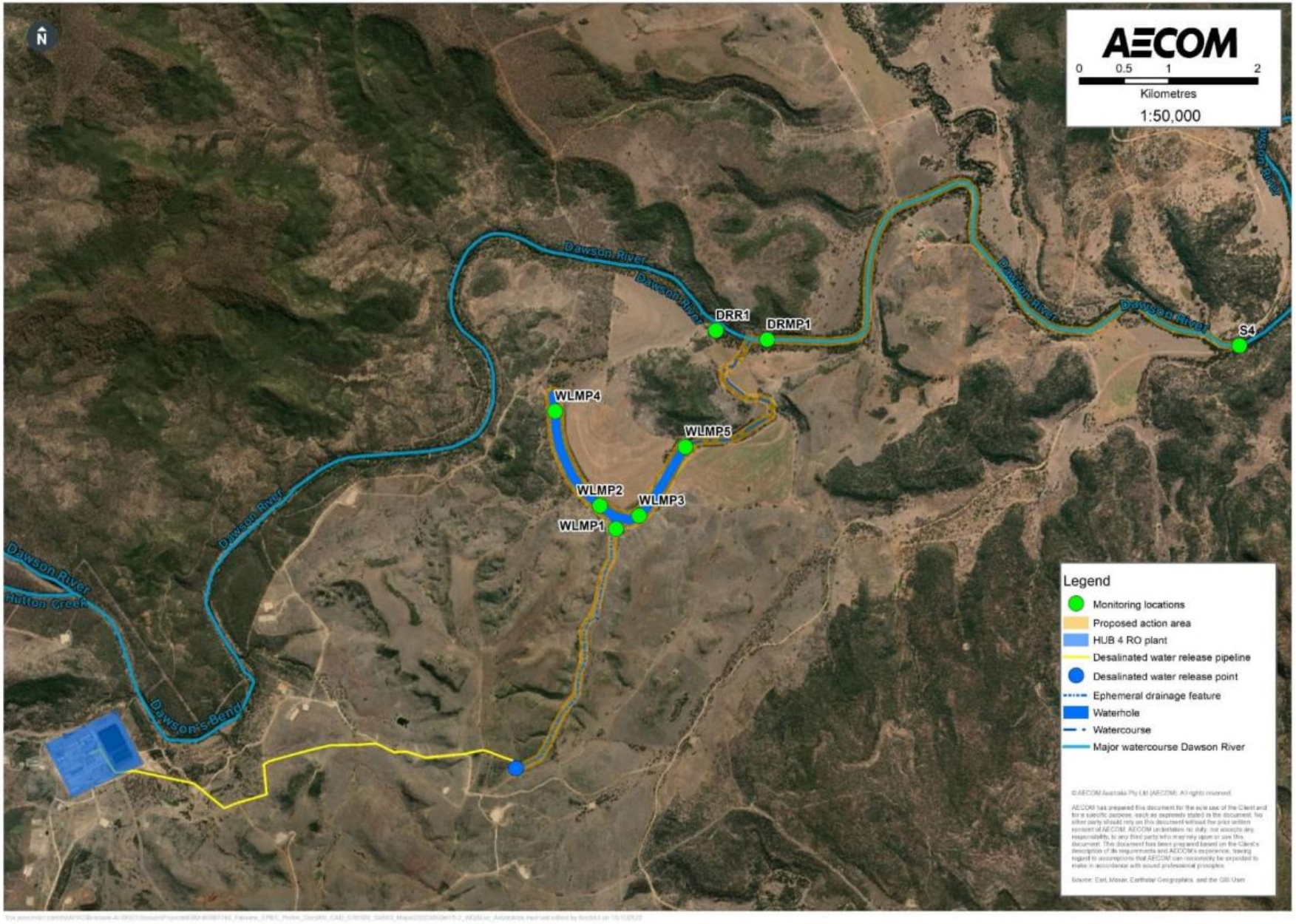
Website means a set of related web pages located under a single domain name attributed to the approval holder and available to the public.

Attachments

Attachment A: Desalinated Water Quality Limits and Parameters for Monitoring

Quality Characteristic	Limit Type	**Desalinated Water Quality Limits**	Unit
Temperature	Monitor and report only		°C
pH	Range	6.5 - 8.5	pH unit
Electrical Conductivity	75th percentile	370	µS/cm
Turbidity	Maximum	50	NTU
Dissolved Oxygen (85 – 110% Saturation)	Range	6.4 – 16.1	mg/L
Total nitrogen	Maximum	620	µg/L
Ammonia	Maximum	0.9	mg/L
Calcium	Minimum	1	mg/L
Chloride	Maximum	175	mg/L
Fluoride	Maximum	1	mg/L
Magnesium	Monitor and report only		mg/L
Potassium	Monitor and report only		mg/L
Sodium	Maximum	115	mg/L
Sulphate	Maximum	5	mg/L
Aluminium	Maximum	55	µg/L
Total Arsenic	Maximum	13	µg/L
Boron	Maximum for days when releases are ≤ 13.5 ML	2.9	mg/L
Boron	Maximum for days when releases are ≥ 13.5 ML and ≤ 18.0 ML	2.5	mg/L
Cadmium	Maximum	0.2	µg/L
Chromium	Maximum	1	µg/L
Copper	Maximum	1.4	µg/L
Iron	Maximum	300	µg/L
Lead	Maximum	3.4	µg/L
Manganese	Maximum	1,900	µg/L
Mercury	Maximum	0.6	µg/L
Nickel	Maximum	11	µg/L
Selenium	Maximum	11	µg/L
Zinc	Maximum	8	µg/L
Hardness	Monitor and report only		mg/L

Attachment B: Map of the Action area



Santos

Appendix C: Dawson River Release Receiving Environment Monitoring Program

Santos Ltd Dawson River Desalinated Release

Receiving Environment Monitoring Program

Prepared for:

Santos Ltd

frc environmental

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frc reference: 230807

Document Control Summary

Project No.:	230807
Status:	Final Report
Project Director:	Ben Cook
Title:	Santos Ltd Dawson River Desalinated Release: Receiving Environment Monitoring Program
Project Team:	B. Cook
Client:	Santos GLNG
Client Contact:	Adrian Lavery and Bennett Warren
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Contents

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Maps

1 Introduction

Santos Ltd operates a number of gas fields in the Bowen and Surat Basins. The Fairview Arcadia Project Area (FAPA) is located in the upper Dawson River Sub-catchment in central Queensland. The FAPA is an operating gas field covering approximately 318,297 ha.

The release of desalinated (permeate) produced water to a drainage feature tributary of the Dawson River of up to 18 megalitres per day (ML/day), not triggered by flow, is authorised in accordance with the FAPA Environmental Authority (EA) EPPG00928713[1] (formerly PEN100178208) (Appendix A):

The desalinated release is authorised from Reverse Osmosis Plant 2 (ROP2), which is in the south-east of the FAPA, to a tributary gully of the Dawson River, which joins the Dawson River midway between "Dawson's Bend" and "Yebna Crossing" (Map 4.1). This area between the tributary gully of the Dawson River, which joins the Dawson River midway between "Dawson's Bend" and "Yebna Crossing" located 8.5km downstream of the receiving wetland is known as the 'receiving environment' as defined by condition of the FAPA EA.

The water course releases include the following elements:

- produced water in the Hub Compressor Station No. 4 (HCS4) gathering network will be collected from the well pads via gathering lines and transported to a produced water management pond of 200 ML capacity, sized for 10 days storage at peak production;
- produced water will then be passed through ROP2 at HCS4 for treatment, and subsequently stored in a permeate pond (HCS04DWB1) of 340 ML capacity, sized for 15 days storage at peak production, before delivery at a maximum rate of 18 ML/day to the desalinated release outfall pipeline (which is the total capacity of the pipe and the maximum design flow for the release scheme);
- desalinated produced water will be released to surface waters as defined by the FAPA EA, at the contaminant release point described in the FAPA EA as ROP2. The coordinates for the release location are those described in condition - Schedule B, Table 3 – Contaminant Release Points of the FAPA EA;
- a 5.3km outfall pipeline will transfer the desalinated produced water from the permeate pond to the proposed outfall at the tributary gully;

[1] EPPG00928713, dated 03 November 2022.

- the released water will flow for 2.9 km down the tributary gully before discharging into the Waterbody, estimated to have a volume of approximately 500 ML; and
- the Waterbody overflows into a downstream section of the tributary gully, which flows for a further 1.8 km before discharging to the Dawson River.

The receiving environment of the desalinated release therefore contains two water types: the Waterbody and the Dawson River (Map 4.1)[2].

The EA requires that the release of desalinated produced water from ROP2 must not cause adverse environmental impacts on the species richness or species abundance of aquatic fauna in the receiving environment. To monitor water quality, and the species richness and abundance of aquatic fauna within the receiving environment, the EA requires the development and implementation of a Receiving Environment Monitoring Program (REMP) for the desalinated release. Table 1.1 defines the scope and content the REMP must address.

Additionally, the REMP addresses requirements of the Commonwealth approval under the *Environment Protection and Biodiversity Act 1999* (EPBC Act approval 2012/6615; Appendix B). Specifically, the REMP provides for water quality and aquatic ecological monitoring to ensure early detection of any potential direct or indirect water quality impacts to threatened aquatic species listed under the EPBC Act, specifically white-throated snapping turtle (*Elseya albagula*) and Fitzroy River turtle (*Rheodytes leukops*), that may be caused by the release of desalinated produced water. Threatened species under the EPBC Act are a Matter of National Environmental Significance.

1.1 Background

The FAPA EA was amended on 31 May 2013 to authorise the desalinated release. The amended conditions of the FAPA EA required baseline biological assessments and biological monitoring to be undertaken prior to the release of contaminants to waters from ROP2. Seven baseline biological assessments and biological monitoring surveys were undertaken over a period of approximately 24 months commencing in August 2013 and finalising in January 2015. The findings from the baseline biological assessments and biological monitoring formulated the development of local water quality guidelines and a revision to the REMP originally developed.

[2] A comparative site on Hutton Creek, upstream of the receiving environment for desalinated release, is considered a third water type in the context of the biological monitoring program for desalinated release.

The release of desalinated produced water from ROP2 to the Dawson River commenced on 23rd July 2015. The commencement of the release to waters enacted the commencement of the REMP.

An EA amendment application was submitted to the Department of Environment and Sciences (DES) on 18 April 2018 to remove the requirement for baseline biological assessment and biological monitoring (former EA conditions B19 – B24), which became redundant after the commencement of the release. This EA amendment was authorised on 11 June 2018. The current EA is dated 25 August 2023.

1.2 Purpose and Scope

The REMP for Dawson River desalinated releases has been developed to monitor and record the effects of the release water on the receiving environment, with the aim of identifying and describing the extent of any adverse environmental impacts on the receiving waters, as required by the EA and to ensure early detection of potential direct or indirect water quality impacts to threatened turtle species.

This report presents the design of the REMP, with the scope of this design document having been guided by the Receiving Environment Monitoring Program Guideline – for use with Environmentally Relevant Activities under the *Environmental Protection Act 1994* (DES 2014), and the conditions of the EA including:

- a description of the release characteristics, including quality and quantity of the release
- an appraisal of the parameters assessed in the baseline monitoring program, and assessment of their efficacy for the REMP
- a description of the receiving environment attributes, including
  - a description of the spatial extent of the receiving waters
  - catchment area and surrounding land use, hydrology, geomorphology, aquatic habitats, background water and sediment quality, and key aquatic communities of waterways in the receiving environment
  - applicable Environmental Values (EVs), and the water quality and biological guidelines applicable for protection of these EVs in the receiving environment
- temporal context of the REMP, and the
- the monitoring program design, including:
  - the timing and frequency of sampling

- the parameters and locations to be sampled
- approach to assessment of monitoring data
- approach to assessment and management of any exceedances of water quality or biological guidelines, and
- reporting requirements.

Early detection of any potential adverse water quality impacts to threatened turtle species is achieved by using an investigative approach to water quality, whereby exceedances of the project specific water quality and biological guidelines (frc environmental 2015a) trigger a specific series of steps involving comparison and evaluation of water quality and biological data. The project specific water quality and biological guidelines were developed using the mean 80th percentile (and mean 20th percentile for parameters where low concentrations can be of concern) of baseline (i.e. pre-release) data. As such at least 20 to 40% of natural variation can fall outside the range indicated by the project specific guidelines; thus, an exceedance of the project specific guideline does not indicate that environmental harm has been caused, only the need to undertake further investigation. Where such investigations indicate potential adverse impacts to aquatic ecosystems, including threatened turtle species, then operational management is implemented. This investigative approach is presented in detail in Section 6.3.

1.3 Roles and Responsibilities

The roles and responsibilities relating to the development and implementation of the REMP are described fully in the EA, which includes the following conditions:

- Condition A5 – all REMP monitoring is undertaken by suitable qualified persons
- Condition A8 – all laboratory analyses and tests required must be undertaken by a laboratory that has NATA accreditation for such analyses and tests
- Condition A16 - the REMP must be implemented
- Condition A15 and B40 - the REMP design document must be certified by a suitably qualified person (Appendix C)

Conditions numbers are subject to change – refer to the EA referenced at the time of writing the report (Appendix A).

1.4 Environmental Authority Compliance Summary

Conditions B36 to B41 relate to the requirements of the REMP. Condition B41 specifies the scope and content of the REMP, with all clauses of this condition achieved by this REMP design document (Table 1.1 and Appendix A).

Table 1.1 Environmental Authority Compliance Summary.

EA condition	Condition	Report section
(B41) (a)	Description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal and spatial variation (e.g. seasonality)	Section 4.1 and 4.2.5
(B41) (b)	Description of applicable environmental values	Section 4.3
(B41) (c)	Description of water quality objectives to be achieved	Section 4.4.1
(B41) (d)	Any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed	Section 8
(B41) (e)	Water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP	Section 4.4.1, 6.1 and 6.2
(B41) (f)	Monitoring for any potential adverse environmental impacts caused by the release	Section 6.1 and 6.2
(B41) (g)	Monitoring for algal blooms	Section 6.2.2
(B41) (h)	Monitoring of stream flow and hydrology	Section 6.2.2
(B41) (i)	An assessment of bank stability, including monitoring for any potential adverse environmental impacts caused by the release including impacts to bank stability and erosion, and an evaluation of watercourse bank slumping	Section 6.2.2

EA condition	Condition	Report section
(B41) (j)	Monitoring of physical chemical parameters as a minimum those specified in Schedule B, Table 4 – Contaminant Limits, Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water and Schedule B, Table 8 – Event-based release- Contaminant monitoring	Section 6.2.2
(B41) (k)	Monitoring biological indicators in accordance ANZECC & ARMCANZ 2000 (including Before, After, Control, Impact (BACI) Principal) and, where possible, consistent with methodologies specified by FRC Environmental Pty Ltd in their report titled Santos Coal Seam Gas Fields Aquatic Ecology Impact Assessment	Section 6.2.2
(B41) (l)	Monitoring metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, A Guide To The Application Of The ANZECC & ARMCANZ Water Quality Guidelines In The Minerals Industry (BATLEY et al) and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments) for permanent, semi-permanent water holes and water storages	Section 6.2.2
(B41) (m)[a]	Monitoring of a selection of invertebrate species (minimum of three from the local receiving environment) to assess ecosystem health (e.g. exoskeleton density) in respect to the availability of calcium and magnesium	Section 6.2.2
(B41) (n)	The methods for analysis and interpretation all monitoring results	Section 6.3; Appendix D
(B41) (o)	The locations of monitoring points (including the locations of proposed background and downstream impacted sites for each release point)	Section 6.2
(B41) (p)	The frequency or scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within two (2) years (depending on wet season flows) in accordance with the	Section 6.2.2

EA condition	Condition	Report section
	Queensland Water Quality Guidelines 2009. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges	
(B41) (q)	Monitoring of quality characteristics must include the limits specified in Schedule B, Table 4 – Contaminant Limits to assess the extent of the compliance of concentrations with water quality objectives derived through condition (B26)(p)	Section 6.1 and 6.2.2
(B41) (r)	Specify sampling and analysis methods and quality assurance and control	Section 6.3; Appendix D
(B41) (s)	Any historical data sets to be relied upon	Section 4
(B41) (t)	Description of the statistical basis on which conclusions are drawn	Section 6.1, 6.2, 7; Appendix D
(B41) (u)	Any control or reference sites	Section 6.2.1
(B41) (v)	Recording of planned and unplanned releases to watercourses, procedures for event monitoring, monitoring methodology used and procedure to establish background surface water quality	Section 6.4

[a] (B41) (m) not applicable to event-based releases

1.5 EPBC Referral Compliance Summary

EPBC Approval is provided in Appendix B. This section and Appendix B are a placeholders to be updated post approval.

2 Description of the Activity

For the purpose of the REMP, the activity is described as the controlled release of desalinated produced water from ROP2 to the Waterbody and the Dawson River via the tributary gully of up to 18 ML/day.

2.1 Release Characteristics

2.1.1 Water Quality

Table 2.1 presents the release water quality characteristics from water quality data collected between 2015 to 2021.

Table 2.1 Minimum and Maximum Values for Desalinated Produced Water Between 2015 and 2021, Compared to EA Contaminant Limits.

Water Quality Parameters	Units	LoR	Count data Points	Minimum	Maximum
Physicochemical Parameters					
Dissolved Oxygen - Field	mg/L	-	156	5.6	13.4
Electrical Conductivity - Field	µS/cm	-	157	33	80% percentile: 129
pH - Field	pH units	-	156	6.3	9.8
Suspended Solids	mg/L	5	157	2	28
Turbidity - Field	NTU	-	NA	NA	NA
Cations					
Calcium (dissolved)	mg/L	1	157	1.0	10.0
Magnesium (dissolved)	mg/L	1	157	NC	NC
Sodium (dissolved)	mg/L	1	157	1.0	40.0
Potassium (dissolved)	mg/L	1	157	NC	4.0
Anions					
Chloride	mg/L	1	154	5.00	36.00
Fluoride	mg/L	0.1	159	NC	0.3
Sulfate as SO4 2-	mg/L	1	157	NC	4.0
Metals and Metalloids					

Water Quality Parameters	Units	LoR	Count data Points	Minimum	Maximum
Aluminium (dissolved)	mg/L	0.01	157	0.01	0.05
Arsenic (dissolved)	mg/L	0.001	160	NC	NC
Boron (dissolved)	mg/L	0.05		0.22	2.05
Cadmium (dissolved)	mg/L	0.0001	158	NC	0.0002
Chromium (dissolved)	mg/L	0.001	158	NC	0.003
Cobalt (dissolved)	mg/L	0.001	158	NC	NC
Copper (dissolved)	mg/L	0.001	3	NC	0.003
Lead (dissolved)	mg/L	0.001	158	NC	0.004
Manganese (dissolved)	mg/L	0.001	158	NC	0.059
Mercury (dissolved)	mg/L	0.0001	158	NC	NC
Nickel (dissolved)	mg/L	0.001	157	NC	0.007
Selenium (dissolved)	mg/L	0.01	158	NC	0.007
Zinc (dissolved)	mg/L	0.005	158	NC	0.142
Nutrients					
Ammonia as N	mg/L	0.01	159	0.01	0.34
Nitrate as N	mg/L	0.01	5	NC	0.05
Nitrite + Nitrate as N	mg/L	0.01	157	NC	0.05
Total Nitrogen as N	mg/L	0.1	157	0.1	0.6
Total Phosphorus as P	mg/L	0.01	NA	NA	NA

NL = no limit

NC = insufficient detections

2.1.2 Water Quantity

Condition B18 of the EA specifies that the maximum daily release must not exceed 18 ML per day from ROP2. Base flow in the Dawson River in the receiving environment is considered any flow <70 ML/day (AECOM 2023).

Modelling indicated a minor (i.e. 0.06 m) increase in water level under low flow conditions in the Dawson River at site S4 under a constant release of 18 ML/day, with negligible changes under moderate and high flows (AECOM 2023). Water levels in the Waterbody since releases commenced are overall higher than during the baseline program (noting that rainfall was lower during the baseline program, and that REMP monitoring of the Waterbody has indicated improved habitat conditions associated with higher water level). However,

water levels in the Dawson River are not significantly changed from natural water levels under low flow and are unchanged from natural under moderate and high flow.

3 Historical Baseline Monitoring

A former condition of the EA required a baseline biological assessment to be undertaken, prior to the first release of desalinated produced water, to identify detectable aquatic flora and fauna of the receiving wetland. The baseline program included surveys of:

- aquatic flora
- aquatic macroinvertebrates
- fish
- frogs
- turtles
- waterbirds, and
- water quality for the parameters listed in *Schedule B, Table 4 – Contaminant Limits* of the EA.

A baseline biological assessment was undertaken from August 2013 to January 2015, over seven seasonal surveys (frc environmental 2015b), as follows:

- survey 1, winter: August 2013
- survey 2, spring: November 2013
- survey 3, summer: January 2014
- survey 4, autumn: April 2014
- survey 5, winter: July 2014
- survey 6, spring: November 2014, and
- survey 7, summer: January 2015.

The indicators assessed in each of the seven surveys were:

- water quality
- aquatic habitat
- sediment quality
- aquatic flora
- macroinvertebrates

- fish
- turtles
- frogs, and
- waterbirds.

Condition B41 of the EA specifies that the REMP must monitor:

- any adverse environmental impacts of the release
- algal blooms
- stream flow and hydrology
- bank stability, erosion and watercourse bank slumping
- water quality parameters listed in Schedule B, Table 4 – Contaminant Limits and Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water
- biological monitoring indicators in accordance with ANZECC & ARMCANZ (2000), including the before, after, control, impact (BACI) principal
- metals and metalloids in sediment, and
- a selection of invertebrate species to assess exoskeleton density.

With respect to the biological indicators, the EA does not specify which indicators to use, providing that they enable any adverse environmental impacts of the release be detected, and that they are monitored in accordance with ANZECC & ARMCANZ (2000) (superseded by ANZG (2018)) and the BACI principal. ANZG (2018) adopts a weight-of-evidence approach, and so the REMP applies a range of indicators that were assessed in the baseline studies, specifically:

- water and sediment quality, which may be directly affected by the release
- macroinvertebrates, fish and turtles, which may be indirectly affected by the release, noting that fish and turtles are at a higher tropic level than the macroinvertebrates, and that two of the turtle species are threatened, and
- microcrustacean exoskeleton condition, which may indicate potential risks associated with low ion (i.e. calcium and magnesium) concentrations on the ability of these taxa to mineralise exoskeletons.

In 2018 monitoring of zooplankton (i.e. pelagic microcrustaceans) was added to the REMP as an additional biological parameter that can indicate potential risks associated with low

calcium and magnesium concentrations on the ability of these taxa to mineralise exoskeletons. Microcrustaceans are also an ecologically important indicator, comprising a significant food resource for fish.

4 Description of Receiving Environment

4.1 Spatial Extent of the Receiving Environment

The EA defines the receiving environment as 'the waters of the Dawson River and connected or surrounding waterways (including the receiving wetland) up to Yebna Crossing, located 8.5 km downstream of the receiving wetland' (Map 4.1).

The receiving environment has two water types, the Waterbody and the Dawson River[3], described below:

- The Waterbody is a large semi-permanent oxbow lake with an approximate volume of 500 ML. There are several dry gullies upstream of the Waterbody, including the gully the release water will be discharged to. An ephemeral stream connects the Waterbody with the Dawson River downstream of the Waterbody. The Waterbody is a riverine wetland and is considered to be a wetland of General Ecological Significance (GES) under the *Environmental Protection Regulation* 2019.
- The Dawson River is a major tributary of the Fitzroy River. The Dawson River and its tributaries and floodplain wetlands comprise an area of approximately 551.9 km^2 of wetland (DES 2023). The stretch of the Dawson River in the receiving environment has a perennial flow regime.

The receiving environment for the REMP is in the upper Dawson River Sub-catchment (EHP 2013).

4.2 Potentially Impacted Waterways

While the receiving environment extends as far downstream as Yebna Crossing (Map 4.1), previous studies predicted that potential impacts to water quality and aquatic ecology from the release of desalinated produced water from ROP2 are most likely to occur only in the Waterbody (Halcrow 2012). However, assessment of water quality of the desalinated produced water presented above in Section 2.1.2 indicate that actual water quality risks to the receiving environment are low.

For the purpose of the REMP, monitoring will continue at the nominated sites in the Waterbody and the Dawson River as far downstream as Yebna Crossing (site S4) to that

[3] Hutton Creek contains a comparative site that will be monitored within the scope of the REMP for DRRS, although Hutton Creek is upstream from the receiving environment. Hutton Creek is considered a distinct water type on the basis of hydrological, geomorphological and biological attributes.

any potential risks can be identified and appropriately managed. Furthermore, site S4 is the compliance point for protecting the environmental value of drinking water.

149° E
149.05° E
149.1° E
149.15° E
149.2° E
149.25° E
25.65° S
25.7° S
25.75° S

PL 91
Dawson River
PL 232
Hutton Creek
PL 92
PL 100
Dawsons Bend
Tributary Gully
Injune Road
Yebna Crossing
Commissioner Creek
Injune Road
Slate Pocket Road
PL 99

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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210208 Santos Dawson River Watercourse Releases: Receiving Environment Monitoring Program

Map 4.1: Spatial extent of the receiving environment

SOURCES

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LEGEND

- Proposed Release Point
- Reverse Osmosis Plant 2
- Receiving Environment as defined in EA EPPG00928713
- Waterbody
- Tributary Gully
- Major Waterway
- Fairview Project Area
- Local Road

N

SCALE

0 0.5 1 2 3 4
Kilometres

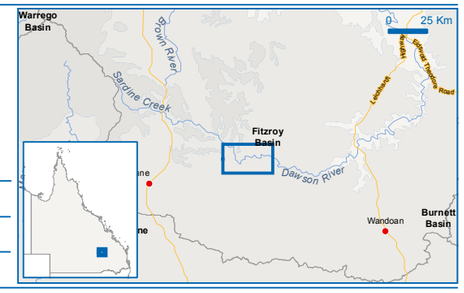
Scale: 1:80,000 @ A3

PROJECTION
Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

DATE
2021-04-15

DRAWN BY
MM

VERSION
02



4.3 Current Condition of the Receiving Environment

4.4 Previous Surveys

Early studies of the aquatic ecology of the Waterbody were completed by Simmonds and Bristow (2012).

Between August 2013 and January 2015 seven baseline biological surveys were completed by frc environmental (baseline monitoring results are synthesised in: frc environmental 2015b):

- survey 1, winter: August 2013
- survey 2, spring: November 2013
- survey 3, summer: January 2014
- survey 4, autumn: April 2014
- survey 5, winter: July 2014
- survey 6, spring: November 2014, and
- survey 7, summer: January 2015.

4.4.1 Hydrology

The flow regime of the Dawson River and its tributaries is dominated by 'unpredictable, highly intermittent summer flow' with some reaches having 'variable, extremely intermittent summer flow' (Kennard et al. 2010); however, groundwater contributions ensure there is perennial baseflow (AECOM 2023). The majority of moderate and high flows are most likely during the summer months coinciding with higher rainfall, although the magnitude, duration and timing (i.e. early or late summer) of these flows can vary between years.

Water levels in the Waterbody fluctuate between seasons and years, although historically there has generally been a significant volume of water in the Waterbody, with few records of the Waterbody drying completely. The Waterbody may be filled when the Dawson River is in high flow, although not all high flow events fill the Waterbody (e.g. the flood flows in December 2014 did not fill the Waterbody). The occurrence of overspilling from the Waterbody to the Dawson River appears to be rare, although not well documented.

Periods of low flow and zero flow in the Dawson River are likely to be the most important 'events' for the REMP, as the concentration of some water quality parameters may increase in the Dawson River at these times if there are also peak releases of desalinated produced

water (Halcrow 2012). Additionally, increased water levels in the Dawson River due to the release when the Dawson River is in low flow condition during turtle nesting seasons is identified as a potential risk to turtles, especially the two threatened species. However, hydrological modelling has shown that increases in water depth in the Dawson River due to the release at these times is unlikely to inundate turtle nests (AECOM 2023).

4.4.2 Geomorphology

The Dawson River originates in the south-east part of the Carnarvon George National Park in high elevation sandstone of the Central Queensland Highlands. The upper Dawson River (i.e. west of Taroom) has a dendritic channel pattern, with major tributaries including Hutton, Baffle and Eurombah Creeks. The upper Dawson River and its tributaries have predominantly confined valley settings, although the upper Dawson River also has partly-confined valley settings in places with small sections of floodplain, such as the floodplain area surrounding the Waterbody. The channel beds of these watercourses contain a mix of bedrock, cobble, gravel, sand and silt, which create a range of hydraulic features, such as pools, riffles, glides and runs when inundated. Stream banks within the receiving environment are dominated by silt and / or clay, and are of variable slope. Sand bars form in the upper Dawson River, with summer flood flows having a notable influence on the deposition and erosion of sand.

The Waterbody is on a small floodplain area near a partly-confined reach of the upper Dawson River. The bed and banks of the Waterbody are comprised of silt, and the banks have a low slope. The Waterbody connects to the Dawson River via a sinuous, ephemeral watercourse.

4.4.3 Aquatic Habitat

Aquatic habitat was assessed during each of the baseline surveys, and is summarised in Table 4.1.

The most obvious and important change in habitat conditions in the seven baseline surveys were changes to water levels and flow. Water levels progressively declined at all sites over surveys 1 – 3 (winter, spring and summer); rainfall prior to survey 4 (autumn) increased water levels at all sites (excluding WLMP4) and increased flow at site DRR1 (and presumably at sites DRMP1 and S4 as well, although these sites were not assessed during surveys 1 – 3). Water levels decreased again over surveys 5 (winter) and 6 (spring), and site WLMP4 was totally dry for these surveys. In the weeks leading up to survey 7 (summer)

significant rainfall caused flooding in Hutton Creek and the Dawson River, and increased water levels in the Waterbody.

Table 4.1 Habitat Characteristics of Each Water Type [a].

Habitat Attribute	Habitat Characteristics		
	Waterbody	**Dawson River**	**Hutton Creek**
Bank stability	*moderate*: bank slope low to moderate vegetation cover highly variable, sometimes low significant cattle disturbances to bank	*moderate*: bank slope moderate to high some unstable and eroding sections of bank vegetation cover moderate some areas of cattle disturbance to bank	*moderate*: bank slope moderate to high some unstable and eroding sections of bank vegetation cover low to moderate some areas of cattle disturbance to bank
Bed stability	*high*: little scouring and deposition cattle disturbance to bed within shallow sections	*low*: significant scouring and deposition of sand following very high flow events	*low*: significant deposition of fine sediment
Substrate diversity	*low*: fine silt and clay	*high*: variable substrate types, including silt and clay, sand, and cobbles significant deposition of sand over cobbles after very high flow events means that substrate composition can vary	*low to moderate*: dominated by thick silt deposition overlying cobbles, pebbles and gravel; boulders that are not covered by silt represent approximately 5% of the site

Habitat Attribute	Habitat Characteristics		
	Waterbody	**Dawson River**	**Hutton Creek**
Riparian vegetation condition	*moderate*: some clearing for creating pasture native vegetation (*Eucalyptus* sp.) dominates canopy layer; no notable shrub layer ground stratum a mixture of native sedges and grasses, and introduced herbaceous weeds (e.g. thistle) recruitment of *Eucalyptus* sp. seedlings noted during the baseline survey	*moderate*: some clearing for creating pasture native vegetation (*Eucalyptus* sp., *Callistemon* sp., *Casuarina* sp.) dominates canopy and shrub layers ground stratum a mixture of native sedges, mat rushes and grasses, and introduced herbaceous weeds (e.g. thistle)	*moderate*: some clearing for creating pasture native vegetation (*Eucalyptus* sp. and *Callistemon* sp.) dominates canopy and shrub layers ground stratum of low cover, including native mat rushed and introduced herbaceous weeds (e.g. thistle) some recruitment of *Eucalyptus* sp. seedlings noted during the baseline survey
Flow habitats	*low*: non-flowing, lentic shallow and deep sections	*moderate*: low to high flow, depending on antecedent rainfall pools (low flow) and runs (low to moderate flow) dominate small sections of riffle also present shallow and deep sections	*low*: low to high flow, depending on antecedent rainfall pool (low flow, shallow to moderate depth water) habitat dominates, and for most of the baseline surveys, a small isolated pool was the only water present at the site site with many deep sections and variable flow habitats present after significant rainfall (observed in only 1 of the 7 baseline surveys)

Habitat Attribute	Habitat Characteristics		
	Waterbody	**Dawson River**	**Hutton Creek**
Physical habitat features	*low*: limited large woody debris limited aquatic plants in water no variation in substrate composition depth variation of non-flowing water provides limited habitat variation	*high*: moderate large woody debris generally moderate but highly variable (i.e. sometimes low) cover of aquatic plants in water undercut banks variation in substrate types range of flow habitats (pools, runs) depth variation	*low to moderate*: limited large woody debris undercut banks no aquatic plants in water substrate is impacted by sedimentation, but boulders provide habitat site often in a near-dry condition, when flow habitats and water depth (and overall amount of aquatic habitat) is very limited site with many deep sections and variable flow habitats present after significant rainfall (observed in only 1 of the 7 baseline surveys)

[a] source: frc environmental 2015c

4.4.4 Water Quality

Results for water quality measured in situ during the baseline surveys, with comparison to published Water Quality Objectives (WQOs; EHP 2013), are summarised as follows (frc environmental 2015b):

- Temperature followed a typical seasonal pattern, and was lowest in the winter surveys and generally highest in the summer surveys, although flood flows reduced water temperature in summer 2014 / 2015 (survey 7). There is no WQO for the temperature of water, but the temperature range recorded over the four surveys is within the tolerance limits of freshwater fauna of the region.
- Electrical conductivity was consistently higher than the WQO at the Waterbody sites, except as sites WLMP1 and WLMP5 in survey 7 (summer 2014 / 2015) after significant rainfall which likely diluted the concentration of dissolved salts at these sites. Electrical conductivity achieved the WQO at sites on the Dawson River and Hutton Creek in all of the surveys, except for site DRR2 on Hutton Creek where electrical conductivity was higher than the WQO in surveys 1 (winter 2013) and 6 (spring 2014).
- The pH of water was within the WQO range at sites on the Dawson River and Hutton Creek in most of the surveys; only site S4 on the Dawson River had low pH in survey 5 and high pH in survey 6. Sites within the Waterbody were within the WQO range in most surveys, although pH was high at all sites on some surveys. There was no consistent season when pH values were high.
- Dissolved oxygen was not within the WQO range at all sites in each water type on most surveys, generally being lower than the WQO range, but also was above the WQO range at least on one survey at most sites (and all water types).
- Turbidity did not achieve the WQO at the Waterbody sites in any of the surveys. Turbidity generally achieved the WQO at sites on the Dawson River, and generally did not achieve the WQO for the site on Hutton Creek (site DRR2).

Synthesis of baseline monitoring data for a broader suite of water quality parameters is presented in frc environmental (2015a,b).

4.4.5 In-stream Sediment Quality

Results for sediment quality in the baseline surveys showed that (frc environmental 2015b):

- for parameters that have a published guideline value (eight parameters), the trigger value was not exceeded by any parameter in any water type, and
- the Waterbody and Hutton Creek generally had notably higher concentrations of nutrients and metals in sediment than the Dawson River. This is likely due to the dominance of fine silts and clays at the Waterbody and Hutton Creek sites compared to the dominance of sand at two of the three Dawson River sites (i.e. DRMP1 and S4). Nutrients and metals bind to fine silts and clays to a greater degree than they bind to sand.

4.4.6 Macroinvertebrates

The Dawson River sites tended to have the highest diversity of macroinvertebrate taxa, which may be due to this water type having high cover of submerged aquatic plants in edge habitat. The Waterbody had the highest overall abundance of macroinvertebrates, indicating large numbers of individuals of fewer taxa compared to the Dawson River sites (frc environmental 2015b). Macroinvertebrate diversity at the Hutton Creek site was similar to the Waterbody, although macroinvertebrate abundance at the Hutton Creek site was intermediate between the Waterbody and the Dawson River. The results for PET richness and SIGNAL-2 scores were generally similar to the results for taxonomic richness of macroinvertebrates, with the Dawson River having notably higher values for these indices than the Waterbody and Hutton Creek (frc environmental 2015b).

Macroinvertebrate communities were highly variable across the surveys and there were no consistent patterns between the three water types (other than the macroinvertebrate communities being partially to clearly differentiated between water types on most surveys). This high level of spatial and temporal variation in macroinvertebrate communities observed during the baseline monitoring program is expected for sub-tropical systems that have unpredictable flow regimes and variation habitat conditions (Kennard et al. 2010), especially when both lotic (flowing water systems) and lentic (still water systems, i.e. the Waterbody) are compared.

Differences in community structure between water types and between sites within water types was driven by differences in the abundance of Ceratopogonidae, Chironominae (non-biting midges), Corixidae (water boatmen), Thiaridae (snails), Dytiscidae (diving beetles) and Atyidae (glass shrimp). Thiaridae and Atyidae were important drivers of community differences for the Dawson River sites (e.g. S4, DRMP1 and DRR1). Overall, the

Waterbody sites had high abundances of Ceratopogonidae, Chironominae (non-biting midges) and Corixidae (water boatmen).

No macroinvertebrate taxon listed under the EPBC Act or NC Act was recorded during the baseline surveys.

4.4.7 Fish

A total of 15 species of native fish, and two exotic species (goldfish, *Carassius auratus,* and mosquitofish*, Gambusia holbrooki*), were caught during the baseline surveys (frc environmental 2015b).

Carp gudgeon (*Hypseleotris* spp.) was the most commonly caught species, in terms of both number of surveys and the number of sites at which it was caught, although the abundance of this species was highly varied. Eastern rainbow fish (*Melanotaenia splendida splendida*) had the highest abundance in the Dawson River. Variation in the abundance and / or presence of fish caught between sites and between surveys could be due to a range of factors, including:

- differences in habitat preferences between some of the species; for example some species of fish may prefer the riverine sites of the Dawson River compared to the Waterbody, e.g. Pacific blue-eyes with notable habitat differences between these water types relevant for this species being substrate composition, physical in-stream habitat cover, and flow variation (see Platten 2011), and
- differences in water levels between surveys, with very low water levels at site WLMP4 during survey 4 (autumn) resulting in no fish caught at this site during this survey (and absence of water during surveys 5 and 6 also meaning no fish were present at this site).

All of the native species that were caught are common and typical of the region. Two of the species (leathery grunter, *Scortum hillii* and southern saratoga, *Scleropages leichardti*) are endemic to the Fitzroy River Basin. No species of fish caught during the baseline surveys are listed under the EPBC Act or the NC Act.

Two exotic species of fish were caught during the baseline surveys: Goldfish (*Carassius auratus*) in the Waterbody, and mosquitofish (*Gambusia holbrooki*) in the Dawson River. These are two of the three exotic species of fish known from the Dawson River, and both species have been caught previously by frc environmental in the Dawson River and connected waterways (goldfish in Hutton Creek; mosquitofish elsewhere in the Dawson

River) (frc environmental, unpublished data). Eastern Gambusia is a restricted biosecurity matter under the Queensland *Biosecurity Act 2014*.

4.4.8 Turtles

Four species of turtle were caught across the baseline surveys:

- Krefft's river turtle (*Emydura macquarii*)
- white throated snapping turtle (*Elseya albagula*)
- saw-shelled turtle (*Wollumbinia latisternum*), and
- eastern long-necked turtle (*Chelodina longicolis*).

Six species of turtle have been caught during operational phase desalinated release REMP monitoring:

- Krefft's river turtle (*Emydura macquarii)*
- white throated snapping turtle (*Elseya albagula*)
- saw-shelled turtle (Wollumbinia latisternum)
- eastern long-necked turtle (*Chelodina longicolis*)
- broad-shelled river turtle (*Chelodina expansa*), and
- Fitzroy River turtle (*Rheodytes leukops*).

Two of these turtle species are threatened species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*:

- white throated snapping turtle (*Elseya albagula*) – critically endangered, and
- Fitzroy River turtle (*Rheodytes leukops*) – vulnerable.

A single white-throated snapping turtle was recorded in the Waterbody in 2017; otherwise, these two threatened species have only been recorded in low abundance in the Dawson River and Hutton Creek. For example, the baseline mean abundance of white throated snapping turtle in both the Dawson River and Hutton Creek was 0.1.

5 Environmental Values

The Queensland *Environmental Protection Act 1994* defines Environmental Values (EV) to be protected for Queensland waters in subordinate policies, specifically the Environmental Protection (Water and Wetland Biodiversity) Policy 2019, which defines:

- Scheduled EV that apply to a sub-regional catchment waters such as the Dawson River
- the management intent for waters such as moderately disturbed (MD) and
- water quality objectives (WQOs) that are intended to maintain or improve the condition of system.

The Environmental Protection (Water and Wetland Biodiversity) Policy 2019 Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment: September 2011 identifies the EVs for the Upper Dawson River (main channel) surface water environment, as summarised in Table 5.1. Table 5.1 also includes assessment of scheduled EV applicability to the waterhole and Dawson River in the proposed action area.

Table 5.1 Environmental Values Assessment for the Waterbody and Dawson River.

Environmental Value	Discussion	Applicability / Level	
		Waterbody	Dawson River
Aquatic Ecosystems	The Waterbody is a moderately disturbed lacustrine wetland that supports a range of common native fish, turtle, invertebrate and aquatic plant species. Several species of waterbird listed as Migratory under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* frequent the Waterbody, although these species are unlikely to be residents at the Waterbody. White-throated snapping turtle (*Elseya albagula*) and Fitzroy River turtle (*Rheodytes leuokops*), which are threatened species under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*, are known from the Dawson River in the project area. It is possible that these turtle species use the Waterbody periodically, but they are unlikely to be residents in the Waterbody.	Applicable – moderate	Applicable – high
Irrigation	There is one licence for irrigation water (License No 14134S) located approximately 71 km downstream of the existing desalinated water release location within the Dawson Valley, noting this licence provides authority to extract from an 'Unnamed tributary of the Dawson River', not the Dawson River. The Glebe Weir is located 156 km downstream of Yebna and is used for supply of water under the Dawson River Supply Scheme for use by irrigators. An additional 70,000 ML of unallocated water from the Dawson River was granted to 13 licenses by the Queensland DRDMW in March 2023.	Not applicable	Applicable – low
Farm Supply/Use	The Waterbody is currently not used for irrigation, nor is it considered to be used to supplement water for other farm based uses (e.g. milking sheds, fruit packing etc.). There is limited extraction of water for general farm supply from the Dawson River in the vicinity of the receiving environment.	Not Applicable	Applicable – low

Environmental Value	Discussion	Applicability / Level	
		Waterbody	Dawson River
Stock Watering	The nearest surface water domestic supply entitlement (Licence 37127S) is located approximately 244 km downstream of the existing desalinated water release location.	Applicable – high	Applicable – high
Aquaculture	There is currently no aquaculture in or within the immediate vicinity of the Waterbody or the receiving environment of the Dawson River.	Not Applicable	Not Applicable
Human Consumption	A water supply scheme is located in the Dawson River located approximately 250 km downstream of the proposed action, extending from upstream of Theodore to downstream of Boolburra.	Applicable – low	Applicable – low
Primary Recreation	The Waterbody is in a remote location and on private land, as such is not accessible to the public. The likelihood of primary recreation (e.g. swimming, etc.) within the Waterbody is considered to be very low. Similarly, public access to the receiving environment reach of the Dawson River is limited. It is possible but not well-known if local landholders use this reach of the Dawson River for swimming.	Applicable – low	Applicable – low
Secondary Recreation	The Waterbody is in a remote location and on private land, as such it is not accessible to the public. The likelihood of secondary recreation (e.g. fishing, sailing or other water sports etc.) within the Waterbody is considered to be very low. Similarly, the receiving environment reach of the Dawson River has few public access points, and while there may be some fishing by local landholders in this reach of the Dawson River, other forms of secondary recreation are unlikely.	Applicable – low	Applicable – low
Visual Appreciation	The Waterbody is in a remote location and on private land, as such it is not accessible to the public. Visual appreciation of environmental values, including picnicking, bush walking etc. are therefore not considered applicable to the Waterbody.	Applicable – low	Applicable – low

Environmental Value	Discussion	Applicability / Level	
		Waterbody	Dawson River
	Similarly, the receiving environment reach of the Dawson River has few public access points, and no established picnic areas or parklands are near this reach of the Dawson River.		
Drinking Water	There is no licenced (or known) extraction of water for drinking or human consumption purposes from the Dawson River or waterhole within the proposed action area. A search of the Business Queensland water entitlement viewer indicates that the closest surface water domestic supply entitlement (Licence 37127S) is located approximately 244 km downstream of the existing desalinated water release location at Theodore for domestic supply and drinking water following treatment. Due to the use of Dawson River water for town supply drinking water remains the primary EV to be protected under the State EA..	Not Applicable	Applicable – low
Industrial Use	The Waterbody is in a remote location and on private land, as such it is not accessible to the public. The property holder does not currently use the Waterbody for industrial purposes (e.g. power generation, manufacturing etc.). Consequently, the industrial use EV is not considered applicable. Similarly, there are no industrial uses of water in the vicinity of the receiving environment reach of the Dawson River	Not Applicable	Not Applicable
Cultural and Spiritual Values	Cultural and spiritual purposes are considered applicable to the Waterbody and the Dawson River. While there are no mapped/documented Cultural Heritage Exclusion Zones within the immediate vicinity of the Waterbody, there are several cultural heritage zones in the vicinity of the Dawson River.	Applicable – moderate	Applicable – high

5.1 Water Quality Guidelines

5.1.1 EA Contaminant Limits for Desalinated Produced Water

Condition B19 of the EA references the contaminant limits for desalinated produced water as presented in *Schedule B, Table 4 – Contaminant Limits* of the EA, presented here in Table 5.2. These guidelines stipulate water quality characteristics of the desalinated produced water that is permitted to be released to the Waterbody via the tributary gully.

Similarly, the EA requires desalinated produced water to achieve the Contaminant Limits for Protecting the Environmental Value of Drinking Water, as presented in Schedule B, Table 5 of the EA, presented here in Table 5.3.

Table 5.2 Contaminant Limits for Desalinated Produced Water (Schedule B, Table 4 – Contaminant Limits of the EA)

Water Quality Parameters	Units	EA Limit
Physicochemical Parameters		
Dissolved Oxygen - Field	mg/L	6.4-16.1
Electrical Conductivity - Field	µS/cm	370 (75%ile)
pH - Field	pH units	6.5-8.5
Suspended Solids	mg/L	NL
Turbidity - Field	NTU	50
Cations		
Calcium (dissolved)	mg/L	Minimum 1
Magnesium (dissolved)	mg/L	NL
Sodium (dissolved)	mg/L	115
Potassium (dissolved)	mg/L	NL
Anions		
Chloride	mg/L	175
Fluoride	mg/L	1.0
Sulfate as SO4 2-	mg/L	5
Metals and Metalloids		
Aluminium (dissolved)	mg/L	0.055
Arsenic (dissolved)	mg/L	NL
Boron (dissolved)	mg/L	2.9

Water Quality Parameters	Units	EA Limit
Cadmium (dissolved)	mg/L	0.0002
Chromium (dissolved)	mg/L	0.001
Cobalt (dissolved)	mg/L	NL
Copper (dissolved)	mg/L	0.0014
Lead (dissolved)	mg/L	0.0034
Manganese (dissolved)	mg/L	1.9
Mercury (dissolved)	mg/L	0.0006
Nickel (dissolved)	mg/L	0.011
Selenium (dissolved)	mg/L	0.011
Zinc (dissolved)	mg/L	0.008
Nutrients		
Ammonia as N	mg/L	0.9
Nitrate as N	mg/L	NL
Nitrite + Nitrate as N	mg/L	NL
Total Nitrogen as N	mg/L	0.62
Total Phosphorus as P	mg/L	NL

Table 5.3 Contaminant Limits for Desalinated Produced Water (Schedule B, Table 5 – Contaminant Limits for Protecting Environmental Value of Drinking Water of the EA)

Quality Characteristic	Units	Drinking Water Limit
Alpha Activity	Bq/L	0.5
Aluminium	mg/L	0.2
Ammonia	mg/L	0.5
Antimony	mg/L	0.003
Arsenic	mg/L	0.01
Barium	mg/L	2
Benzene	µg/L	1
Beta Activity	Bq/L	0.5
Bisphenol A	µg/L	200
Boron	µg/L	4000

Quality Characteristic		Units	Drinking Water Limit
Bromide		mg/L	7
Cadmium		mg/L	0.002
Chromium		mg/L	0.05
Copper		mg/L	2
Cyanide		mg/L	0.08
Ethylbenzene		µg/L	300
Fluoride		mg/L	1.5
Iodide		mg/L	0.5
Lead		mg/L	0.01
Manganese		mg/L	0.5
Mercury		mg/L	0.001
Molybdenum		mg/L	0.05
Nickel		mg/L	0.02
Nonylphenol		µg/L	500
PAH (as B(a)P TEF)	TEF:	µg/L	0.01
Benz[a]anthracene	0.1		
Benzo[b+]fluoranthene	0.1		
Benzo[k]fluoranthene	0.1		
Benzo[a]pyrene	1.0		
Chrysene	0.01		
Dibenz[a,h]anthracene	5		
Indeno[1,2,3-cd]pyrene	0.1		
Selenium		mg/L	0.01
Silver		mg/L	0.1
Strontium		mg/L	4
Toluene		µg/L	800
TPH		µg/L	200
Vanadium		mg/L	0.05
Xylenes		µg/L	600

Quality Characteristic	Units	Drinking Water Limit
Zinc	mg/L	3
Disinfection by-products:		
Bromochloroacetonitrile	mg/L	Monitor only
Dichloroacetonitrile	mg/L	Monitor only
N-Nitrosodimethylamine	µg/L	0.1
Trihalomethanes (THM):	mg/L	0.25
Bromodichloromethane		
Bromoform		
Chloroform (Trichloromethane)		
Dibromochloromethane		

5.1.2 Receiving Environment Water Quality

Local, project specific water quality guidelines (WQGs) for the Environmental Value of Protection of Aquatic Ecosystems have been developed for the parameters listed in *Schedule B, Table 4 – Contaminant Limits* of the EA (frc environmental 2015a). The local WQGs for the Waterbody and the Dawson River for the parameters that have monitoring points in the receiving environment are presented in Table 5.4, with several other parameters also monitored to aid interpretation of biological monitoring results or to support water quality investigations should any be required in the future.

The WQGs represent trigger levels for parameters that when achieved provide protection of the relevant EV. Where a WQG is not met, further investigation is required to determine if adverse environmental harm has been or may be caused. Thus, exceedance of the WQGs does not indicate adverse environmental harm in itself; only the need for further investigation (refer to Section 7.3). Note that where a WQG is endorsed by stakeholders and is scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019, it is known as a Water Quality Objective (WQO). Default published WQOs have been published for the Dawson River; however, the approach of the National Water Quality Guidelines is to use preferentially use locally derived WQGs if they are available (ANZG 2018). This preference extends also to sediment and biological parameters (presented below).

The project specific WQGs typically represent high trigger values on the basis that contaminants generally increase concentrations above levels that may become toxic or

harmful to aquatic ecosystems. However, the desalinated produced water may sometimes have the opposite affect for some parameters, where it may reduce the concentration to a level that may become harmful, for example, low dissolved oxygen or low pH. In such cases a minimum trigger has also been developed, and the local WQG is presented as a range.

Local water quality guidelines could not be developed for Hutton Creek because data was only available from one reference site (a minimum of three reference sites are needed where two years of data are available (DES 2022). Therefore, the applicable water quality guidelines for Hutton Creek are those published in the Dawson EPP (EHP 2013) (Table 5.4). However, baseline water quality data from site DRR2 on Hutton Creek was summarised to aid in the interpretation of water quality data collected at this site during REMP events (Appendix E).

The full baseline range (i.e. minimum and maximum) for each parameter for each water type is presented in Appendix F to aid interpretation of water quality monitoring data.

Table 5.4 Local Water Quality Guidelines Developed From Baseline Data as per the QWQG.

Parameter	Unit	Local Water Quality Guideline		Default Water Quality Guidelines [a]
		Waterbody	Dawson River	Hutton Creek
Physical Chemical				
Temperature [b]	°C	19.0 – 29.3	15.8 – 27.1	–
Dissolved Oxygen [b]	mg/L	6.4 – 16.1	6.4 – 16.1	6.4 – 16.1
Electrical Conductivity @ 25°C	µS/cm	627	500	500
pH [a]	pH Unit	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5
Suspended Solids	mg/L	128	50	50
Turbidity [b]	NTU	monitor only	monitor only	monitor only
Nutrients				
Ammonia as N [a]	mg/L	0.9	0.9	0.9
Total Nitrogen as N	mg/L	3.93	0.62	0.62
Ions				
Calcium	mg/L	monitor only	monitor only	monitor only
Magnesium	mg/L	monitor only	monitor only	monitor only
Total Metals and Metalloids				
Boron	µg/L	2900 [c]	2900 [c]	2900 [c]
Zinc	µg/L	12	8	8
Dissolved Metals and Metalloids				
Boron	µg/L	2900 [c]	2900 [c]	2900 [c]
Zinc	µg/L	8	8	8

source: frc environmental 2015b

[a] default guideline as presented in *Schedule B, Table 4 – Contaminant Limits* of the EA.

[b] based on field data

[c] refer to Appendix A, based on direct toxicity assessment of total boron (AECOM 2019)

5.1.3 In-stream Sediment Quality

Local, project specific sediment quality guidelines were developed for selected parameters, including metals and metalloids as specified in Condition B41 (l) of the EA (frc environmental 2015c) (Table 5.5).

Where these guidelines are exceeded, then this would trigger further investigation as described in Section 7.3.

Table 5.5 Local Sediment Quality Guidelines (Trigger Values) for Metals and Metalloids in Each Water Type.

Parameter	Units	Trigger Value [a]	SQG-High [a]	LOR	Waterbody			Dawson River			Hutton Creek		
					count	median	80th percentile	count	median	80th percentile	count	median	80th percentile
Aluminium	mg/kg	–	–	0.5	63	7097	13933	45	1874	5191	21	6290	11800
Arsenic	mg/kg	20	70	1	63	2.57	3.5	45	1.33	2.36	21	2.5	4.5
Boron	mg/kg	–	–	5	63	9.97	18.8	45	5.15	17.9	21	12	25
Cadmium	mg/kg	1.5	10	0.5	54	<0.5	<0.25	42	<0.5	<0.25	18	<0.5	<0.25
Chromium	mg/kg	80	370	1	63	10.0	12	45	3.78	6.42	21	8.3	15
Copper	mg/kg	65	270	1	63	9.07	14	45	2.37	5.93	21	7	11
Iron	mg/kg	–	–	2	63	10727	17867	45	4050	9353	21	12100	20700
Lead	mg/kg	50	220	1	63	13.7	17.6	45	4.38	8.72	21	11.5	16
Manganese	mg/kg	–	–	1	63	466	648	45	92.4	230.5	21	264	337
Mercury	mg/kg	0.15	1	0.5	63	<0.5	<0.25	45	<0.5	<0.25	21	<0.5	<0.25
Nickel	mg/kg	21	52	0.5	63	7.57	11.5	45	2.7	5.53	21	5.4	9
Selenium	mg/kg	–	–	1	63	<1	1	45	<1	1.73	21	<1	1
Zinc	mg/kg	200	410	5	63	33.6	51.3	45	9.92	25.1	21	25.3	45

LOR = analytical limit of reporting

Blue shading denotes trigger values for each water type; where the published trigger value was adopted it applied to all three water types.

[a] Trigger Values and SQG- High values as published in ANZG (2018)

5.1.4 Biological Guidelines

Local, project specific biological guidelines for the Environmental Value of Protection of Aquatic Ecosystems have been developed (frc environmental 2015b) for macroinvertebrates and fish:

- macroinvertebrates (Table 5.6), and
- fish:
  - Waterbody: four species (i.e. ≥ 4)
  - Dawson River: five species (i.e. ≥ 5)
  - Hutton Creek: two species (i.e. ≥ 2)

White-throated snapping turtle and Fitzroy River turtle are included in the REMP as 'monitor only', because the low frequency of occurrence of the threatened turtle species recorded during the baseline program precludes development of a practical local biological guideline. For the purpose of the REMP, raw turtle monitoring data (i.e. species, abundance by life history stage and apparent health) is recorded and compared with baseline data. Successful recruitment by threatened turtles is the main threatening process for the threatened turtle species due to nest predation by introduced predators (pigs, foxes, dogs, cats) and native predators (goannas), and trampling of nests by cattle. The baseline program failed to record any juveniles of the threatened turtle species, and so absence of juveniles of the threatened turtle species is not an indicator of adverse impact caused by the release of desalinated produced water. Monitoring data for other turtle species will also be recorded and evaluated, such as for Krefft's turtle (*Emydura krefftii*), which is common in the Waterbody and Dawson River within the receiving environment. Where monitoring data indicates potential risks to Krefft's turtle, investigation into possible risks to threatened turtles will be implemented.

Macrocrustacean exoskeleton condition is also assessed qualitatively, and notes of reproduction (i.e. gravid individuals) are made, with exoskeleton condition and evidence of reproduction qualitatively compared with baseline observations. Where there is a notable decline in apparent exoskeleton condition, and / or frequency of evidence of reproduction, compared to baseline observations, it could indicate water quality impacts, especially low concentrations of ion (calcium and magnesium). Therefore, where there is an apparent decline in the exoskeleton condition or frequency of reproduction in macrocrustaceans, further investigation would be triggered, as described in Section 6.3.

Zooplankton (i.e. pelagic microcrustaceans) have also been included as a biological parameter since 2018, because this group of aquatic fauna may be particularly sensitive to water quality changes, especially low concentrations of ion (calcium and magnesium).

There is no baseline data available for zooplankton, so the approach used to evaluate zooplankton comprises multivariate statistical analyses (i.e. permutational analysis of variance (PERMANOVA) and multi-dimensional scaling (MDS)) of the full time series of zooplankton data (i.e. since 2018). Where these analyses indicate an outlier in the recent / current monitoring event, then this would trigger further investigation as described in Section 7.3.

Table 5.6 Local biological guidelines for macroinvertebrates for each water type.

Macroinvertebrate index	Waterbody	Dawson River	Hutton Creek
Abundance	92.3 – 252.8	39.9 – 152.0	23.0 – 207.4
Taxonomic Richness	5.67 – 10.8	9.93 – 16.9	4.0 – 10.0
PET richness	0.0 – 1.2	1.47 – 4.0	0.0 – 1.0
SIGNAL-2 Score	2.65 – 3.20	3.46 – 4.00	2.90 – 3.30

Source: frc environmental 2015c

6 Temporal Context of the REMP

Temporal considerations are important for the Dawson River Watercourse Releases REMP:

- periods of desalinated release: REMP monitoring is implemented as per design presented in this report, adhering to post-wet (autumn) and pre-wet (spring) monitoring where possible for aquatic ecology parameters (i.e. high river flows may require flexibility in monitoring of some parameters), and additional summer and winter monitoring events for water quality only, and
- following cessation of the desalinated releases: two-years of post-release monitoring, adhering to pre-wet and post-wet frequency for REMP surveys, then cessation of monitoring program.

7 Monitoring Program Design

7.1 Monitoring Program Components

The desalinated produced water is monitored prior to release to the Waterbody in accordance with EA Conditions B19 and B20. Release of this water may:

- directly influence certain water quality and sediment quality parameters within the receiving environment
- directly influence bank stability
- indirectly influence algae blooms in the Waterbody, and
- indirectly influence biological communities (i.e. threatened turtle species, fish, macroinvertebrates and zooplankton) within the receiving environment.

Therefore the receiving environment monitoring components are:

- hydrology
- geomorphology (bed and bank stability)
- water quality
- sediment quality
- algae blooms
- biology:
  - white-throated snapping turtle and Fitzroy River turtle
  - fish
  - macroinvertebrates
  - zooplankton
  - crustacean exoskeleton condition.

These monitoring components align with those required under Condition 41 of the EA, and allow for early detection of potentially adverse direct or indirect impacts to threatened turtles as required under the Commonwealth approval.

7.2 Monitoring Sites and Indicators

7.2.1 Monitoring Sites

The desalinated produced water is monitored prior to release to the Waterbody.

The REMP includes sites within the receiving environment (i.e. the Waterbody and Dawson River downstream of the release) to assess any influences of the releases on the water quality of aquatic ecology of the receiving environment, and upstream control sites to enable control site – test site comparisons, and implementation of BACI (before-after-control-impact) analyses if needed (Table 7.1, Map 6.1). Specifically:

- hydrology will be monitored at control sites DRR1 and receiving environment sites WLMP1, DRMP1 and S4 on the Dawson River
- monitoring of geomorphology (bed and bank stability) to ensure compliance with Condition B24 of the EA will involve assessment of bed and bank stability using the Sustainable Rivers Audit physical habitat methodology at control sites DRR1 and DRR2, and receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4
- water quality and algal blooms will be monitored at (Table 7.1, Map 6.1) at control sites DRR1 and DRR2, and receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5, DRMP1 and S4, and
- sediment, aquatic habitat and biological parameters (including crustacean exoskeleton condition) will be monitored at sites control sites DRR1 and DRR2, and receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4.

Table 7.1 Description of REMP Monitoring Sites for Desalinated Releases Program.

Site	Description	GDA94	
		Latitude	Longitude
Waterbody sites within the Receiving Environment			
WLMP1 [a]	Waterbody; 200 m downstream of where the tributary gully discharges into the Waterbody.	-25.708	149.146
WLMP2 [b]	Waterbody; 450 m upstream of where the tributary gully discharges into the Waterbody.	-25.706	149.143
WLMP3 [c]	Waterbody; 300 m downstream of where the tributary gully discharges into the Waterbody.	-25.707	149.149
WLMP4 [d]	Waterbody; 1.5 km upstream of where the tributary gully discharges into the Waterbody.	-25.698	149.139
WLMP5 [e]	Waterbody; 1.0 km downstream of where the tributary gully discharges into the Waterbody.	-25.701	149.153
Dawson River sites within the Receiving Environment			
DRMP1	Dawson River; 3.5 km downstream of where the tributary gully discharges into the Waterbody and 200 m downstream of the confluence of the tributary gully and the Dawson River.	-25.6905	149.1675
S4	Dawson River at Yebna Crossing; 9.8 km downstream of where the tributary gully discharges into the Waterbody and 8 km downstream of the confluence of the tributary gully and the Dawson River. Represents the downstream extent of the receiving environment.	-25.692	149.216
Control Sites Upstream of the Receiving Environment			
DRR1 [f]	Dawson River; 550 m upstream of the confluence of the tributary gully and the Dawson River.	-25.688	149.156
DRR2 [g]	Hutton Creek; 34 km upstream of the confluence of the tributary gully and the Dawson River	-25.718	148.971

Baseline site represented by: [a] = WMP1, [b] = WMP2, [c] = WMP3, [d] = WMP4, [e] =WMP5, [f] = RS1, [g] = RS2

149° E
149.05° E
149.1° E
149.15° E
149.2° E
25.65° S
25.7° S
25.75° S

PL 91
Dawson River
PL 92
Hutton Creek
PL 232
PL 100
PL 99
Commissioner Creek
Tributary Gully
Injune Road
St George Rockhampton Road

DRR1
DRMP1
S4
WLMP4
WLMP5
WLMP2
WLMP1
WLMP3
DRR2
S3a
S1a

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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210208 Santos Dawson River Watercourse Releases: Receiving Environment Monitoring Program

Map 7.1: Monitoring sites for the Santos Dawson River Watercourse Releases Receiving Environment Monitoring Program

SOURCES

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LEGEND

Monitoring Sites
- Dawson River sites
- Hutton Creek sites
- Waterbody sites

Waterbody

Tributary Gully

Major Waterway

Fairview Project Area

Local Road

N

SCALE

0 1 2 4
Kilometres

Scale: 1:75,000 @ A3

PROJECTION
Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

DATE
2021-04-15

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VERSION
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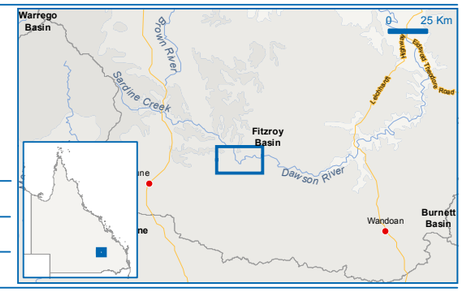

7.2.2 Indicators to be Monitored and Frequency of Monitoring

The water quality indicators to measure in the desalinated produced water prior to release to the Waterbody are presented in Table 5.2 and Table 5.3. The frequency of monitoring ranges from daily to weekly during releases from ROP 2 for parameters listed in Table 5.2, and is quarterly for parameters listed in Table 5.3.

A summary of the indicators and monitoring frequency used at control and receiving environment sites is presented in Table 7.2, with:

- flow discharge measured in cubic metres per second (m^3/s) recorded at the gauging stations, and visual observations of flow conditions also recorded as part of the pre-wet season and post-wet season aquatic habitat assessments
- the water quality indicators presented in Table 5.3 and Table 5.4 assessed quarterly
- algal blooms assessed visually during quarterly water quality monitoring assessments
- geomorphological monitoring of bed and bank stability assessed as part of the pre-wet season and post-wet season aquatic habitat assessments
- sediment quality indicators presented in Table 5.5 will be monitored twice each year, adhering to a pre-wet and post-wet schedule, where possible
- aquatic habitat and biological parameters (fish, macroinvertebrates – see Table 5.6, turtles, zooplankton and microcrustacean exoskeleton condition) will be monitored twice per year, adhering to a pre-wet and post-wet schedule, where possible (Table 7.2).

A detailed explanation of the methods is provided in the procedures for aquatic ecological monitoring (Appendix D). If unsafe conditions (e.g. river flows following rain events) prevent the safe application of the procedures (e.g. fish / turtle netting), the frequency of monitoring components may be altered.

REMP monitoring is proposed to cease two years post cessation of the desalinated releases, implementing only pre-wet and post-wet frequency monitoring (i.e. 4 monitoring rounds completed after releases cease).

Table 7.2 REMP design for Dawson River Watercourse Releases Desalinated Releases Program.

Monitoring Component	Parameter	Monitoring Site	Monitoring Frequency	Action Level
Hydrological Components				
stream flow	discharge (m^3/s) and water level (m)	gauging stations located at receiving environment sites WLMP1, and S4	discharge monitored daily but accessed as needed	monitor only
		WLMP1, DRMP1 and control site DRR1	visual observations twice per year (notionally pre-wet and post-wet season)	
Geomorphology Components				
bed and bank stability	assessment of bed and bank	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	compare against Section 7.3
Water Quality Components – Aquatic Ecosystems [a]				
physico-chemical parameters	temperature, pH, electrical conductivity, turbidity, dissolved oxygen	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3

Monitoring Component	Parameter	Monitoring Site	Monitoring Frequency	Action Level
	total suspended solids	receiving environment sites WLMP1, WLMP2, WLMP3 WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3
nutrients	total nitrogen	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3
	ammonia	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3
metals and metalloids	total and dissolved boron	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3
	dissolved zinc	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	compare against Section 7.3
ions	calcium and magnesium	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	Monitor only

Monitoring Component	Parameter	Monitoring Site	Monitoring Frequency	Action Level
	dissolved metals and metalloids (Al, As, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se)	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	Required if triggered by exceedances investigation	compare against Section 7.3
major ions	total Cl, Fl, K, Na, SO_4 and total Hardness as $CaCO_3$	receiving environment sites WLMP1, WLMP2, WLMP3, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	Required if triggered by exceedances	Compare against Section 7.3
algae	visual inspection	receiving environment sites WLMP1, WLMP4, WLMP5 and DRMP1; control sites DRR1 and DRR2	quarterly (notionally pre-wet season and post-wet season, and summer and winter)	Monitor only
Water Quality Components – Drinking Water Quality [a]				
drinking water components	alpha activity, aluminium, ammonia, antimony, arsenic, barium, benzene, beta activity, bisphenol A, boron, bromide, cadmium, chromium, copper, cyanide, ethylbenzene, fluoride, iodide, lead, manganese, mercury, molybdenum, nickel, nonylphenol, PAH (as B(a)P TEF), selenium, silver, strontium, toluene, TPH, vanadium, xylenes, zinc	receiving environment site S4	first release day of each quarter	Compare against Section 7.3

Monitoring Component	Parameter	Monitoring Site	Monitoring Frequency	Action Level
Sediment Quality Components				
metals and metalloids	total metals and metalloids (As, B, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn)	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	Compare against Section 7.3
Biological Components				
threatened turtle species	Monitor only (compare raw monitoring data with baseline data)	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	Monitor only
macroinvertebrates	richness of aquatic macroinvertebrate taxa identified to the lowest practical taxonomic level; density of exoskeleton of crustaceans and molluscs	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	Compare against Section 7.3
fish	richness of species	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	Compare against Section 7.3

Monitoring Component	Parameter	Monitoring Site	Monitoring Frequency	Action Level
zooplankton	Multivariate statistical analyses of full time series of data	receiving environment sites WLMP1, WLMP4, WLMP5, DRMP1 and S4; control sites DRR1 and DRR2	twice per year (notionally pre-wet season and post-wet season)	Compare against Section 7.3

[a] only water quality monitoring relating to the receiving environment is presented. Refer to the EA for monitoring requirements for Inlet to Release Pipe (HCS04DWB1) for ROP2.

7.3 Investigation and Management Responses to Exceedances

As noted above, an exceedance of a WQG does not indicate an adverse impact to Environmental Values of the receiving environment, but instead triggers a need for further investigation so as to ensure early detection of any potential risks.

The specific steps involved in investigating an exceedance of a project specific WQG are presented in Figure 7.1

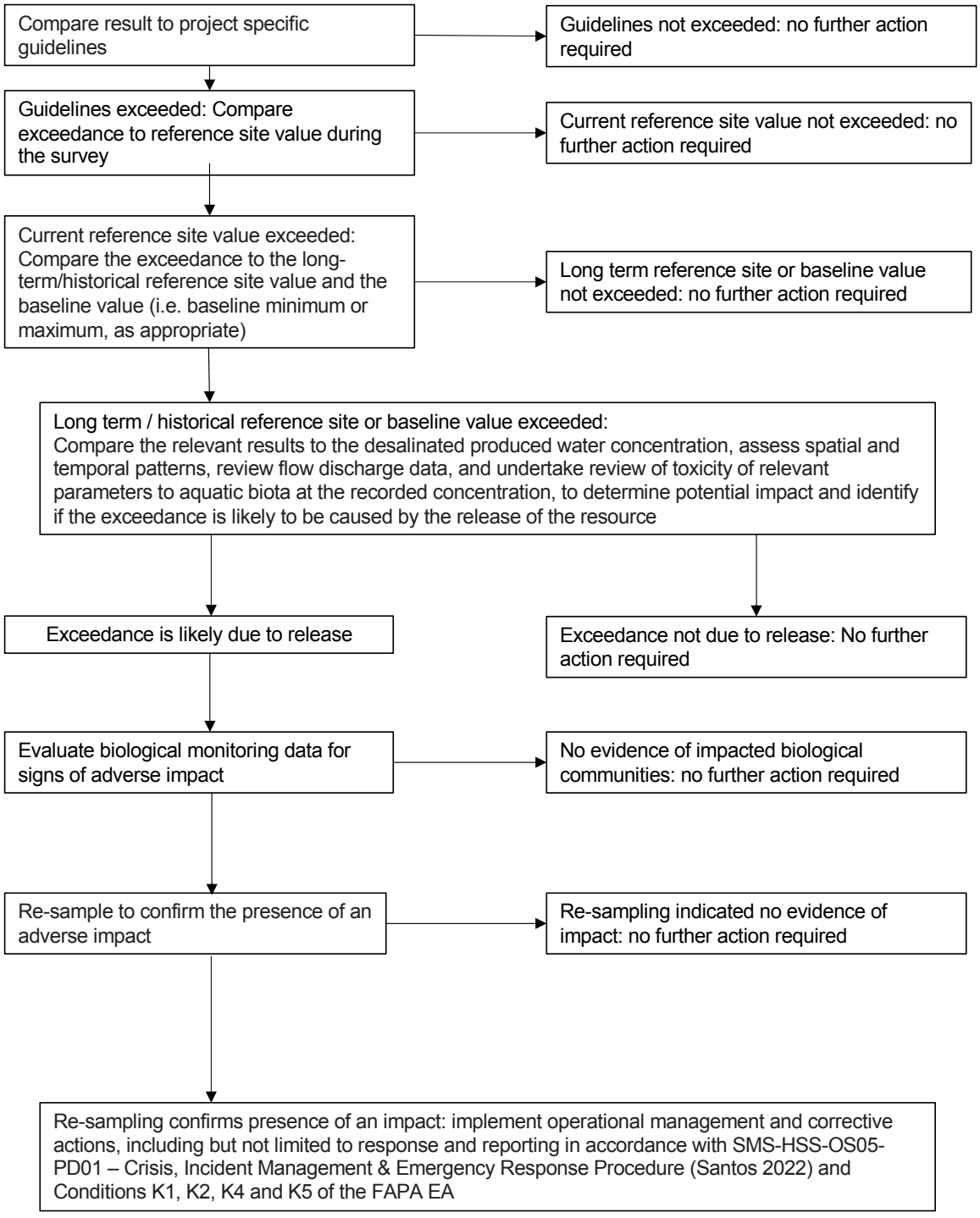

Figure 7.1 Steps for investigating exceedances of the project specific water quality, sediment quality and biological guidelines.

7.4 Quality Assurance and Quality Control

In accordance with Conditions A5, A15 and B40 of the EA, the REMP will be maintained, certified (Appendix C) and undertaken by suitably qualified persons. The monitoring, analysis and reporting, will have regard to the procedures and quality assurance / quality control (QA/QC) requirements set out in the following documents:

- Australian Guidelines for Fresh and Marine Water Quality (ANZG 2018)
- Monitoring and Sampling Manual 2018, Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (DES 2018)
- AS 3778.3.1 Measurement of Flow in Open Channels
- Sustainable Rivers Audit physical habitat methodology (MDBC 2004)
- Australian / New Zealand Standard AS5667.1 Water Quality – Sampling
- AS/NZ5667.12 Guidance on Sampling of Bottom Sediments
- Handbook for Sediment Quality Assessment (Simpson et al. 2005)
- Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual (DNRM 2001)
- SMS-HSS-OS05-PD01 – Crisis, Incident Management & Emergency Response Procedure (Santos 2022), and
- procedures for aquatic ecological monitoring (Appendix D).

Further details of the QA/QC procedures for each parameter are provided in the water sampling manual and procedures for aquatic ecological monitoring documents.

7.4.1 Recording of Planned and Unplanned Releases and Procedure for Event Monitoring

Condition B41(v) of the EA requires the recording of planned and unplanned releases to watercourses, procedures for event monitoring, monitoring methodology used and procedure to establish background surface water quality.

Condition B18 of the EA authorises the planned release of up to 18 ML/day of desalinated produced water to the Waterbody. The quantity of desalinated released will be measured and recorded by maintenance staff.

Conditions B18 and B41(v) will be appropriately managed through the SMS-HSS-OS05-PD01 – Crisis, Incident Management & Emergency Response Procedure (Santos 2022). This procedure also documents any reporting and notification requirements, as detailed in EA Conditions K1, K2, K4 and K5.

7.4.2 Assumptions and Qualifications

To allow for comparisons with baseline conditions, the proposed desalinated release monitoring sites are based on the location of baseline monitoring sites.

Some sites (e.g. WLMP4) may be dry in some surveys, depending on factors such as antecedent rainfall. Where sites are dry, bank stability and sediment quality will still be sampled during the desalinated release monitoring program.

8 Data Analysis and Reporting

8.1 Quarterly REMP Reports

Water quality, sediment quality, aquatic habitat (including bed and bank stability) and biological parameters are assessed during the post-wet season (autumn) and the pre-wet season (spring), with water quality assed during winter and summer. Therefore, there will be four quarterly REMP Survey Reports each year (i.e. spring and autumn reports – all parameters; summer and winter reports – water quality only).

For each quarterly report, the methods, results and analyses (i.e. comparisons to project specific guidelines; see Appendix D for data analyses and statistical procedures) of the applicable survey data will be presented. For the quarter leading up to the survey, the following will also be presented:

- monitoring results of the desalinated produced water, and
- a review of data in accordance with Section 6.3.

8.2 Incident Reports

Santos Ltd will report incidents and non-conformances as required per Conditions K1, K2, K4 and K5 of the EA, as described in section 6.3.

8.3 Annual Report

An over-arching annual report will be prepared that responds specifically to EA and EPBC approval conditions relevant to the REMP.

The report will include the following:

- a discussion of whether compliance with each condition was achieved, and if not what corrective actions were taken
- a hydrograph, presenting for the 12-month reporting period the volume and timing of all release events, daily water level date, and the dates of each monitoring event
- the quarterly REMP survey reports appended to the annual report, and referenced in the report where appropriate

- long-term trend graphs of key parameters (including calcium, magnesium, boron) and discussion
- all triggers (exceedances) that have occurred during the reporting period, including for water quality, sediment quality, and biological monitoring components, presented in a table:
  - the table will include the date, location, parameter, and trigger value for each trigger (exceeding parameter)
  - the results of each trigger (exceedance) investigation, in accordance with Figure 7.1, will be presented,
- any incident reports referenced and appended, and

a discussion of all monitoring results, including whether the results indicate a change to the health of the receiving environment.

9 References

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Appendix A Environmental Authority

Permit

Environmental Protection Act 1994

Environmental authority EPPG00928713

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPPG00928713

Environmental authority takes effect on 25 August 2023.

Environmental authority holder(s)

Name(s)	Registered address
SANTOS TOGA PTY LTD	Ground Floor, Santos Centre 60 Flinders Street ADELAIDE SA 5000
TOTALENERGIES EP AUSTRALIA	BGC Centre Level 13, 28 The Esplanade PERTH WA 6000
KGLNG E&P Pty Ltd	Level 11 28 The Esplanade PERTH WA 6000
TOTALENERGIES EP AUSTRALIA II	BGC Centre, Level 13 28 The Esplanade PERTH WA 6000
SANTOS QUEENSLAND, LLC	Ground Floor, Santos Centre 60 Flinders Street ADELAIDE SA 5000
PAPL (Upstream) Pty Limited	c/- Addisons Commercial Lawyers Level 12, 60 Carrington Street SYDNEY NSW 2000
SANTOS TPY CSG CORP.	Ground Floor, Santos Centre 60 Flinders Street ADELAIDE SA 5000

SANTOS TPY, LLC	Santos Centre G, 60 Flinders Street ADELAIDE SA 5000
BRONCO ENERGY PTY LIMITED	Ground Floor, Santos Centre 60 Flinders Street ADELAIDE SA 5000

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Schedule 3 - 06 - A petroleum activity carried out on a site containing a high hazard dam or a significant hazard dam	ATP526; ATP2012; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PL90; PL91; PL92; PL99; PPL76; PPL92
Ancillary 63 - Sewage Treatment - 1(a-i) - Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of 21 to 100EP - if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Ancillary 08 - Chemical Storage - 3 - Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c)	ATP526; ATP2012; PL232; PL233; PL234; PL235; PL236; PL90; PL91; PL92, PL99; PL100; PL420; PL421; PL440; PL1017; PPL76; PPL92
Schedule 3 - 08 - A petroleum or GHG storage activity, other than items 1 to 7, that includes an activity from Schedule 2 with an AES	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Ancillary 63 - Sewage Treatment - 1(b-i) - Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Ancillary 64 - Water treatment - 3 - Treating 10ML or more raw water in a day	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92

Environmentally relevant activity/activities	Location(s)
Ancillary 62 - Resource recovery and transfer facility operation - 1(c) - Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 2 regulated waste	ATP526; ATP2012; PL232; PL233; PL234; PL235; PL236; PL420; PL421 PL440; PL90, PL91, PL92, PL99; PL100; PL1017; PPL76, PPL92
Ancillary 55 - Other waste reprocessing or treatment - 2(c) - Operating a facility for receiving and either reprocessing or treating, in a year, the following quantity of category 2 regulated waste - more than 10,000t	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL232; PL1017; PPL76; PPL92
Schedule 3 - 07 - A petroleum activity involving injection of a waste fluid into a natural underground reservoir or aquifer	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Schedule 3 - 03 - A petroleum activity that is likely to have a significant impact on a category A or B Environmentally Sensitive Area	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PL2066; PPL76; PPL92
Ancillary 15 - Fuel burning - Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Ancillary 14 - Electricity generation - 1 - Generating electricity by using gas at a rated capacity of 10MW electrical or more	ATP526; ATP2012; PL90; PL91; PL92; PL99; PL100; PL232; PL233; PL234; PL235; PL236; PL420; PL421; PL440; PL1017; PPL76; PPL92
Non-Scheduled - Petroleum Activity - Water Monitoring Authority (WMA)	WMA2020

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Mobile and temporary activities

If you operate a mobile and temporary environmentally relevant activity (ERA), other than regulated waste transport, you are required to maintain a work diary. You must:

- use the approved form for a work diary (ESR/2015/1696);
- keep the work diary records for 2 years after the last entry;
- inform the administering authority within 7 days of the work diary being lost or stolen;
- record the information required in the work diary for each location within 1 day of leaving the location.

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days)

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority - on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise - on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

The anniversary day of this environmental authority is the same day each year as the effective date. The payment of the annual fee will be due each year on this day. An annual return will be due each year on 01 April.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

	25 August 2023
Signature	Date

Tristan Roberts
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Energy and Extractive Resources
GPO Box 2454, BRISBANE QLD 4001
Phone: (07) 3330 5715
Email: EnergyandExtractive@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access State controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Conditions of environmental authority

SCHEDULE A- GENERAL

A1 This environmental authority authorises the carrying out of the following resource activity(ies):

(a) the petroleum activities listed in *Schedule A, Table 1 – Scale and Intensity for the Activities* to the extent they are carried out in accordance with the activity's corresponding scale and intensity;
(b) incidental activities that are not otherwise specified relevant activities.

Schedule A, Table 1 – Scale and Intensity for the Activities

Tenure Numbers	Petroleum Activities and Infrastructure	GLNG Project		GFD Project	
		Scale (number of activities)	Intensity (maximum size in total)	Scale (number of activities)	Intensity (maximum size in total)
ATPs: 526/2012 PLs: 90, 91, 92, 99, 100, 232,	Coal seam gas exploration, appraisal and development wells	1256 wells	2611 ha	1,711 ha	Up to 2,567 ha
	Stimulation activities	All wells are subject to stimulation activities			
	Injection Wells FV77 and FV82	2	6 ha	N/A	
	Gathering lines/transmission lines	N/A		As required	
	Access Roads	N/A		As required	Access road width: up to 30m
	Compressor Stations (below the threshold of 500kg of fuel per hour)	N/A		1	Up to 8ha

Tenure Numbers	Petroleum Activities and Infrastructure	GLNG Project		GFD Project	
		Scale (number of activities)	Intensity (maximum size in total)	Scale (number of activities)	Intensity (maximum size in total)
233, 234, 235, 236, 420, 421, 440, 1017 PPLs: 76, 92, 2066	Compressor Station(s)	11 A-CS-01 / ACS-02 ACS-03 CS1 CS2 CS3 F-HCS-04 F-HCS-05 F-NCS-04-01 F-NCS-04-02 F-NCS-05-01 F-NCS-05-02	360 ha	N/A	
	Regulated Structure(s)	N/A		4	Up to 64 ha
	Regulated Structure(s) (Dams) ≥400 megalitres	5	250 ha	N/A	
	Regulated Structure(s) (Dams) <400 megalitres	43	270 ha	N/A	
	Low Hazard Dam(s)	4910	1229 ha	N/A	
	Water Treatment Facilities that allow treated water to be released to waters other than seawater	7	≤50 ML/day	N/A	
	Water Treatment Facilities	6	≤25 ML/day	1	Up to 10 ha
	Sewage Treatment Plant(s)	N/A		11	>100 equivalent persons (EP) ≤ 450EP: As required
				26	>21 EP ≤ 100 EP: As required
	Sewage Treatment Plant(s) that discharge treated effluent to an infiltration trench or through an irrigation scheme, or to land for dust suppression or construction purposes	11	>100 equivalent persons (EP) ≤ 450 EP	N/A	
		26	>21 EP ≤ 100EP	N/A	

A2 The resource activities in condition (A1) are authorised subject to the conditions of this environmentalauthority.

A3 A register identifying infrastructure constructed and disturbance incurred under the GFD Project Environmental Impact Statement must be maintained. This register must be provided to the administeringauthority upon request.

A4 This environmental authority authorises a relevant act[1] to occur only to the extent that:

(a) the relevant act is an ordinary consequence of carrying out the resource activities authorised bythis environmental authority in accordance with its conditions; or

(b) the relevant act is specifically authorised by the conditions of this environmental authority and carrying out an activity which results in the relevant act does not contravene the conditions of this authority.

[1] See section 493A of the *Environmental Protection Act 1994*

Monitoring

A5 All monitoring required must be undertaken by a suitably qualified person.

A6 If requested by the administering authority in relation to investigating a complaint, monitoring must becommenced within 10 business days.

A7 The administering authority must be advised in writing of the results of the investigation (including an analysis and interpretation of the monitoring results) and actions proposed or undertaken to resolve the complaint within five (5) business days of completing the complaint investigation, unless a longer time isagreed to by the administering authority.

A8 All laboratory analyses and tests required must be undertaken by a laboratory that has NATAaccreditation for such analyses and tests.

A9 Notwithstanding condition (A8), where there are no NATA accredited laboratories for a specific analyte orsubstance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

A10 Monitoring and sampling must be carried out in accordance with the requirements of the followingdocuments (as relevant to the sampling being undertaken), as amended from time to time:

(a) for waters and aquatic environments, the Queensland Government's Monitoring and SamplingManual Environmental Protection (Water) Policy 2009.

(b) for groundwater, the Australian Government's Groundwater Sampling and Analysis -

A FieldGuide and any applicable Australian Standard.

(c) for noise, the latest Department of Environment and Science Noise Measurement Manual andany applicable Australian Standard.

(d) for air, the Queensland Air Quality Sampling Manual and/or Australian Standard 4323.1:1995 Stationary source emissions method 1: Selection of sampling positions, as appropriate for therelevant measurement

(e) for soil, the Guidelines for Surveying Soil and Land Resources, 2nd edition (McKenzie et al. 2008), and/or the Australian Soil and Land Survey Handbook, 3rd edition (National Committeeon Soil and Terrain, 2009)

(f) for dust, Australian Standard AS3580.

Contingency Procedures for Emergency Environmental Incidents

A11 Petroleum activities involving significant disturbance to land cannot commence until the development of written contingency procedures for emergency environmental incidents which include, but are not necessarily limited to:

(a) A clear definition of what constitutes an environmental emergency incident or near miss for thepetroleum activity.

(b) Consideration of the risks caused by the petroleum activity including the impact of flooding and other natural events on the petroleum activity.

(c) Response procedures to be implemented to prevent or minimise the risks of environmental harm occurring.

(d) The practices and procedures to be employed to restore the environment or mitigate any environmental harm caused.

(e) Procedures to investigate causes and impacts including impact monitoring programs for releases to waters and/or land.

(f) Training of staff to enable them to effectively respond.

(g) Procedures to notify the administering authority, local government and any potentially impactedlandholder.

Maintenance of Plant and Equipment

A12 All plant and equipment must be maintained and operated in their proper and effective condition.

A13 The following infrastructure must be signed with a unique reference name or number in such a way that it is clearly observable:

(a) regulated dams and low consequence dams

(b) exploration, appraisal and development wells

(c) water treatment facilities

(d) sewage treatment facilities

(e) specifically authorised discharge points to air and waters

(f) any chemical storage facility associated with the environmentally relevant activity of chemicalstorage

(g) field compressor stations
(h) central compressor stations
(i) gas processing facilities; and
(j) pipeline compressor stations.

A14 Measures to prevent fauna being harmed from entrapment must be implemented during the constructionand operation of well infrastructure, dams and pipeline trenches.

Documentation

A15 A certification must be prepared by a suitably qualified person within 30 business days of completing every plan, procedure, program and report required to be developed under this environmental authority,which demonstrates that:

(a) relevant material, including current published guidelines (where available) have been considered in the written document
(b) the content of the written document is accurate and true; and
(c) the document meets the requirements of the relevant conditions of the environmental authority.

A16 All plans, procedures, programs, reports and methodologies required under this environmental authority must be written and implemented.

A17 All documents required to be developed under this environmental authority must be kept for five (5) years.

A18 All documents required to be prepared, held or kept under this environmental authority must be provided to the administering authority upon written request within the requested timeframe.

A19 A record of all complaints must be kept including the date, complaint's details, source, reason for the complaint, description of investigations and actions undertaken in resolving the complaint.

Third Party Audit

A20 A third party auditor, nominated by the holder of this environmental authority and accepted by the administering authority, must audit compliance with the conditions of this environmental authority at a minimum frequency of every three (3) years.

A21 Notwithstanding condition (A20), and prior to undertaking the third party audit, the scope and content ofthe third party audit can be negotiated with the administering authority.

A22 An audit report must be prepared and certified by the third party auditor presenting the findings of each audit carried out.

A23 Any recommendations arising from the audit report must be acted upon by:

(a) investigating any non-compliance issues identified; and
(b) as soon as reasonably practicable, implementing measures or taking necessary action to ensure compliance with the requirements of this environmental authority.

A24 A written response must be attached to the audit report detailing the actions taken or to be taken on stated dates:

(a) by the holder to ensure compliance with this environmental authority; and
(b) to prevent a recurrence of any non-compliance issues identified.

A25 The audit report required by condition (A22) and the written response to the audit report required bycondition (A24) must be submitted with the subsequent annual return.

SCHEDULE B – WATER

General

B1 Contaminants must not be directly or indirectly released to any waters except as permitted under this environmental authority.

B2 The extraction of groundwater as part of the petroleum activities from underground aquifers must not directly or indirectly cause environmental harm to any watercourse or wetland.

Works in Watercourses and Wetlands

B3 Only construction or maintenance of linear infrastructure is permitted in or within a general ecologically significant wetland or in a watercourse.

B4 Despite condition (B3), the infrastructure and associated activities necessary for construction and/or maintenance purposes specified in *Schedule B, Table 1 – Authorised Works in a Watercourse* are permitted in the locations specified in *Schedule B, Table 1 – Authorised Works in a Watercourse*.

Schedule B, Table 1 – Authorised Works in a Watercourse

Tenure	Description of Infrastructure/Works	Latitude	Longitude
PL232	Pipeline outfall location for ROP2 permeate	-25.732	149.136
PL232	Remedial works in tributary (Reach 1)	-25.732 to -25.729	149.135 to 149.138
PL232	Remedial works in tributary (Reach 2)	-25.729 to -25.726	149.138 to 149.140
PL232	Remedial works in tributary (Reach 3)	-25.726 to -25.726	149.140 to 149.141
PL232	Remedial works in tributary (Reach 4)	-25.726 to -25.718	149.141 to 149.142
PL232	Remedial works in tributary (Reach 5)	-25.718 to -25.715	149.142 to 149.143
PL232	Remedial works in tributary (Reach 6)	-25.715 to -25.710	149.143 to 149.145
PL232	Remedial works in tributary (Reach 7)	-25.710 to -25.708	149.145 to 149.145
PL232	Remedial works in tributary (Reach 8)	-25.708 to -25.705	149.145 to 149.146
PL232	Remedial works in wetland (Reach 9)	-	-
PL232	Remedial works in tributary (Reach 10)	-25.696 to -25.690	149.162 to 149.161
PL91	Fairview HCS-05 Flare Zone Area.	-25.6108068 -25.61055504 -25.61040637 -25.60988553 -25.60976285 -25.61083767 -25.60941074 -25.60942276 -25.60959198 -25.61022479	148.919138 148.9192011 148.9192646 148.9194891 148.9195311 148.9191318 148.919622 148.9195673 148.9192641 148.9187133

Tenure	Description of Infrastructure/Works	Latitude	Longitude
PL421	ASC-03 (centre point of facility)	-25.184184	148.838267

Note: Coordinates are decimal degrees as per Zone 56, GDA 94 datum

B5 The construction and/or maintenance of linear infrastructure that will result in significant disturbance in or on the bed and banks of a watercourse or within a general ecologically significant wetland must be conducted in accordance with the following order of preference:

a) conducting works in times when there is no water present;
b) conducting works in times of no flow;
c) conducting works in times of flow but in a way that does not impede low flow.

B6 The construction and maintenance of linear infrastructure authorised under condition (B3) and authorised works specified in Schedule B, Table 1 must comply with the water quality limits specified in *Schedule B,Table 2 – Release Limits for Construction or Maintenance of Linear Infrastructure"*

Schedule B, Table 2 - Water Release limits for Construction or Maintenance of Linear Infrastructure

Water Quality Parameters	Units	Water Quality Limits
Turbidity	NTU	For a general ecologically significant wetland, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within 50m downstream of the construction or maintenance activity.
		For a general ecologically significant wetland, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within 50m downstream of the construction or maintenance activity.
Hydrocarbons	-	No visible sheen

B7 Monitoring must be undertaken at a reasonable frequency to ensure compliance with condition (B6).

B8 A register must be kept of all linear infrastructure construction and maintenance activities in a wetland ofother environmental value and watercourses, which must include:

(a) location of the activity (e.g. GPS coordinates (**GDA**94) and watercourse name)
(b) estimated flow rate or surface water at the time of the activity
(c) duration of work
(d) results of impact monitoring carried out under condition (B6).

B9 Petroleum activities must occur outside a wetland of high ecological significance.

B10 Petroleum activities must not negatively impact a wetland of high ecological significance.

B11 Linear infrastructure activities, other than linear infrastructure construction and/or maintenance activities, must not change the existing surface water hydrological regime of any general ecologically significant wetland.

B12 The construction and/or maintenance of linear infrastructure in any general ecologically significant wetland must not:

(a) prohibit the flow of surface water in or out of the wetland;
(b) impact surface water quality in the wetland unless specifically authorised by this environmental authority;
(c) drain the wetland;
(d) fill the wetland;
(e) impact bank stability; or
(f) result in the clearing of riparian vegetation outside of the required footprint.

Floodplains

B13 Where the petroleum activity is carried out on floodplains the petroleum activity must be carried out in away that does not:

(a) concentrate flood flows in a way that will or may cause or threaten an adverse environmental impact; or
(b) divert flood flows from natural drainage paths and alter flow distribution; or
(c) increase the local duration of floods; or
(d) increase the risk of detaining flood flows.

Erosion and Sediment Control

B14 For activities involving significant disturbance to land, control measures that are commensurate to the site-specific risk of erosion, and risk of sediment release to waters must be implemented to:

(a) preferentially divert stormwater around significantly disturbed land, or allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities;
(b) minimise soil erosion resulting from wind, rain, and flowing water;
(c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water;
(d) minimise work-related soil erosion and sediment runoff; and
(e) minimise negative impacts to land or properties adjacent to the activities (including roads).

Contaminant Release – Coal Seam Gas Water

B15 Subject to condition (B16), the release of contaminants to waters must only occur from the release points specified in *Schedule B, Table 3 – Contaminant Release Points*.

Schedule B, Table 3 – Contaminant Release Points

Description	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Contaminant	Description of Receiving Waters
Reverse Osmosis Plant 1 "Pony Hills Water Treatment Plant" (ROP1)	-25.76870484	149.030008341	Treated coal seam gas water	Tributary of Hutton Creek
Reverse Osmosis Plant 2 (ROP2)	-25.73	149.14	Treated coal seam gas water	Tributary of the Dawson River

B16 The release of contaminants to waters from ROP2 in accordance with condition (B15) must cease on or before 23 July 2026.

B17 The release of contaminants to waters from ROP2 in accordance with condition (B15) must not cause an adverse impact on the species richness or species abundance of aquatic fauna.

B18 The maximum volume of contaminants released to waters under condition (B15) must not exceed:

(a) 5.1 ML per day for ROP1;
(b) 18 ML per day for ROP2.

Receiving Environment Monitoring

B19 The release of contaminants to waters authorised by condition (B15) must not exceed the limits specified in *Schedule B, Table 4 – Contaminant Limits* and drinking water limits specified in *Schedule B,Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water*.

B20 The release of contaminants to waters authorised by condition (B15) must be monitored at the locations and for each quality characteristic and at the frequency specified in *Schedule B, Table 4 – Contaminant Limits* and *Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water*.

Schedule B, Table 4 – Contaminant Limits

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Temperature	HCS04DWB1	-25.730	149.090	Monitor only	Monitor only	Daily during release from ROP2
pH	HCS04DWB1	-25.730	149.090	Range	6.5-8.5	
Electrical Conductivity	HCS04DWB1	-25.730	149.090	75th %ile	370 µS/cm	
	ROP1 end of pipe	-25.76870484	149.030008341	Maximum	500 µS/cm	Daily during release from ROP1
Turbidity	HCS04DWB1	-25.730	149.090	Maximum	50 (NTU)	Daily during release from ROP2
Dissolved Oxygen (85-110% Saturation)	HCS04DWB1	--25.730	149.090	Range	6.4-16.1 mg/L	Daily during release from ROP2
Total nitrogen	HCS04DWB1	-25.730	149.090	Maximum	620 µg/L	Weekly during release from ROP2
Ammonia	HCS04DWB1	-25.730	149.090	Maximum	0.9 mg/L	
Calcium	HCS04DWB1	-25.730	149.090	Minimum	1 mg/L	
Chloride	HCS04DWB1	-25.730	149.090	Maximum	175 mg/L	
Fluoride	HCS04DWB1	-25.730	149.090	Maximum	1 mg/L	
Magnesium	HCS04DWB1	-25.730	149.090	Monitor only	mg/L	Weekly during release from ROP2
Potassium	HCS04DWB1	-25.730	149.090	Monitor only	mg/L	
Sodium	HCS04DWB1	-25.730	149.090	Maximum	115 mg/L	
Sulphate	HCS04DWB1	-25.730	149.090	Maximum	5 mg/L	
Aluminium	HCS04DWB1	-25.730	149.090	Maximum	55 µg/L	
Total Arsenic	HCS04DWB1	-25.730	149.090	Maximum	13 µg/L	
Boron	HCS04DWB1	-25.730	149.090	Maximum	2.9mg/L ≤ 13.5ML/Day OR 2.5mg/L ≤18.0 ML/day	Weekly during release from ROP2
	Dawson River MP1	-25.690	149.163	Maximum	2.9 mg/L	Weekly during release from ROP1
Cadmium	HCS04DWB1	-25.730	149.090	Maximum	0.2 µg/L	
Chromium (VI)	HCS04DWB1	-25.730	149.090	Maximum	1 µg/L	Weekly during release from ROP2
Copper	HCS04DWB1	-25.730	149.090	Maximum	1.4 µg/L	
Iron	HCS04DWB1	-25.730	149.090	Maximum	300 µg/L	
Lead	HCS04DWB1	-25.730	149.090	Maximum	3.4 µg/L	
Manganese	HCS04DWB1	-25.730	149.090	Maximum	1,900 µg/L	
Mercury	HCS04DWB1	-25.730	149.090	Maximum	0.6 µg/L	
Nickel	HCS04DWB1	-25.730	149.090	Maximum	11 µg/L	

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Selenium	HCS04DWB1	-25.730	149.090	Maximum	11 µg/L	
Zinc	HCS04DWB1	-25.730	149.090	Maximum	8 µg/L	
	Dawson River MP1	-25.690	149.163	Maximum	8 µg/L	Weekly during release from ROP1
Hardness (mg/L)	HCS04DWB1	-25.730	149.090	Monitor only	Monitor only	Weekly during release from ROP2

Note: All metals and metalloids must be measured as dissolved (filtered in the field).
Note: HCS04DWB1 refers to the inlet to release pipe of the dam identified as HCS04DWB1.

Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water

Quality Characteristic	Monitoring Point	Limit Type	Drinking Water Limit	Release Point	Monitoring Frequency
Alpha Activity	Dawson River S4 (coordinates: -25.6920, 149.2160)	Maximum	0.5 Bq/L	ROP1 and ROP2	First release day of each quarter
Aluminium			200 µg/L		
Ammonia			500 µg/L		
Antimony			3 µg/L		
Arsenic			10 µg/L		
Barium			2000 µg/L		
Benzene			1 µg/L		
Beta Activity			0.5 Bq/L		
Bisphenol A			200 µg/L		
Boron			4000 µg/L		
Bromide			7000 µg/L		
Cadmium			2 µg/L		
Chromium			50 µg/L		
Copper			2000 µg/L		
Cyanide			80 µg/L		
Ethylbenzene			300 µg/L		
Fluoride			1500 µg/L		
Iodide			500 µg/L		
Lead			10 µg/L		
Manganese			500 µg/L		
Mercury			1 µg/L		
Molybdenum			50 µg/L		
Nickel			20 µg/L		
Nonylphenol			500 µg/L		

Quality Characteristic	Monitoring Point	Limit Type	Drinking Water Limit	Release Point	Monitoring Frequency
PAH (as B(a)P TEF) TEF: Benz[a]anthracene 0.1 Benzo[b+j]fluoranthene 0.1 Benzo[k]fluoranthene 0.1 Benzo[a]pyrene 1.0 Chrysene 0.01 Dibenz[a,h]anthracene 5 Indeno[1,2,3-cd]pyrene 0.1			0.01 µg/L		
Selenium			10 µg/L		
Silver			100 µg/L		
Strontium			4000 µg/L		
Toluene			800 µg/L		
TPH			200 µg/L		
Vanadium			50 µg/L		
Xylenes			600 µg/L		
Zinc			3000 µg/L		
<u>Disinfection by-products:</u>					
Bromochloroacetonitrile	Dawson River S4 (coordinates: -25.6920, 149.2160)	Monitor only	Monitor only	ROP1 and ROP2	First release day of each quarter
Dichloroacetonitrile		Monitor only	Monitor only		
N-Nitrosodimethylamine		Maximum	0.1 µg/L		
Trihalomethanes (THM): Bromodichloromethane Bromoform Chloroform (Trichloromethane) Dibromochloromethane		Maximum	250 µg/L		

B21 Weekly monitoring for the quality characteristic of boron must be undertaken at S4 (Dawson River, coordinates: -25.6920, 149.2160) when the boron concentration of the release exceeds 2.0 mg/L at HSC04DWB1.

B22 If the quality characteristic of Boron at S4 is between 1.2 mg/L and 1.5 mg/L, all third parties that undertake irrigation using water from the Dawson River, up to a distance of 20km downstream of S4, must be notified.

B23 If the quality characteristic of Boron at S4 exceeds 1.5mg/L, all third parties downstream of S4 that undertake irrigation using water from the Dawson River upstream of the Glebe Weir (coordinates: -25.4647, 150.0349), must be notified.

B24 Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.

B25 Notwithstanding any other condition of this environmental authority, there must be no release of any toxicsubstance in any amount or concentration, either alone or in combination with substances already in the receiving water or release, that cause acute toxicological effects to aquatic organisms in the receiving environment, with the exception of the release authorised in *Schedule B, Table 6 – Event-based ReleasePoint* within the receiving environment mixing zone presented in the Dawson River Event Release Technical Impact Assessment Report 2016 (AECOM).

Contaminant Release – Event-based release of Coal Seam Gas Water

B26 Subject to conditions (B26) to (B35), the release of contaminants to waters must only occur from the release point specified in *Schedule B, Table 6 – Event-based Contaminant Release Point.*

Schedule B, Table 6 – Event-based Contaminant Release Point

Description	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Contaminant	Description of Receiving Waters
Event-based release	-25.728583	149.093207	Coal seam gas water	Dawson River

B27 The release of contaminants to waters authorised by condition (B26) must only occur as a contingency measure to support the beneficial use of coal seam water during rainfall events.

B28 A diffuser outlet must be used at the contaminant release location specified in *Schedule B, Table 6 –Event-based Contaminant Release Point.*

B29 The release of contaminants must only occur during periods of natural flow events when the limits in *Schedule B, Table 7 – Event-based release – Limits for release* are met.

Schedule B, Table 7 – Event-based release – Limits for release

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Receiving environment stream flow (m^3/sec)	Upstream Dawson River gauging station (S3A)	-25.7237	149.0915	Minimum	>1.16m^3/sec	Prior to release and continuous (15min intervals) during release
Electrical Conductivity	Upstream Dawson River gauging station (S3A)	-25.7237	149.0915	Monitor only	Monitor only	Prior to release and continuous (15min intervals) during release
Electrical Conductivity	Release location (i.e. at pumping source or inlet to pipe)	-25.728583	149.093207	Maximum	10,000 µS/cm	Prior to release and continuous (15min intervals) during release

B30 The release of contaminants to waters authorised by condition (B26) must not exceed the limits specified in *Schedule B, Table 8 – Event-based release – Contaminant monitoring* or *Schedule B, Table 9 – Event-based Release - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

B31 The release of contaminants to waters authorised by condition (B26) must be monitored at the locationsand for each quality characteristic and at the frequency specified in S*chedule B, Table 8– Event-based release – Contaminant* Limits and Schedule *B, Table 9 – Event based release - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

Schedule B, Table 8 – Event-based release – Contaminant monitoring

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Volume of untreated CSG water	Release location (end of pipe)	-25.728583	149.093207	Monitor	ML	Continuous (15min intervals) during release
pH	Release location (end of pipe)	-25.728583	149.093207	Range	6.5 - 8.5	Within 2 hours of commencement of release, and daily during release thereafter
Temperature	Release location (end of pipe)	-25.728583	149.093207	Monitor	°C	
Turbidity	Release location (end of pipe)	-25.68836	149.15716	Monitor	Monitor (NTU)	

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Total Nitrogen	Downstream monitoring point S1a	-25.72464	149.10405	Monitor	µg/L	Within 2 hours of commencement of release, and weekly during release thereafter
Ammonia	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	0.9 mg/L	
Chloride	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	175 mg/L	
Fluoride	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	2 mg/L	
Magnesium	Downstream monitoring point S1a	-25.72464	149.10405	Monitor	mg/L	
Potassium	Downstream monitoring point S1a	-25.72464	149.10405	Monitor	mg/L	Within 2 hours of commencement of release, and weekly during release thereafter
Sodium	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	115 mg/L	
Sulfate	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	5 mg/L	
Aluminium	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	150 µg/L*	
Arsenic (Total)	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	13 µg/L	
Boron	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	1.2 mg/L	
Cadmium	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	0.2 µg/L	
Chromium (VI)	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	1 µg/L	
Copper	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	2.5 µg/L*	
Iron	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	350 µg/L	

Quality Characteristic	Monitoring Point (MP)	Latitude (Decimal degrees GDA94)	Longitude (Decimal degrees GDA94)	Limit Type	Limit	Monitoring Frequency
Lead	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	3.4 µg/L	
Manganese	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	1,900 µg/L	
Mercury	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	0.6 µg/L	
Nickel	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	11 µg/L	
Selenium	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	11 µg/L	
Zinc	Downstream monitoring point S1a	-25.72464	149.10405	Maximum	15 µg/L^	
Hardness as CaCO3	Downstream monitoring point S1a	-25.72464	149.10405	Monitor	mg/L	
Receiving environment stream flow (m^3/sec)	Downstream monitoring point S1a	-25.72464	149.10405	Monitor (m^3/sec)	Monitor	Continuous (15min intervals) during release
Electrical Conductivity	Downstream monitoring point S1a	-25.72464	149.10405	95^{th} Percentile	370 µS/cm	Continuous (15min intervals) during release

Note: all metals and metalloids must be measured as dissolved unless otherwise specified.

* Limit based on the protection of 80% of species (ANZECC, 2000)

^ Limit based on the protection of 90% of species (ANZECC, 2000)

Schedule B, Table 9 – Event based release- Contaminant Limits for Protecting the Environmental Value of Drinking Water

Quality Characteristic	Monitoring Point	Limit Type	Drinking Water Limit	Release Point	Monitoring Frequency
Alpha Activity	Dawson River S1a (coordinates - 25.72464, 149.10405)	Maximum	0.5 Bq/L	Schedule B, Table 6 Event-based Contaminant Release Point.	Following release on the first release day of each quarter
Aluminium			200 µg/L		
Ammonia			500 µg/L		
Antimony			3 µg/L		
Arsenic			10 µg/L		
Barium			2000 µg/L		
Benzene			1 µg/L		
Beta Activity			0.5 Bq/L		
Bisphenol A			200 µg/L		
Boron			4000 µg/L		
Bromide			7000 µg/L		
Cadmium			2 µg/L		
Chromium			50 µg/L		
Copper			2000 µg/L		
Cyanide			80 µg/L		
Ethylbenzene			300 µg/L		
Fluoride			1500 µg/L		
Iodide			500 µg/L		
Lead			10 µg/L		
Manganese			500 µg/L		
Mercury			1 µg/L		
Molybdenum			50 µg/L		
Nickel			20 µg/L		
Nonylphenol			500 µg/L		
PAH (as B(a)P TEF) TEF: Benz[a]anthracene 0.1 Benzo[b+j]fluoranthene 0.1 Benzo[k]fluoranthene 0.1 Benzo[a]pyrene 1.0 Chrysene 0.01 Dibenz[a,h]anthracene 5 Indeno[1,2,3-cd]pyrene 0.1			0.01 µg/L		
Selenium			10 µg/L		
Silver			100 µg/L		
Strontium			4000 µg/L		
Toluene			800 µg/L		
TPH			200 µg/L		
Vanadium			50 µg/L		
Xylenes			600 µg/L		
Zinc			3000 µg/L		

B32 The environmental authority holder must take all reasonable and practicable measures to maintain safe and practical access to monitoring locations specified in *Schedule B, Table 4 – Contaminant Limits, Schedule B, Table 5 – Contaminant Limits for Protecting the*

Environmental Value of Drinking Water, *Schedule B, Table 8 – Event-based release – Contaminant monitoring* and *Schedule B, Table 9 – Event based releases - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

B33 If the release limits defined in *Schedule B, Table 9 – Event based releases - Contaminant Limits for Protecting the Environmental Value of Drinking Water-* or S*chedule B, Table 8 – Event-based release -Contaminant monitoring* are exceeded, the following events must occur:

(a) the release of contaminants to waters authorised by condition (B26) must cease within 24 hours of becoming aware of any exceedance: and

(b) the holder of the environmental authority must demonstrate to the administering authority a strategy for managing future releases without exceedances before undertaking further releases.

B34 If the quality characteristic of Boron of the release exceeds the release limit of 1.2 mg/L specified in andS*chedule B, Table 8 – Event- based release - Contaminant monitoring*, all third parties that undertake irrigation using water from the receiving waters up to a distance of 300km downstream must be notified.

B35 Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters or cause a material build-up of sediment in such waters.

Receiving Environment Monitoring Program

B36 For the release authorised in *Schedule B, Table 3 – Contaminant Release Points*, a REMP must be developed to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised activity(ies) by 1 February 2014. The REMP must include periodic monitoring for the effects of the discharge on the receiving environment (under natural flow conditions) asa result of contaminant releases to waters from the site.

B37 For the release authorised in *Schedule B, Table 3 – Contaminant Release Points,* for the purposes of the REMP, the receiving environment is the waters of the Dawson River and connected or surrounding waterways (including the receiving wetland) up to Yebna Crossing, located 8.5 km downstream of the receiving wetland.

B38 For the release authorised in *Schedule B, Table 6 – Event Based Contaminant Release Point*, a Receiving Environment Monitoring Program (REMP) Design Document that addresses each criterionpresented in condition (B41), except criteria (B41)(m), must be prepared and submitted to the administering authority for approval prior to any release occurring under condition (B29). Due consideration must be given to any comments made by the administering authority on the REMP Design Document and subsequent implementation of implemented for the duration of the program.

B39 Conditions (B40) and (B41) apply to the releases authorised in *Schedule B, Table 3 – ContaminantRelease Points* and *Schedule B, Table 6 – Event-based Contaminant Release Point.*

B40 The REMP must be reviewed and certified by a suitably qualified person.

B41 The REMP must address but not be limited to the following:

a) description of potentially affected receiving waters including key communities and backgroundwater quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal and spatial variation (e.g. seasonality);
b) description of applicable environmental values, including but not limited to:
    i. hydrology (flow, duration, periodicity, connectivity with groundwater systems;
    ii. physiochemical properties;
    iii. the suitability of the water for supply as drinking water;
    iv. aquatic ecosystem parameters including flow and fauna habitat; and
    v. geomorphological features;
c) description of water quality objectives to be achieved;
d) any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed;
e) water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during theREMP.
f) monitoring for any potential adverse environmental impacts caused by the release;
g) monitoring for algal blooms;
h) monitoring of stream flow and hydrology;
i) an assessment of bank stability, including monitoring for any potential adverse environmentalimpacts caused by the release including impacts to bank stability and erosion, and an evaluation of watercourse bank slumping;
j) monitoring of physical chemical parameters as a minimum those specified in *Schedule B, Table4 – Contaminant Limits, Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water and Schedule B, Table 8 – Event-based release- Contaminant monitoring;*
k) monitoring biological indicators in accordance ANZECC & ARMCANZ 2000 (including Before,After, Control, Impact (BACI) Principal) and, where possible, consistent with methodologies specified by FRC Environmental Pty Ltd in their report titled *Santos Coal Seam Gas Fields Aquatic Ecology Impact Assessment*;
l) monitoring metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, *AGuide To The Application Of The ANZECC & ARMCANZ Water Quality Guidelines In The Minerals Industry* (BATLEY et al) and/or the most recent version of AS5667.*1 Guidance on Sampling of Bottom Sediments*) for permanent, semi-permanent water holes and water storages;
m) monitoring of a selection of invertebrate species (minimum of three from the local receiving environment) to assess ecosystem health (e.g. exoskeleton density) in respect

to the availability of calcium and magnesium;

n) the methods for analysis and interpretation all monitoring results;
o) the locations of monitoring points (including the locations of proposed background and downstream impacted sites for each release point);
p) the frequency or scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within two (2) years (depending on wet season flows) in accordance with the *Queensland Water Quality Guidelines* 2009. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges;
q) monitoring of quality characteristics must include the limits specified in *Schedule B, Table 4 – Contaminant Limits* to assess the extent of the compliance of concentrations with water quality objectives derived through condition (B28)(p);
r) specify sampling and analysis methods and quality assurance and control;
s) any historical data sets to be relied upon;
t) description of the statistical basis on which conclusions are drawn,
u) any control or reference sites; and
v) recording of planned and unplanned releases to watercourses, procedures for event monitoring,monitoring methodology used and procedure to establish background surface water quality.

Well Testing

B42 Subject to condition (B43) and condition (B44), the injection of CSG water or better quality groundwateris authorised in wells that are not exploration, appraisal or development wells, for the purposes of hydraulic testing, where such hydraulic tests are undertaken for no more than two (2) consecutive days.

B43 The maximum volume of CSG water or better quality groundwater injected for the purposes of hydraulic testing identified in condition (B42) must not exceed 1ML per hydraulic test.

B44 Written notification detailing the type and location (GPS coordinates) of any hydraulic testing undertaken in accordance with condition (B42) must be provided to the administering authority at least10 business days prior to the commencement of the hydraulic test.

Seepage Monitoring Program

B45 A seepage monitoring program must be developed by a suitably qualified person which is commensuratewith the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants byno longer than 3 months following the effective date of this environmental authority.

B46 The seepage monitoring program required by condition (B45) must include but not necessarily be limited to:

(a) identification of the containment facilities for which seepage will be monitored
(b) identification of trigger parameters that are associated with the potential or actual contaminantsheld in the containment facilities as provided for in condition (B47).
(c) identification of trigger concentration levels that are suitable for early detection of contaminant releases at the containment facilities
(d) installation of background seepage monitoring bores where groundwater quality will not havebeen affected by the petroleum activities authorised under this environmental authority to useas reference sites for determining impacts
(e) installation of seepage monitoring bores that:
    i. are within formations potentially affected by the containment facilities authorised under this environmental authority (i.e. within the potential area of impact)
    ii. provide for the early detection of negative impacts prior to reaching groundwaterdependent ecosystems bores, or water supply bores
    iii. provide for the early detection of negative impacts prior to reaching migration pathwaysto other formations (i.e. faults, areas of unconformities known to connect two or more formations)
(f) monitoring of groundwater at each background and seepage monitoring bore at least annuallyfor the trigger parameters identified in condition (B47)
(g) seepage trigger action response procedures for when trigger parameters and trigger levels identified in conditions (B47) and (B46)(c) trigger the early detection of seepage, or upon becoming aware of any monitoring results that indicate potential groundwater contamination
(h) a rationale detailing the program conceptualisation including assumptions, determinations,monitoring equipment, sampling methods and data analysis; and
(i) provides for annual updates to the program for new containment facilities constructed in eachannual return period.

B47 Seepage monitoring bores identified in (B46) (b) must be monitored annually for the trigger parameter(s)specified in *Schedule B, Table 10 Seepage Monitoring Trigger Parameters*.

Schedule B, Table 10 Seepage Monitoring Trigger Parameters

Parameter	Units	Untreated Coal SeamWater	Permeate	Brine
Static Water Level	m	monitor	monitor	monitor
pH	pH unit	monitor	monitor	monitor
EC	µS/cm	monitor	monitor	monitor
Major Anions (sulphate,chloride)	mg/L	monitor	-	-
Major Cations (calcium, magnesium, sodium and potassium)	mg/L	monitor	-	-

Seepage Monitoring Bore Drill Log

B48 A bore drill log must be completed for each seepage monitoring bore in condition (B46) which must include:

(a) bore identification reference and geographical coordinate location
(b) specific construction information including but not limited to depth of bore, depth and length ofcasing, depth and length of screening and bore sealing details
(c) standing groundwater level and water quality parameters including physical parameter andresults of laboratory analysis for the possible trigger parameters
(d) lithological data, preferably a stratigraphic interpretation to identify the important featuresincluding the identification of any aquifers; and
(e) target formation of the bore.

SCHEDULE BA - FLUID INJECTION

BA1 The injection of treated coal seam gas water, treated water or brine into a groundwater aquifer is not authorised unless stated under condition (BA2) of this environmental authority.

Injection of Brine from Pony Hills Water Treatment Plant into Timbury Hills Formation or CSG-Depleted Source Formations

Target Aquifers

BA2 The holder of this environmental authority is permitted to inject brine or CSG water (injection fluid), on PL90, PL91, PL92, PL99, PL100, PL232, PPL76 and PPL92, into:

(a) the Timbury Hills formation; or
(b) CSG-depleted source formations; provided the:
  (i) injection zone formation is shown to be hydraulically isolated from water resource formations, as identified in Attachment 2: *Hydrogeology, 4 May 2008, Environmental Management Plan for the Fairview Project Area*, URS, through substantial and competentaquitards; and
  (ii) the injection fluid shows inconsequential reactivity with the injection zone formation fluidsand the formation itself.

Area of Review

BA3 The holder of this environmental authority must identify and review the location of all known wells, faultsand other geologic features which could affect containment within 1,000 m of the well, and that penetrate the injection zone formation. If the review identifies the potential for migration of formation or injection fluids out of the injection zone formation, mitigating action to prevent such migration must be taken before using the injection well. Details of the mitigation measures are to be recorded and providedto the administrating authority as part of the Well Completion Report.

Minimum Construction Requirements

BA4 All injection wells must be cased and cemented to prevent the movement of injection fluids into or between water resource aquifers. The casing and cement used in the construction of each newly drilledwell shall be designed for the life expectancy of the well.

BA5 In determining and specifying casing and cementing requirements, at least the following must be considered:

(a) identification of formations and water resource aquifers;
(b) depth to the bottom of the lowest occurring water resource aquifer;
(c) quality of formation fluids;
(d) depth to the injection zone;
(e) estimated maximum and average injection pressures;
(f) external pressure, internal pressure and axial loading;
(g) hole size;
(h) size and grade of casing strings;
(i) class of cement; and
(j) thermal regime.

BA6 The injection well must include the following:

(a) surface casing fully cemented at least 20 m into competent impermeable strata of:
  (i) the uppermost occurring aquitard below the lowest occurring water resource aquifer; or
  (ii) the aquitard overlying the CSG-depleted source formation;
(b) production casing fully cemented into the injection zone formation;
(c) an annulus packer located within 30 m of the injection fluid release point;
(d) casing centralisers;
(e) inert fluid in the annulus;
(f) a fluid level detection system measuring the annulus fluid; and
(g) injection tubing extending through the packer to the injection zone.

Hydraulic Isolation and Well Completion Report

BA7 Upon completion of construction and development of an injection well, a Well Completion Report shall be submitted to the administering authority including logs and other tests conducted during the drilling and construction of the well. The report shall be prepared by an appropriately qualified practitioner and shall include:

(a) information considered in the design of the well and casing design;
(b) details of the “as constructed” well including but not limited to: lithology, injection zone formation fracture pressure, injection zone formation pressure prior to injection, casing strings, and cement type and volumes;
(c) substantiated commentary on the potential for reaction between the formation fluid and injectionfluid;
(d) a detailed interpretation of the logs against their specific objectives, for approval prior to commencement of injection operations;
(e) temperature survey and a casing integrity assessment technique such as:
(f) radioactive tracer survey; or
(g) oxygen activation log; or
(h) cement integrity log; or
(i) an equivalent survey technique approved by the administering authority; and

(j) a completed well schematic diagram.

BA8 In the event of converting an existing well to an injection well, as well as the above, a full length casinginspection log must be run.

Mechanical Integrity

BA9 The holder of this environmental authority must demonstrate the internal and external mechanical integrity of the injection system. A well demonstrates mechanical integrity if:

(a) there is no significant leakage in the casing, tubing, or packer; and
(b) there is no significant fluid movement into a water resource aquifer through vertical channels adjacent to the well bore hole.

BA10 Mechanical integrity must be demonstrated at the following times:

(a) prior to commencement of injection;
(b) every five years after commencement of operation;
(c) following well refurbishment after a demonstration of loss of hydraulic isolation or if the injection tubing has been disturbed; and
(d) if the injection well is unused for a continuous period of twelve months, prior torecommencement of use.

Operating Requirements

BA11 The rate and volume of injection fluid must not cause wellhead pressures to exceed 90 per cent of:

(a) the formation fracture pressure; or
(b) the pressure at which the hydraulic isolation logging was carried out.

BA12 Injection must only occur through the injection tubing.

BA13 The injection fluid must be demonstrated to be aseptic.

BA14 The injection fluid must not contain more dissolved oxygen than the formation fluid or 200 parts per billion, whichever is the greater.

Existing Injection Wells

BA15 Wells currently in use as injection fluid disposal wells and not specifically authorised for that use must be either refurbished to meet the requirements of this environmental authority or plugged and abandoned in compliance with this environmental authority no later than three (3) years from the anniversary of issuance of this environmental authority.

Plugging and Abandonment

BA16 Prior to abandoning an injection well, the well must be plugged with cement which will not allow the movement of injection fluids into or between water resource aquifers. The cement plug(s) shall be placed by methods such as:

(a) the balance method; or
(b) the dump bailer method; or
(c) the two-plug method.

BA17 The well to be abandoned must be in a state of static equilibrium with the mud weight equalized top to bottom by circulating mud at least once prior to the placement of the cement plug(s).

Well Closure Plan

BA18 The holder of this environmental authority must, within three (3) months from the date of this approval,develop and submit a well closure plan including the following:

(a) the type and number of plugs to be used;
(b) the placement of each plug including the elevation of the top and bottom of each plug;
(c) the type, grade and quantity of material to be used in plugging;
(d) the method of placement of the plugs;
(e) any proposed test or measure to be made; and
(f) the estimated cost of closure.

Note: These requirements are in addition to any other requirements that may exist under other Acts [for example, *Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland,* Natural Resources and Mines, 2004, Queensland Government].

Well Integrity

BA19 Unless otherwise stated in the conditions of this environmental authority, injection wells must be constructed according to the current standards applicable to water bore drilling activities under the *Water Act 2000* (i.e. Minimum Construction Requirements for Water Bores in Australia [National Water Commission, 2012 or subsequent revisions]).

BA20 Fluid injection authorised by this environmental authority must have appropriate records and documents which support and indicate mechanical integrity and which hold a certificate of mechanical integrity prepared and certified by a suitably qualified person, available for inspection such that:

(a) there is no significant leakage in the casing, tubing, or packer; and

(b) there is no significant fluid movement into a water resource aquifer through vertical channels adjacent to the well bore hole.

BA21 Wells used for untreated coal seam water or brine fluid injection must have:

(a) an annulus packer at the junction of the aquitard and the target formation within the production casing;
(b) injection tubing installed which extends through the packer into the target formation;
(c) an inert fluid in the annulus between the injection tubing and the production casing; and
(d) a system installed to record any loss of containment of the inert fluid.

BA22 For fluid injection:

(a) where injection tubing is required by condition (BA20), injection must only occur through injection tubing;
(b) the injection pressure must not exceed the dry overburden pressure of the base of the overlying aquitard for injection at depth less than 100 m or 90 per cent of the formation fracture pressure for injection at depth greater than 100 m.

Brine Injection Monitoring and Reporting

BA23 The holder of this environmental authority must:

(a) monitor the nature of the injection fluid at sufficient frequency to yield data statistically representative of its characteristics. The sampling program shall have regard to changes in source of injection fluid, changes in flow rates from source aquifers and changes in any injection fluid treatment train;
(b) continuously record injection pressure, flow rate, and cumulative volume of the injection fluid;
(c) record the annulus pressure each hour;
(d) measure the standing volume of annulus fluid each six months;
(e) undertake pressure testing of packer, casing and cement each six months;
(f) undertake an annual packer isolation test; and
(g) in the event of an anomalous pressure or volume recording, to inform the administering authority within 24 hours of the occurrence.

Injection Management Plan

BA24 An Injection Management Plan, prepared by a suitably qualified person, must be submitted to the administering authority prior to any proposed fluid injection activity(ies).

BA25 The Injection Management Plan required by condition (BA24) must include but not necessarily belimited to:

(a) estimated volumes and rates of fluid to be produced and injected;

(b) a description of the physical, chemical and biological components and their concentrations ofthe fluid to be produced;
(c) details of how and where the fluid will be produced, aggregated, stored and kept separate from waters until it is, treated and injected into the source aquifer;
(d) details of where the fluid is proposed to be treated including a description of the treatment process;
(e) a demonstration that the injection fluid has inconsequential reactivity with the target formation and native groundwater it will come into contact with;
(f) the characteristics of the receiving environment;
(g) identification of the water quality impact zone and the hydraulic impact zone;
(h) identification of all existing bores, lakes, wetlands, environmental assets and watercourses connected to groundwater, faults and other geologic features that occur within the water quality impact zone and the hydraulic impact zone;
(i) identification of proposed fluid injection wells;
(j) identification of the environmental values and water quality objectives of the potential water quality impact zone of the target formation in accordance with the *Environmental Protection Act 1994, Environmental Protection Regulation 2008*, *Environmental Protection (Water) Policy 1997and the Queensland Water Quality Guidelines 2006*;
(k) an assessment of the potential impacts on the environmental values of the receiving environment including migration of injection fluid or native groundwater out of the target formation through wells, bores, wetlands, connected watercourses, faults or other geologic features likely to impact on other aquifers;
(l) a risk assessment consistent with the risk framework specified in *Australian Guidelines for Water Recycling: Managed Aquifer Recharge* identifying potential hazards, their inherent risk, preventative measures for the management of potential hazards and after consideration of the operational monitoring to manage potential hazards identified in the risk assessment including details on sampling and analysis methods including frequency and locations, and quality assurance and control;
(m) verification methods to assess performance of the injection activities;
(n) control measures that will be implemented for fluid storage, treatment and injection to prevent or control the release of a contaminant or waste to the environment;
(o) the indicators or other criteria against which the performance of fluid injection will be assessed;
(p) procedures that will be adopted to regularly review the monitoring program and to report to management and the administering authority should unforeseen or non-compliant monitoring results be recorded;
(q) procedures that will be implemented to prevent unauthorized environmental harm from unforeseen or non-compliant monitoring results;
(r) procedures for dealing with accidents, spills, failure of containment structures, and other incidents that may arise in the course of fluid injection; and
(s) a program to monitor impacts on the environmental values of the receiving environment identified by condition (BE25)(k).

SCHEDULE C – LAND

General

C1 Contaminants must not be directly or indirectly released to land except as permitted under this environmental authority.

Top Soil Management

C2 Top soil must be managed in a manner that preserves its biological and chemical properties.

Land Management

C3 Land that has been significantly disturbed by the pipeline activities must be managed to ensure that gully erosion or subsidence do not occur on that land.

Chemical Storage

C4 Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable.

Pipeline Operation and Maintenance

C5 Contaminants authorised to be released to land under conditions (C6), (C8), (C14) and (C20) must be carried out in a manner that ensures:

(a) vegetation is not damaged;
(b) soil quality is not adversely impacted;
(c) there is no surface ponding or runoff beyond the designated release area;
(d) there is no aerosols or odours;
(e) deep drainage below the root zone of any vegetation is minimised;
(f) the quality of shallow aquifers is not adversely affected.

Pipeline Wastewater

C6 Contaminants that are hydrostatic test water from pipelines and contaminants from low point drains, maybe released to land in accordance with condition (C5).

C7 Produced water may be re-used in:

(a) drilling and well hole activities; or
(b) stimulation activities.

C8 Produced water may be released to land for the following purposes:

(a) dust suppression;
(b) construction and operational purposes for the petroleum activity authorized by this environmental authority; and
(c) irrigation.

C9 Produced water irrigated to land must:

(a) not exceed the release limits specified in *Schedule C, Table 1a - Irrigation water quality monitoring*; and

(b) be monitored at the frequency and for the quality characteristics at the monitoring point specified in *Schedule C, Table 1a – Irrigation water quality monitoring*; or
(c) the process under (C10) has been completed.

C10 Produced water for irrigation which does not meet criteria in condition (C9) (a) and (b) may be used for irrigation provided a report has been completed which:

(a) determines soil structure, stability and productive capacity will be maintained or improved;
(b) determines there are no toxic effects to crops;
(c) determines yields and produce quality are maintained or improved;
(d) states water quality criteria, which has been determined in accordance with the assessment procedures outlined in Schedule C, Table 1b Assessment procedures for water quality criteria;and
(e) includes a water monitoring program to ensure that condition (C10) (a)(b) and (c) are being achieved.

Schedule C, Table 1a – Irrigation water quality monitoring

Quality Characteristic	Release Limit	Limit Type	Frequency	Monitoring Point
Electrical conductivity (EC)	<950 µs/cm^3	95th percentile over aone-year period	Fortnightly	At a location following final treatment and prior to release.
Sodium adsorption ratio (SAR) for heavy soils	≤6			
SAR for light soils	≤12			
Ph	6.0 – 8.5			
Aluminium	20 mg/L	Maximum	Bi-annually	
Arsenic	2.0 mg/L			
Boron	Refer to table 9.2.18 of ANZECC	Refer to table 9.2.18 of ANZECC		
Cadmium	0.05 mg/L			
Chromium	1 mg/L			
Cobalt	0.1 mg/L			
Copper	5 mg/L			

Quality Characteristic	Release Limit	Limit Type	Frequency	Monitoring Point
Fluoride	2 mg/L	Maximum		
Iron	10 mg/L			
Lithium	2.5 mg/L			
Lead	5 mg/L			
Manganese	10 mg/L			
Mercury	0.002 mg/L			
Molybdenum	0.05 mg/L			
Nickel	2 mg/L			
Zinc	5 mg/L			

Schedule C, Table 1b Assessment Procedures for Water Quality Criteria

Water Quality Criteria	Assessment Procedure
electrical conductivity sodium adsorption ratio pH	Salinity Management Handbook, with reference to Chapter 11; and/or Australian and New Zealand Guidelines for Fresh and Marine Water Quality, with reference to Volume 1 Chapter 4 and Volume 3 Chapter 9. The assessment should consider: • soil properties within the root zone to be irrigated (e.g. clay content, cation exchange capacity, exchangeable sodium percentage) • water quality of the proposed resource (e.g. salinity, sodicity) • climate conditions (e.g. rainfall) • leaching fractions • average root zone salinity (calculated) • crop salt tolerance (e.g. impact threshold and yield decline) • management practices and objectives (e.g. irrigation application rate, amelioration techniques) • broader landscape issues (e.g. land use, depth to groundwater) • any additional modelling and tests undertaken to support the varied water quality parameters.
heavy metals	Australian and New Zealand Guidelines for Fresh and Marine Water Quality, with reference to Volume 1 Chapters 3 and 4 and Volume 3 Chapter 9. The assessment should aim to derive site specific trigger values (e.g. cumulative contaminant loading limit) based on the methodology provided in the above mentioned procedure.

C11 Produced water may be used for domestic or stock purposes provided the water quality complies with the criteria specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000).

C12 Produced water may be transferred to a third party to be used for the following purposes, subject to condition (C13):

(a) dust suppression;
(b) construction and operational purposes; or
(c) domestic or stock purposes provided the water quality complies with criteria specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000).

C13 If the responsibility of produced water is given or transferred to a third party in accordance with condition (C12), the holder of the environmental authority must ensure:

(a) the responsibility of the produced water is given or transferred in accordance with a written agreement (third party agreement);
(b) the third party is made aware of the General Environmental Duty under section 319 of the *Environmental Protection Act 1994*.

Sewage Treatment Works

C14 Greywater or treated sewage effluent from a treatment system with a daily peak design capacity of up to 450 EP may be:

(a) released to land by sub-surface or spray irrigation provided it is to a fenced and signed contaminant release area that is:
    (i) a minimum distance of 50 metres from any watercourse, wetland or protected area;and
    (ii) a minimum distance of 100 metres from any potable water supply or stock drinking water supply; and
    (iii) kept vegetated with groundcover that is not a prohibited or restricted pest species;or
(b) used for dust suppression and construction purposes subject to condition (C21).

C15 When circumstances prevent the irrigation of treated sewage effluent to land, the contaminants must be directed to on-site storage or lawfully disposed of off-site.

Sewage Treatment Works Between 100 EP and 450 EP

C16 Treated sewage effluent released to land must be monitored at the frequency and for the quality characteristics specified in *Schedule C, Table 2 Treated sewage effluent standards for release to land from sewage treatment works with a daily peak design capacity of greater than 100 EP* for each quality characteristic.

C17 Prior to construction of a sewage treatment works with a daily peak design capacity of greater than 100 EP, the minimum area of land and location to be utilised for irrigation of treated sewage effluent, excluding any necessary buffer zones, must be nominated.

C18 All nominated locations and minimum areas of land in condition (C17) for sewage treatment works with adaily peak design capacity of greater than 100 EP, must be determined using the Model for Effluent Disposal using Land Irrigation (MEDLI) program or recognised equivalent and use model inputs representative of the activity and release location including but not limited to effluent quality, soil and vegetation types, and climatic conditions.

C19 Treated sewage effluent must only be released to the nominated locations and minimum areas of land determined by the MEDLI program or recognised equivalent identified in condition (C18).

C20 Treated sewage effluent released to land must comply, at the monitoring point(s), with each of the release limits specified in *Schedule C, Table 2 Treated sewage effluent standards for release to land from sewage treatment works with a daily peak design capacity of greater than 100 EP* for each quality characteristic.

Schedule C, Table 2 Treated sewage effluent standards for release to land from sewage treatment works with a daily peak design capacity of greater than 100EP

Quality Characteristic	ReleaseLimit	Limit Type	Frequency	Monitoring Point
5-day Biochemical Oxygen demand (BOD)	20 mg/L	Maximum	Quarterly	Release pipe from sewage treatment works
E. coli	1000 cfu per 100 mL	80th percentile based on at least 5 samples with not less than 30 minutes between samples		
	10,000 cfu per 100 mL	Maximum		
pH	6.0 - 8.5	Range	Monthly	
Dissolved Oxygen	2 mg/L	Minimum		
Electrical Conductivity		Monitor only		

Treated Sewage Effluent Use for Dust Suppression and Construction Purposes

C21 Treated sewage effluent may only be used for dust suppression and construction purposes provided that:

(a) access by the general public can be restricted while effluent is in use ;
(b) on local government controlled roads, written approval from the relevant Local Government has been given to the holder of this environmental authority; and
(c) the treated sewage effluent quality:
  (i) is monitored at the location and frequency specified *in Schedule C, Table 3 Treated Sewage Effluent Standards for Dust Suppression and Construction Purposes*; and
  (ii) meets the release limits for each quality characteristic specified in Schedule C, *Table3 Treated Sewage Effluent Standards for Dust Suppression and Construction Purposes*.

Schedule C, Table 3 – Treated Sewage Effluent Standards for Dust Suppression and Construction Purposes

Quality Characteristic	Sampling and *In situ* Measurement Point Location	Limit type	Release Limit	Frequency
pH	Standpipe from the sewage treatment works	Range	6.0 to 8.5	Monthly
5-day Biochemical Oxygen Demand (BOD)		Median	20 mg/L	
Electrical Conductivity		Maximum	1600 uS/cm	
Total Suspended Solids		Maximum	30 mg/L	
E. coli		80^{th} percentile based on at least 5 samples with not less than 30 minutes between samples	<100 cfu per 100 mL	
		Maximum	1000 cfu per100mL	

SCHEDULE D – BIODIVERSITY VALUES

Confirming Biodiversity Values

D1 Prior to undertaking activities that result in significant disturbance to land in areas of native vegetation,confirmation of on-the-ground environmentally sensitive areas and wetlands at that location must be undertaken by a suitably qualified person.

D2 A suitably qualified person must develop and certify a methodology so that condition (D1) can be complied with and which is appropriate to confirm on-the-ground environmentally sensitive areas and wetlands.

D3 Where areas mapped as environmentally sensitive areas and wetlands differ from those confirmed under conditions (D1) and (D2), petroleum activities may proceed in accordance with the conditions of the environmental authority based on the confirmed on the- ground values.

D4 All documentation survey information photographs, field data or any material associated with the field validation requirements in (D1) must be maintained for the life of the environmental authority to demonstrate to the administering authority that surveys were conducted in a manner consistent with requirements contained in (D2).

D5 The location of the petroleum activity must be selected in accordance with the following site planning principles:

(a) maximise the use of areas of pre-existing disturbance
(b) in order of preference, avoid, minimise or mitigate any impacts, including cumulative impacts,on areas of native vegetation or other areas of ecological value
(c) minimise disturbance to land that may result in land degradation
(d) in order of preference, avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation; and
(e) in order of preference, avoid then minimise clearing of native mature trees.

Disturbance to Land – Environmentally Sensitive Areas

D6 Petroleum activities must be carried out in accordance with *Schedule D, Table 1 – Petroleum Activities in Environmentally Sensitive Areas, Schedule D, Table 2 – Authorised Disturbance* and any other relevant conditions of this environmental authority.

Schedule D, Table 1 – Petroleum Activities in Environmentally Sensitive Areas

ESA Category	Within the ESA	Primary Protection Zone of the ESA	Secondary Protection Zone of the ESA
Category A ESAs	No petroleum activities permitted	Only low impact petroleum activities permitted.	Limited petroleum activities permitted subject to condition (D10) **Limited impact camps** permitted subject to condition (D10) **Limited impact petroleum activities** permitted subject to condition (D10)
Category B ESAs excluding 'Endangered' Regional Ecosystems	Only low impact petroleum activities permitted	Limited petroleum activities permitted subject to condition (D10) Limited impact camps permitted subject to condition (D10) Limited impact petroleum activities permitted subject to condition (D10)	N/A
Category C ESAs that are Nature Refuges, Koala Habitat and/or Declared Catchment Areas	Only low impact petroleum activities permitted	Limited petroleum activities permitted subject to condition (D10) Limited impact camps permitted subject to conditions (D7) and (D10) Limited impact petroleum activities permitted subject to condition (D10)	N/A
Category B ESAs that are 'Endangered' Regional Ecosystems	Only limited petroleum activities permitted subject to conditions (D11a and D11b)	Limited petroleum activities permitted subject to condition (D10) Limited impact camps permitted subject to condition (D10) Limited impact petroleum activities permitted subject to condition (D10)	N/A
Category C ESAs that are Essential Habitat and/or 'Of Concern' Regional Ecosystems	Only limited petroleum activities permitted subject to conditions (D11a and D11b)	Limited petroleum activities permitted subject to condition (D10) Limited impact camps permitted subject to conditions (D7) and (D10) Limited impact petroleum activities permitted subject to condition (D10)	N/A

ESA Category	Within the ESA	Primary Protection Zone of the ESA	Secondary Protection Zone of the ESA
Category C ESAs that are Regional Parks (Resource Use Area)	Only limited petroleum activities permitted subject to conditions (D11a and D11b)	Limited petroleum activities permitted subject to condition (D10) Limited impact camps permitted subject to condition (D10) Limited impact petroleum activities permitted subject to condition (D10)	N/A
Category C ESAs that are State Forests and/or Timber Reserves	Limited petroleum activities permitted subject to conditions (D11a and D11b) Petroleum activities that are extraction activities and screening activities permitted.	N/A	N/A
	Limited impact camps permitted. Limited impact petroleum activities permitted subject to conditions (D8) and (D11a and D11b)		

Note: Approvals may be required under the Forestry Act 1959 where the petroleum activity(ies) is proposed to be carried out in ESAs that are State Forests or Timber Reserves.

Schedule D, Table 2 – Authorised Disturbances

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
Yebna North Temporary Camp	The area defined within the "Location of Development" point coordinates	149.164 149.165 149.166 149.166 149.166 149.166 149.166	-25.6443 -25.6436 -25.6439 -25.6444 -25.6448 -25.6452 -25.6455	N/A	2 ha	Primary Protection Zone of a Category C ESA (Of Concern Regional Ecosystem)
Dawson's Bend Road Widening and Co-located Power Lines	Section 1	-25.720723 to -25.719763	149.050898 to 149.048122	Length within PPZ of Category C ESA **283 m**	Area within PPZ of Category C ESA **1.11 ha**	PPZ of Category C ESA (Of Concern RE 11.10.7/ 11.10.9/11.3.25)
	Section 2	-25.71906 to -25.721033	149.040465 to 149.036057	Length within Category C ESA **70 m** Length within PPZ of Category C ESA **414 m**	Area within Category C ESA **0.23 ha** Area within PPZ of Category C ESA **1.53 ha**	Category C ESA (Of Concern RE 11.10.7/ 11.10.9/11.3.25)
	Section 3	-25.737755 to -25.742661	149.009531 to 148.998035	Length within PPZ of Category C ESA **1325 m**	Area withinPPZ of Category C ESA **3.82 ha**	PPZ of Category C ESA(Of Concern RE 11.3.2/ 11.3.25)
	Section 4	-25.751823 to -25.75041	148.983035 to 148.947449	Length within Category C ESA 2580 m Length within PPZ of Category C ESA **1280 m**	Area within Category C ESA **7.26 ha** Area within PPZ of Category C ESA **3.62 ha**	Category C ESA (State Forest/ Timber Reserve which is predominantly RE 11.10.9)
	Section 5	-25.727628 to -25.727588	149.075484 to 149.073348	Length within PPZ of Category C ESA **216 m**	Area within PPZ of Category C ESA **0.58 ha**	PPZ of Category C ESA(Of Concern RE 11.10.8)
Total for sections within ESA and PPZ				**6168 m**	**18.15 ha**	

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
Water to Grade Flowlines	FV36 (FV06-37)	-25.648185 to -25.649338	148.930447 to 148.92969	Length within PPZ of Category C ESA **354 m**	Area within PPZ of Category C ESA **0.38 ha**	Category C ESA (Essential Habitat within RE 11.10.1/ 11.10.13a and RE 11.9.4a)
	FV103 (FV06-38)	-25.644467 to -25.650721	148.936713 to 148.9391135	Length within PPZ of Category C ESA **735 m**	Area within PPZ of Category C ESA **0.89 ha**	Category C ESA (Essential Habitat within RE 11.10.1/ 11.10.13a andRE 11.9.4a)
	FV34 (FV06-32) and Connecting Flowlines	-25.641787 to -25.642241	148.943019 to 148.938051	Length within Category C ESA **685 m** Length within PPZ of Category C ESA **952 m**	Area within Category C ESA **0.83 ha** Area within PPZ of Category C ESA **1.4 ha**	Category C ESA (Essential Habitat within RE 11.10.1/ 11.10.13a)
		-25.641787 to -25.641818	148.943019 to 148.945227			
		-25.642471 to -25.642241	148.930648 to 148.938051			
		-25.642471 to -25.64314	148.930648 to 148.933636			
		-25.642241 to -25.64342	148.938051 to 148.936485			
		-25.641787 to -25.641818	148.943019 to 148.945227			
	FV10-03 (FV-WP-49)	-25.678885 to -25.680651	148.895576 to 148.900354	Length within PPZ of Category C ESA **659 m**	Area within PPZ of Category C ESA **1.3 ha**	Category C ESA (Essential Habitat within RE 11.10.1/ 11.10.13a)
Total for sections within ESA and PPZ				**3385 m**	**4.8 ha**	
Brine Dams	Brine DamA+B (as per 6399 – Fairview F-	-25.751025 -25.751261 -25.751242 -25.751220 -25.751156	149.073924 149.072946 149.072660 149.072508 149.072194			

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
	HCS-04 Remote Brine Pond A and B Constraints Mapping, dated 23 May 2012)	-25.751110 -25.750970 -25.750952 -25.750853 -25.750194 -25.749429 -25.749322 -25.749188 -25.749091 -25.749088 -25.748916 -25.748500 -25.748468 -25.747809 -25.747611 -25.747516 -25.747253 -25.747835 -25.748766 -25.749702 -25.750627 -25.750863	149.072048 149.071686 149.071650 149.071470 149.070739 149.070477 149.070469 149.070463 149.070475 149.070464 149.070189 149.069686 149.069628 149.068897 149.068825 149.068957 149.070644 149.070963 149.071797 149.071624 149.072405 149.073808		Area within PPZ of Category C ESA **6.72 ha**	PPZ Category C ESA (Of Concern RE) (11.10.8)
	Brine DamC+D (as per 6399 – Fairview F-HCS-04 Remote Brine Pond C and D Constraints Mapping, dated 23 May 2012)	-25.741196 -25.743597 -25.743510 -25.743221 -25.742409 -25.742232 -25.741825 -25.741343 -25.741210 -25.741173 -25.740292 -25.739765 -25.739636 -25.740474 -25.740806 -25.740891 -25.744807 -25.745344 -25.745153 -25.745059 -25.745042 -25.744835	149.073263 149.071490 149.071493 149.071507 149.071772 149.071901 149.072205 149.072807 149.073125 149.073226 149.073412 149.073637 149.073745 149.073879 149.074079 149.073333 149.070273 149.069394 149.069606 149.069814 149.069853 149.070173		Area within PPZ of Category C ESA **1.71 ha**	PPZ Category C ESA (Of Concern RE) (11.10.8)

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
	Flowline	-25.73526 to -25.746804	149.080295 to 149.068909	Length within PPZ of Category C ESA **2069 m**	Area within PPZ of Category C ESA **4.14 ha**	PPZ Category C ESA (Of Concern RE) (11.10.8)
Total for sections within ESA and PPZ				**2069 m**	**12.56 ha**	
	Brine dam E and F	-25.75103	149.08078		36	PPZ of Category B ESA (Endangered Regional Ecosystem)
		-25.75180	149.08151			
		-25.75180	149.08129			
		-25.75312	149.08084			
		-25.75312	149.08040			
		-25.75463	149.08013			
		-25.75509	149.08012			
		-25.75747	149.08050			
		-25.75765	149.08303			
		-25.75708	149.08422			
		-25.75718	149.08435			
		-25.75717	149.08440			
		-25.75708	149.08448			
		-25.75695	149.08448			
		-25.75676	149.08451			
		-25.75652	149.08464			
		-25.75638	149.08475			
		-25.75637	149.08481			
		-25.75644	149.08488			
		-25.75665	149.08491			
		-25.75684	149.08501			
		-25.75673	149.08512			
		-25.75584	149.08606			
		-25.75561	149.08621			
		-25.75478	149.08628			
		-25.75448	149.08623			
		-25.75440	149.08607			

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
		-25.75432	149.08555			
		-25.75469	149.08434			
		-25.75472	149.08315			
		-25.75456	149.08272			
		-25.75467	149.08181			
		-25.75456	149.08175			
		-25.75433	149.08182			
		-25.75371	149.08228			
		-25.75357	149.08264			
		-25.75332	149.08336			
		-25.75295	149.08411			
		-25.75269	149.08480			
		-25.75251	149.08539			
		-25.75220	149.08604			
		-25.75047	149.08491			
		-25.75038	149.08491			
		-25.75061	149.08405			
		-25.75063	149.08382			
		-25.75020	149.08357			
		-25.74984	149.08333			
		-25.74979	149.08333			
		-25.74911	149.08374			
		-25.74872	149.08409			
Brine transfer line	BL from Dam E and F to F-HCS04 (Dam A and B)	-25.75310 to -25.75094	149.08035 to 149.06923	678	1.2	PPZ of Category B ESA (Endangered Regional Ecosystem)
Total for sections within ESA and PPZ				**678 m**	**37.2 ha**	
FV530/531/532 (FV07-10) and connecting flowlines				3755	8.146	In accordance with Appendix 1
	0	-25.65680	149.04005			Protection Zone (Essential
	1	-25.65713	149.04038			

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
	2	-25.65714	149.04070			Habitat) Category C ESA Secondary Protection Zone (Essential Habitat)
	3	-25.65790	149.04230			
	4	-25.65826	149.04280			
	5	-25.65997	149.04311			
	6	-25.66007	149.04279			
	7	-25.66031	149.04262			
	8	-25.66068	149.04250			
	9	-25.66163	149.04183			
	10	-25.66179	149.04117			
	11	-25.66242	149.04013			
	12	-25.66330	149.04008			
	13	-25.66332	149.04061			
	14	-25.66371	149.04126			
	15	-25.66401	149.04106			
	16	-25.66391	149.04086			
	17	-25.66475	149.03999			
	18	-25.66483	149.04021			
	19	-25.66515	149.04080			
	20	-25.66524	149.04127			
	21	-25.66545	149.04192			
	22	-25.66576	149.04254			
	23	-25.66613	149.04278			
	24	-25.66721	149.04383			
	25	-25.66738	149.04385			
	26	-25.66778	149.04434			
	27	-25.66837	149.04426			
	28	-25.66903	149.04445			
	29	-25.66963	149.04482			
	30	-25.67003	149.04508			
	31	-25.67181	149.04529			
	32	-25.67328	149.04556			
	33	-25.67380	149.04536			

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
	34	-25.67399	149.04548			
	35	-25.67451	149.04725			
	36	-25.67489	149.04770			
	37	-25.67556	149.04918			
	38	-25.67666	149.05016			
	39	-25.67012	149.04373			
	40	-25.67015	149.04334			
	41	-25.67031	149.04265			
	42	-25.67005	149.04223			
	43	-25.67001	149.04171			
	44	-25.67002	149.04086			
	45	-25.66992	149.04049			
	46	-25.67025	149.03818			
	47	-25.67099	149.03503			
	48	-25.67150	149.03343			
	49	-25.67192	149.03286			
Access Track Upgrade	Way Point (WP) 27 to WP 38	-25.671168	149.139478	14500	0.0087	Category A ESA and PPZ (RE 11.10.1)
		-25.582716	149.074461			
Yebna WellsAccess Road	Way Point (WP) 1 to 2	-25.6478 to -25.6491	149.1255 to 149.1176	N/A	1.02 ha	Category A PPZ(Expedition NP)
Belington Road	Way Point (WP) 2 to 3	-25.6491 to -25.6493	149.1176 to 149.1182	N/A	0.57 ha	
	Way Point (WP) 4 to 5	-25.6579 to -25.6612	149.1294 to 149.1334			
CDJV Temporary Workers Campand Office	Point 1 to Point 33 as depicted in the plan titled F-HCS-04 CDJV Camp	-25.738082 to -25.736834	149.079144 to 149.079201	N/A	2.44ha	Primary Protection Zoneof a Category C ESA (Of Concer n Regiona

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
						l Ecosystem)
FKG Temporary Workers Camp	Point 1 to Point 14 as depicted in the plan titled F-HCS-04-FKG Camp	-25.714544 to -25.714518	149.042233 to 149.042306	N/A	3.19ha	Primary Protection Zoneof a Category C ESA (Of Concer n Regiona l Ecosystem)
Tenix Temporary Workers Camp	Point 1 to Point 45 as depicted in the plan titled F-HCS-04 Tenix Camp	-25.718279 to -25.714581	149.048019 to 149.048076	N/A	2.71	Primary Protection Zoneof a Category C ESA (Of Concer n Regiona l Ecosystem)
Temporary Castle Hill Camp and associated effluent disposalarea*	Point 1 to 12 as depicted in the plan titled *Arcadia Valley Phase 1 Camp Proposed Infrastructure Project area*	-25.3303 to –25.3303	148.851 to 148.852	N/A	3.9	Primary Protection Zoneof a Category C ESA (Of Concern Regional Ecosystem) Primary Protection Zoneof a Category BESA (endangered regional ecosystem)
	Point 13-16 as depicted in the plan titled *Arcadia Valley Phase 1 Camp Proposed Infrastructure Project area*	-25.3288 to -25.3289	148.856 to 148.856			

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
Pony Hills Long Distance Water Line	Flowline	-25.762684 to -25.765751	149.044457 to 149.043946	334	0.5	Category C ESA (State Forest)
Brine Transfer Pipeline	ROP1-ROP2	- 25.76586952 to - 25.76850752	149.0442076 to 149.0274380	1850 m	2.4 ha	Category C ESA (State Forest)
Communications Tower	N/A	-25.731826	149.059830	N/A	0.1	Primary Protection Zoneof a Category C ESA (Of Concern Regional Ecosystem) (11.10.7)
		-25.731674	149.059648			
		-25.732094	149.059580			
		-25.731945	149.059386			
Multi-Well Pad FV530, 531, 532 (FV07-10,1,2,3	1	-25.6643180	149.0398467	N/A	1.76	Category C ESA(Essential Habitat) Category C ESA(State Forest or Timber Reserve or Of Concern RE) Category C Primary Protection Zone(State Forest or Timber Reserveor Of Concern RE)
	2	-25.6637166	149.0402548			
	3	-25.6634887	149.0404102			
	4	-25.6640964	149.0414963			
	5	-25.6643332	149.0413410			
	6	-25.6649257	49.0409328			
Mt Kingsley Well Pad	Multi directional well pad	- 25.23202138	148.90189708	N/A	0.78	

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
Mt Kingsley Padto Mt Kingsley Dam water flow line	Flow line	-25.23193209 to -25.257497	148.90112716 to 148.872817	N/A	0.008	
Access Road Upgrade (FV87 FV03-15)	WP38 toWP77	-25.582716	149.074461	26000	0.0156	
		-25.544839	149.006555			
Access Road (Ironbark Gully	PSC 1 to PSC 4	-25.4887	148.8309	N/A	N/A	
		-25.4827	148.8775			
Bonnie Doon Road Upgrade (including Hutton Creek Crossing Upgrade section)	Bonnie Doon Road (including Hutton Creek Crossing Upgrade section)	-25.73179 to -25.74991	148.91978 to 148.92953	1200	0.68	Category C (Of Concern RE) ESA Primary Protection Zone of a Category C (Of Concern RE) ESA Primary Protection Zone of a Category B (Endangered RE) ESA
Access track upgrade and maintenance	Belington 1, Hungry Creek 1, Lynd Range 1 wells and the southern part of Lonesome Holding	Start: - 25.64929998 Finish (at Belington 1): - 25.56101196 Finish (at Lynd Range 1): - 25.38941103 Finish (at southern part of Lonesome Holding): -25.542188	Start: 149.1181351 Finish (at Belington 1): 149.1062990 Finish (at Lynd Range 1): 149.0276311 Finish (at southern part of Lonesome Holding): 149.006971	Approximately 12.6 km	N/A	Category A PPZ (Expedition Limited Depth NP)

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
	Access to northern part Lonesome Holding	Start: - 25.48872297 Finish: -25.4774363	Start: 148.8311230 Finish: 148.8807696			
	New Country 1 Access Road	Start: - 25.140335 Finish: - 25.146178	Start: 148.964078 Finish: 148.952609			
Decommissioning, rehabilitation works and associated monitoring for the New Country 1 well	New Country 1 well pad	Centre point: - 25.146685	Centre point: 148.952675	N/A	0.7	Category A PPZ (Expedition Limited Depth NP)
Lynd Range 1 well	Lynd Range 1 well Pad	Centre point: - 25.38981945	Centre point: 149.0275379	N/A	0.9ha	Category A PPZ (Expedition Limited Depth NP)
Belington 1 well	Belington 1 well pad	Centre point: - 25.56157446	Centre point: 149.1067040	N/A	1.85 ha	Category A PPZ (Expedition Limited Depth NP)
Belington camp	Belington camp	Centre point: - 25.56016299	Centre point: 149.1068372	N/A	0.46	Category A PPZ (Expedition Limited Depth NP)
Water Gathering Line	IR4 to AWAF1	-25.74917 to -25.76212	148.95110 to 149.05015	7,195 m	12.35 ha	Category C ESA (State Forest)
				195 m	0.35 ha	Category C ESA (Essential Habitat Squatter Pigeon)
				115 m	0.20 ha	Category C ESA (Of Concern Regional Ecosystem 11.9.7)

Authorised Activity	Authorised Activity Section	Location of Development (GDA94)		Size of Development		ESA
		Latitude	Longitude	Length (m)	Area of Disturbance (ha)	
				2,330 m	4.75 ha	Category C ESA PPZ (Of Concern Regional Ecosystem and Essential Habitat)
				350 m	0.80 ha	Category B ESA (Endangered Regional Ecosystem) (11.9.5, 11.9.10)
				2,480 m	6.35 ha	Category B ESA PPZ (Endangered Regional Ecosystem)
Total for sections within ESA and PPZ				**12,665 m**	**24.8 ha**	
WMA 2020	Surface Water Monitoring Location	-25.693	149.213		0.02	Category C ESA (Of Concern Regional Ecosystem) Category C ESA (Essential Habitat)

** Temporary Castle Hill Camp Infrastructure must be removed on or before 31 December 2021*

Note: PPZ = Primary Protection Zone, BL = Brine transfer line, the values listed in the table under "Size of Development" have been rounded up to the nearest 5 m or 0.5 ha.

D7 Limited impact camps must not be located within a primary protection zone of Category C ESA (EssentialHabitat) or Category C ESA (Nature Refuges).

D8 Limited impact petroleum activities must not be located within areas that contain commercial species.

D9 Despite condition (D6) decommissioning petroleum activities are authorised within all ESAs other thanCategory A ESAs, and within all ESA protection zones when conducted in accordance with the land disturbance planning principles provided in condition (D5).

D10 Limited petroleum activities, limited impact camps or limited impact petroleum activities located within a primary protection zone or secondary protection zone of an environmentally sensitive area in accordance with *Schedule D, Table 1 – Petroleum Activities in Environmentally Sensitive*

Areas, and activities listed in *Schedule D, Table 2 – Authorised Disturbances* must not negatively affect the adjacent environmentallysensitive area.

D11a Prior to carrying out limited petroleum activities or limited impact petroleum activities undertaken within environmentally sensitive areas in accordance with *Schedule D, Table 1 Petroleum Activities in Environmentally Sensitive Areas*, it must be demonstrated that:

a) No reasonable or practicable alternative exists for carrying out the activities within the environmentally sensitive area
b) The activities are preferentially located in pre-existing areas of clearing or significant disturbance

D11b In addition to condition D11a, linear infrastructure construction corridors that are a limited petroleum activity or limited impact petroleum activity authorised in environmentally sensitive areas must:

a) maximise co-location
b) be minimised in width to the greatest practicable extent, taking into account the following matters:
    i. safe vehicle movement
    ii. drainage devices installed are of a type that is appropriate for the access track / road type and location
    iii. erosion and sediment control measures installed are in accordance condition (B14); and
    iv. power line stays have been preferentially located within the pipeline right of way where possible.
c) be no greater than 40 m total width; and
d) where more than 2 linear infrastructure services are to be co-located in a linear infrastructure construction corridor in accordance with (a) and (c), an additional 11 m is authorised to be added to the construction corridor width for each additional co-located linear infrastructure service, up to a maximum corridor width of 62m.

Offset Delivery

D12 An Offset Plan must be prepared in accordance with section 5 of the Offset Strategy at Appendix AB of the final environmental impact statement (EIS) decided by the Coordinator- General on 3 September 2015. After a decision under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and three (3) months prior to any construction activities, the proponent must submit the Offset Plan to the Department of Environment and Science. The Offset Plan must consider offsets for any significant residual impacts to the following prescribed environmental matters:

(i) remnant regional ecosystems listed as endangered (*Vegetation Management Act 1999* [VM Act] Class)
(ii) remnant regional ecosystems listed as of concern (VM Act Class)
(iii) essential habitat for the species listed in schedule D, Table 4.
(iv) wetlands of general ecological significance.

The Offset Plan must:

(a) detail how the specific offset requirements conditioned by the Commonwealth Minister for the Environment in any approval for the project under the EPBC Act will be delivered

(b) detail proposed offsets to address any significant residual impacts for the prescribed environmental matters at condition (D12) (i)-(iv)
(c) include, but not necessarily be limited to:
  (i) a detailed description of the land to which the plan relates, the matters affected and the extent and likely timing of impact on each matter
  (ii) evidence that impacts to the prescribed environmental matters in D12(i)-(iv) can be offset
  (iii) for the prescribed environmental matters listed in D12 (i)-(iv), the method for delivering the offset in accordance with the *Environmental offsets Act 2014*, including consideration of land-based offsets, direct benefit management plans, offset transfers and/or offset payments and other tenure activities
(d) ensure a legally binding mechanism to protect and manage offset areas
(e) include a staging plan to demonstrate how offsets will be delivered and managed over the life of the project
(f) consider existing, proposed and future offsets prepared and/or planned under the existing environmental authorities pertaining to the project area.

Maximum Disturbance

D13 Disturbance to ecological receptors listed in *Schedule D, Table 4 Maximum disturbance limits*, must not exceed the relevant maximum disturbance limits.

Schedule D, Table 4 Maximum disturbance limits

Ecological Receptor	Proposed disturbance area for Fairview Arcadia Project Area (ha)
Environmental Matter	
Endangered Regional Ecosystems (remnant and high value regrowth) (VM Act Class)	220
Of-concern Regional Ecosystems (remnant and high value regrowth) (VM Act Class)	1065.3
Essential habitat (*Chalinolobus dwyeri* (Large-eared pied bat))	3
Essential habitat (*Nyctophilus corbeni* (South -eastern long eared bat))	3
Essential habitat (*Melaleuca irbyana*)	74
Essential habitat (*Eriocaulon carsonii subsp. orientale*)	2.5
Wetlands (general ecological significance)	24.7
Protected Areas	
Resource reserves	252
State forest and timber reserves	1183.2

D14 No Significant Residual Impacts are authorised to occur on the Short-beaked Echidna (*Tachyglossus aculeatus*) or the Platypus (*Ornithorhynchus anatinus*).

D15 An environmental offset made in accordance with the *Environmental Offsets Act 2014* and Queensland Environmental Offsets Policy, as amended from time to time, must be undertaken for the maximum disturbance limits detailed in *Schedule D, Table 4 Maximum disturbance limits*, for

each of the following prescribed environmental matters unless a lesser extent of the impact has been approved in accordance with condition D17 for staged offsets:

(i) remnant regional ecosystems listed as endangered (VM Act Class);
(ii) remnant regional ecosystems listed as of concern (VM Act Class);
(iii) essential habitat for the species listed in schedule D, Table 4; and
(iv) wetlands of general ecological significance.

D16 Environmental offsets required by condition D15 may be carried out in stages. An environmental offset can be delivered for each stage of the impacts to prescribed environmental matters.

D17 A notice of election for the staged environmental offset referred to in condition D16, if applicable, must be provided to the administering authority no less than three months before the proposed commencement of that stage, unless a lesser timeframe has been agreed to by the administering authority.

D18 Conditions D12 to D17 apply only to disturbances associated with the GFD project.

SCHEDULE E – WASTE

General Waste Management

E1 Measures must be implemented so that waste is managed in accordance with the waste and resource management hierarchy and the waste and resource management principles.

E2 Waste, including waste fluids, but excluding waste used in closed-loop systems, must be transported off-site for lawful re-use, remediation, recycling or disposal, unless the waste is specifically authorised by conditions (B21), (B30), (BA2), (E3), (E7), (E8), (C6), (C8) and (C14) to be disposed of or used on site.

E3 Unless otherwise authorised by the conditions of this EA to be released to land, Waste fluids, other than flare precipitant stored in flare pits, or residual drilling material, or drilling fluids stored in sumps, must be contained in either:

(a) an above ground container; or
(b) a structure which contains the wetting front.

E4 Vegetation waste may be burned if it relates to a state forest, timber reserve or forest entitlement area administered by the *Forestry Act 1959* and a permit has been obtained under the *Fire and Rescue Service Act 1990*.

Brine and Salt Management

E5 Following the completion of the petroleum activity(ies), any residual brine and / or solid salt present in any structure must be removed and transported to a facility that can lawfully reuse, recycle or dispose of suchwaste under the *Environmental Protection Act 1994*.

Investigation into Alternative CSG Water Management Options

E6 The Salt and Brine Management Plan must be developed by December 2019 that has investigated the following:

(a) the viability of waste reuse or recycling through chemically processing or treating brine or salt residues to create useable or saleable products;
(b) the viability of the injection of brine into a natural underground structure that is geologically isolated and does not contain groundwater and does or could supply water for potable or agricultural purposes;
(c) the outcomes of the investigations and proposed actions forward, and identified methods for the beneficial use and of brine and salt; and

(d) procedures for identifying and implementing opportunities to improve the CSG water management practices.

Residual Drilling Materials

E7 If sumps are used to store residual drilling material or drilling fluids, they must only be used for the duration of drilling activities.

E8 Residual drilling material can only be disposed of on-site:

(a) by mix-bury-cover method if the residual drilling material meets the approved quality criteria; or

(b) if it is certified by a suitably qualified third party as being of acceptable quality for disposal toland by the proposed method and that environmental harm will not result from the proposed disposal.

E9 Records must be kept, to demonstrate compliance with condition (E7) and condition (E8).

SCHEDULE F – NOISE

F1 Petroleum activities must not cause environmental nuisance at a sensitive place, other than where an alternative arrangement is in place.

F2 Notwithstanding condition (F1), emission of noise from the petroleum activity at levels less than those specified in *Schedule F, Table 1 Noise nuisance limits* are not considered to be environmental nuisance.

Schedule F, Table 1 Noise nuisance limits

Time period	Metric	Short term noise event	Medium term noise event	Long term noise event
7:00am 6:00pm	LAeq,adj,15 min	45 dBA	43 dBA	40 dBA
6:00pm 10:00pm	LAeq,adj,15 min	40 dBA	38 dBA	35 dBA
10:00pm 6:00am	LAeq,adj,15 min	28 dBA	28 dBA	28 dBA
	Max $L_{pA,15\ min}$	55 dBA	55 dBA	55 dBA
6:00am 7:00am	LAeq,adj,15 min	40 dBA	38 dBA	35 dBA

Note: The noise limits in Table 1 have been set based on the following deemed background noise levels (LABG):7:00am - 6:00 pm: 35 dBA
6:00pm - 10:00 pm: 30 dBA
10:00pm - 6:00 am: 25 dBA
6:00am - 7:00 am: 30 dBA

F3 If the noise subject to a valid complaint is tonal or impulsive, the adjustments detailed in *Schedule F, Table 2 Adjustments to be added to noise levels at sensitive receptors* are to be added to the measured noise level(s) to derive LAeq, adj, 15 min.

Schedule F, Table 2 Adjustments to be Added to Noise Levels at Sensitive Receptors

Noise characteristic	Adjustment to noise
Tonal characteristic is just audible	+ 2 dBA
Tonal characteristic is clearly audible	+ 5 dBA
Impulsive characteristic is detectable	+ 2 to + 5 dBA

F4 Notwithstanding condition (F2), emission of any low frequency noise must not exceed either (F4(a)) and (F4(b)), or (F4(c)) and (F4(d)) in the event of a valid complaint about low frequency noise being made to the administering authority:

(a) 60 dB(C) measured outside the sensitive receptor; and

(b) the difference between the external A-weighted and C-weighted noise levels is no greater than20 dB; or
(c) 50 dB(Z) measured inside the sensitive receptor; and
(d) the difference between the internal A-weighted and Z-weighted (Max LpZ, 15 min) noise levels is nogreater than 15 dB.

F5 A Blast Management Plan must be developed for each blasting activity in accordance with AustralianStandard 2187.

F6 Blasting operations must be designed to not exceed an air blast overpressure level of 120 dB (linear peak) at any time, when measured at or extrapolated to any sensitive place.

F7 Blasting operations must be designed to not exceed a ground-borne vibration peak particle velocity of 10mm/s at any time, when measured at or extrapolated to any sensitive place.

SCHEDULE G – AIR

Fuel Burning or Combustion Equipment

G1 If compressor stations meet the definition of fuel burning or combustion equipment, the design of the equipment must be capable of achieving air quality objectives for each environmental value stated in the *Environmental Protection (Air) Policy 2019*.

G2 Fuel burning or combustion equipment must:

(a) not be operated unless it is listed in *Schedule G, Table 1 – Authorised Releases of Contaminants to Air from Point Sources;*
(b) not exceed the release limits specified in *Schedule G, Table 1 – Authorised Releases of Contaminants to Air from Point Sources;*
(c) be monitored for the release limits at the release point locations and at the monitoring frequency specified in *Schedule G, Table 1 – Authorised Releases of Contaminants to Air from Point Sources.*

Schedule G, Table 1 – Authorised Releases of Contaminants to Air from Point Sources

Resource Authority	Facility	Release Point Locations	Release Limits			Monitoring Frequency
			Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)	NOx as Nitrogen Dioxide Maximum Mass Emission Rate (g/s)	
PL91	CS1	Compressor 1 (K048)	5.5	24	2	At least one release point must be monitored per year on a rotational basis.
		Compressor 2 (K044)	6.0	33	2	
PL420 & 421	A-CS-01 / ACS-02	Compressor 1 (K049)	6.0	23	2	At least one release point must be monitored per year on a rotational basis, with all release points
		Compressor 2 (K046)	6.0	23	2	
		Compressor 1	7.0	17	2	
		Compressor 2	7.0	17	2	
		Compressor 3	7.0	17	2	

Resource Authority	Facility	Release Point Locations	Release Limits			Monitoring Frequency
			Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)	NOx as Nitrogen Dioxide Maximum Mass Emission Rate (g/s)	
		Compressor 4	7.0	17	2	monitored at least once in a 3 year period.
		Compressor 5	7.0	17	2	
		Compressor 6	7.0	17	2	
		Compressor 7	7.0	17	2	
		Compressor 8	7.0	17	2	
		Generator 1	7.5	17	2	
		Generator 2	7.5	17	2	
		Generator 3	7.5	17	2	
		Generator 4	7.5	17	2	
		Generator 5	7.5	17	2	
PL92	CS2	Compressor A (K057)	6.0	23	2	At least one release point must be monitored per year on a rotational basis.
		Compressor B (K058)	6.0	23	2	
		Compressor C (K059)	6.0	23	2	
		Compressor D (Ko55)	8.1	17	2	
		Compressor E (K056)	8.1	17	2	
		Compressor F (K050)	10.0	17	10	At least one release point must be monitored per year on a rotational basis.
		Compressor G (K051)	10.0	17	10	
		Compressor H (K052)	10.0	17	10	
		Compressor J (K053)	10.0	17	10	
PL421		Compressor 1	12.3	17	2	All release points must be monitored during
		Compressor 2	12.3	17	2	

Resource Authority	Facility	Release Point Locations	Release Limits			Monitoring Frequency
			Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)	NOx as Nitrogen Dioxide Maximum Mass Emission Rate (g/s)	
	ACS-03	Compressor 3	12.3	17	2	commissioning of the facility. Thereafter, at leastone release point must be monitoredper year on a rotational basis, with all release points monitored atleast once in a 6 year period.
		Compressor 4	12.3	17	2	
		Compressor 5	12.3	17	2	
		Compressor 6	12.3	17	2	
		Compressor 7	12.3	17	2	
		Compressor 8	12.3	17	2	
		Generator 1	8.0	17	2	
		Generator 2	8.0	17	2	
		Generator 3	8.0	17	2	
		Generator 4	8.0	17	2	
PL92	CS3	Compressor 1 (K063)	8.3	17	2	At least one release point must be monitored per year on a rotational basis, with all release points monitored at least once in a 6 year period
		Compressor 2 (K064)	8.3	17	2	
		Compressor 3 (K065)	8.3	17	2	
		Compressor 4 (K066)	8.3	17	2	
		Compressor 5 (K067)	8.3	17	2	
		Compressor 6 (K068)	8.3	17	2	
		Compressor 7 (K069)	8.3	17	2	
		Compressor 8 (K070)	8.3	17	2	
PL232	F-HSC-04	Hub GTC1	15.0	18	2	All release points

Resource Authority	Facility	Release Point Locations	Release Limits			Monitoring Frequency
			Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)	NOx as Nitrogen Dioxide Maximum Mass Emission Rate (g/s)	
		Hub GTC2	15.0	18	2	must be monitored during commissioning of the facility. Thereafter, at least one release point must be monitored per year on a rotational basis, with all release points monitored at least once in a 6 year period.
		Hub GTC3	15.0	18	2	
		Hub GTC4	15.0	18	2	
		Hub GTC5	15.0	18	2	
		Hub GTA1	15.0	20	2	
		Hub GTA2	15.0	20	2	
		Hub GTA3	15.0	20	2	
		Hub GTA4	15.0	20	2	
		Hub GTA5	15.0	20	2	
PL91	F-HSC-05	Hub GTC1	15.0	18	2	All release points must be monitored during commissioning of the facility. Thereafter, at least one release point must be monitored per year on a rotational basis, with all release points monitored at least once in a 6 year period
		Hub GTC2	15.0	18	2	
		Hub GTC3	15.0	18	2	
		Hub GTC4	15.0	18	2	
		Hub GTA1	15.0	20	2	
		Hub GTA2	15.0	20	2	
		Hub GTA3	15.0	20	2	With all release points monitored at least once in a 6 year period.
		Hub GTA4	15.0	20	2	
		Hub GTA5	15.0	20	2	
		Hub GTA6	15.0	20	2	
Note: The above NOx release limits are applicable during all timings except start-up, shut down and calibration of emission monitoring devices. The start-up duration is allowed up to 30 minutes.						

Venting and flaring

G3 Unless venting is authorised under the *Petroleum and Gas (Production and Safety) Act 2004* or the *Petroleum Act 1923*, waste gas must be flared in a manner that complies with all of (G3(a)) and (G3(b)) and (G3(c)), or with (G3(d)):

(a) an automatic ignition system is used, and
(b) a flame is visible at all times while the waste gas is being flared, and
(c) there are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours, or
(d) it uses an enclosed flare

SCHEDULE H – REGULATED STRUCTURES

Assessment of Consequence Category

H1 The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933[1]) at the following times:

a) prior to the design and construction of the structure, if it is not an existing structure; or
b) prior to any change in its purpose or the nature of its stored contents.

H2 A consequence assessment report and certification must be prepared for each structure assessed andthe report may include a consequence assessment for more than one structure.

H3 Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933).

Design and Construction of a Regulated Structure

H4 Conditions H5 to H9 inclusive do not apply to existing structures.

H5 All regulated structures must be designed by, and constructed[2] under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933).

H6 Construction of a regulated structure is prohibited unless:

a) the holder has submitted a consequence category assessment report and certification to theadministering authority; and
b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.

[1] This is the publication number, which can be used as a search term to find the latest version of the publication at www.des.qld.gov.au.

[2] Certification of design and construction may be undertaken by different persons.

H7 Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) and must be recorded in the Register of Regulated Structures.

H8 Regulated structures must:

a) be designed and constructed in compliance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933);
b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of:
    i. floodwaters from entering the regulated dam from any watercourse or drainage line;and
    ii. wall failure due to erosion by floodwaters arising from any watercourse or drainageline.
c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.

H9 Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, andstate that:

a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure
b) construction of the regulated structure is in accordance with the design plan.

Notification of Affected Persons

H10 All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure:

a) for existing structures that are regulated structures, within 6 months of this condition taking effect;
b) prior to the operation of the new regulated structure; and
c) if the emergency action plan is amended, within 5 business days of it being amended.

Operation of a Regulated Structure

H11 Operation of a regulated structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following:

a) one paper copy and one electronic copy of the design plan and certification of the ‘design plan’in accordance with condition H6;

b) a set of 'as constructed' drawings and specifications;
c) certification of the 'as constructed drawings and specifications' in accordance with condition H9;
d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan;
e) the requirements of this authority relating to the construction of the regulated structure have been met;
f) the holder has entered the details required under this authority, into a Register of Regulated Structures; and
g) there is a current operational plan for the regulated structure. A current operational plan is not required for existing structures.

H12 Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.

Mandatory Reporting Level

H13 Conditions H14 to H16 inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.

H14 The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.

H15 The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.

H16 The holder must record any changes to the MRL in the Register of Regulated Structures.

Design Storage Allowance

H17 The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.

H18 By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).

H19 The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.

Annual Inspection Report

H20 Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.

H21 At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required.

H22 The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933).

H23 The holder must within 20 business days of receipt of the annual inspection report, provide to the administering authority:

a) The recommendations section of the annual inspection report; and
b) If applicable, any actions being taken in response to those recommendations; and
c) If, following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder, providethis to the administering authority within 10 business days of receipt of the request.

Transfer Arrangements

H24 The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.

Decommissioning and Rehabilitation

H25 Regulated structures must not be abandoned but be either:

a) decommissioned and rehabilitated to achieve compliance with condition H26; or
b) be left in-situ for a use by the landholder provided that:
    i. it no longer contains contaminants that will migrate into the environment; and
    ii. it contains water of a quality that is demonstrated to be suitable for its intended use(s); and
c) the holder of the environmental authority and the landholder agree in writing that the;
    i. dam will be used by the landholder following the cessation of the environmentally relevant activity(ies); and
    ii. landholder is responsible for the dam, on and from an agreed date.

H26 Before surrendering this environmental authority the site must be rehabilitated to achieve a safe, stable, non-polluting landform and be suitable for the relevant final land use.

Register of Regulated Structures

H27 A Register of Regulated Structures must be established and maintained by the holder for each regulated structure.

H28 The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.

H29 The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition H11 has been achieved.

H30 The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.

H31 All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

SCHEDULE I – WELL CONSTRUCTION, MAINTENANCE AND STIMULATION ACTIVITIES

Drilling Activities

I1 Oil based or synthetic based drilling muds must not be used in the carrying out of the petroleum activity(ies).

I2 Drilling activities must not result in the connection of the target gas producing formation and another aquifer.

I3 Practices and procedures must be in place to detect, as soon as practicable, any fractures that have or may result in the connection of a target gas producing formation and another aquifer as a result of drilling activities.

Stimulation Activities

I4 Polycyclic aromatic hydrocarbons or products that contain polycyclic aromatic hydrocarbons must not be used in stimulation fluids in concentrations above the reporting limit.

I5 Stimulation activities must not negatively affect water quality, other than that within the stimulation impact zone of the target gas producing formation.

I6 Stimulation activities must not cause the connection of the target gas producing formation and another aquifer.

I7 The internal and external mechanical integrity of the well system prior to and during well stimulation must be ensured such that there is:

a) no significant leakage in the casing, tubing, or packer; and
b) there is no significant fluid movement into another aquifer through vertical channels adjacent to the well bore hole.

I8 Practices and procedures must be in place to detect, as soon as practicable, any fractures that cause the connection of a target gas producing formation and another aquifer.

Stimulation Risk Assessment

I9 Prior to undertaking well stimulation activities, a risk assessment must be developed to ensure that stimulation activities are managed to prevent environmental harm.

I10 The stimulation risk assessment must be carried out for every well to be stimulated prior to stimulation activities being carried out at that well and address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to:

a) a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice;
b) provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority;
c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s);
d) naturally occurring geological faults;
e) seismic history of the region (e.g. earth tremors, earthquakes);
f) proximity of overlying and underlying aquifers;
g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation.
h) identification and proximity of landholders' active groundwater bores in the area where stimulation activities are to be carried out;
i) the environmental values of groundwater in the area;
j) an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater;
k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity;
l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers;
m) a description of the well mechanical integrity testing program;
n) process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. microseismic measurements, modelling etc);
o) practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation;
p) groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow;
q) a description of the chemicals used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation;
r) a mass balance estimating the concentrations and absolute masses of chemicals that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation;
s) an environmental hazard assessment of the chemicals used including their mixtures and theresultant chemicals that are formed after stimulation including:
    (i). toxicological and ecotoxicological information of chemicals used;

(ii). information on the persistence and bioaccumulation potential of the chemicals used;

(iii). identification of the stimulation fluid chemicals of potential concern derived from the risk assessment;

t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities;

u) if used, identification and an environmental hazard assessment of using radioactive tracerbeads in stimulation activities

v) an environmental hazard assessment of leaving stimulation chemicals in the target gas producing formation for extended periods subsequent to stimulation;

w) human health exposure pathways to operators and the regional population;

x) risk characterisation of environmental impacts based on the environmental hazard assessment;

y) potential impacts to landholder bores as a result of stimulation activities;

z) the determination of the likelihood of causing interconnectivity and/or negative water quality as aresult of stimulation activities undertaken in close proximity or each other; and

aa) potential environmental or health impacts which may result from stimulation activities includingbut not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.

Water Quality Baseline Monitoring

I11 Prior to undertaking any stimulation activity, a baseline bore assessment must be undertaken of the water quality of:

(a) all landholders' active groundwater bores (subject to access being permitted by the landholder) that are spatially within a two (2) kilometre horizontal radius from the location of the stimulation initiation point within the target gas producing formation; and

(b) all landholders' active groundwater bores (subject to access being permitted by the landholder) in any aquifer that is within 200 metres above or below the target gas producing formation and is spatially located with a two (2) kilometre radius from the location of the stimulation initiation point; and

(c) any other bore that could potentially be adversely impacted by the stimulation activity(ies) in accordance with the findings of the risk assessment required by conditions (I9) and (I10).

I12 Prior to undertaking stimulation activities at a well, there must have sufficient water quality data to accurately represent the water quality in the well to be stimulated. The data must include, as a minimum,the results of analyses for the parameters in condition (I13).

I13 Baseline bore and well assessments must include relevant analytes and physico-chemical parameters to be monitored in order to establish baseline water quality and must include, but not necessarily be limited to:

(a) pH
(b) electrical conductivity [µS/m]
(c) turbidity [NTU]
(d) total dissolved solids [mg/L]
(e) temperature [°C]
(f) dissolved oxygen [mg/L]
(g) dissolved gases (methane, chlorine, carbon dioxide, hydrogen sulfide) [mg/L]
(h) alkalinity (bicarbonate, carbonate, hydroxide and total as CaCO3) [mg/L]
(i) sodium adsorption ratio (SAR)
(j) anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L]
(k) cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L]
(l) dissolved and total metals and metalloids (including but not necessarily being limited to: aluminium, arsenic, barium, borate (boron), cadmium, total chromium, copper, iron, fluoride,lead, manganese, mercury, nickel, selenium, silver, strontium, tin and zinc) [µg/L]
(m) total petroleum hydrocarbons [µg/L]
(n) BTEX (as benzene, toluene, ethylbenzene, ortho-xylene, para- and meta-xylene, and total xylene) [µg/L]
(o) polycyclic aromatic hydrocarbons (including but not necessarily being limited to: naphthalene, phenanthrene, benzo[a]pyrene) [µg/L]
(p) sodium hypochlorite [mg/L]
(q) sodium hydroxide [mg/L]
(r) formaldehyde [mg/L]
(s) ethanol [mg/L]; and
(t) gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L].

I14 Despite condition I13, baseline bore and well assessment undertaken prior to 13 April 2021 must include the minimum water quality analytes and physico-chemical parameters identified in the Baseline Assessment Guideline (EHP) and any restricted stimulation fluids as defined in the *Environmental Protection Act 1994*, as amended from time to time, in order to establish baseline water quality.

Stimulation Impact Monitoring Program

I15 A Stimulation Impact Monitoring Program must be developed prior to the carrying out of stimulation activities which must be able to detect adverse impacts to water quality from stimulation activities and must consider the findings of the risk assessment required by conditions (I9) and (I10) that relate to stimulation activities and must include, as a minimum, monitoring of:

(a) the stimulation fluids to be used in stimulation activities at sufficient frequency and which sufficiently represents the quantity and quality of the fluids used; and
(b) flow back waters from stimulation activities at sufficient frequency and which

sufficiently represents the quality of that flow back water; and

(c) flow back waters from stimulation activities at sufficient frequency and accuracy to demonstrate that 150 per cent of the volume used in stimulation activities has been extracted from the stimulated well; and

(d) all bores in accordance with condition (I11) at the following minimum frequency:

i. monthly for the first six (6) months subsequent to the stimulation activities being undertaken; then

ii. annually for the first five (5) years subsequent to the stimulation activities being undertaken or until analytes and physico-chemical parameters listed in condition (I13) are not detected in concentrations above baseline bore monitoring data on two (2) consecutive monitoring occasions.

I16 The Stimulation Impact Monitoring Program must provide for monitoring of:

a) analytes and physico-chemical parameters relevant to baseline bore and well assessments toenable data referencing and comparison including, but not necessarily being limited to the analytes and physico-chemical parameters in condition (I13); and

b) any other analyte or physico-chemical parameters that will enable detection of adverse water quality impacts and the inter-connection with a non-target aquifer as a result of stimulation activities including chemical compounds that are actually or potentially formed by chemical reactions with each other or coal seam materials during stimulation activities.

I17 The results of the Stimulation Impact Monitoring Program must be made available to any potentially affected landholders upon request by that landholder.

SCHEDULE J – REHABILITATION

Rehabilitation Planning

J1 A Rehabilitation Plan must be developed by a suitably qualified person and must include the:

(a) rehabilitation goals; and
(b) procedures to be undertaken for rehabilitation that will:
  (i). achieve the requirements of conditions (J2) to (J6) inclusive; and
  (ii). provide for appropriate monitoring and maintenance.

Transitional Rehabilitation

J2 Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria:

(a) contaminated land resulting from petroleum activities is remediated and rehabilitated;
(b) the areas are:
  (i). non-polluting;
  (ii). a stable landform;
  (iii). re-profiled to contours consistent with the surrounding landform
(c) surface drainage lines are re-established;
(d) top soil is reinstated; and
(e) either:
  (i). groundcover, that is not prohibited or restricted pest species, is growing; or
  (ii). an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.

Remaining Dams

J3 Where there is a dam, (including a low consequence dam) that is being or intended to be used by the landholder or overlapping tenure holder, the dam must be decommissioned to no longer accept inflow from the petroleum activity(ies) and the contained water must be of a quality suitable for the intended on-going uses(s) by the landholder or overlapping tenure holder.

Pipeline Activities

J4 Pipeline trenches must be backfilled, and topsoils reinstated within three months after pipe laying.

J5 Reinstatement and revegetation of the pipeline right of way must commence within 6 months after cessation of petroleum activities for the purpose of pipeline construction.

J6 Backfilled, reinstated, and revegetated pipeline trenches and right of ways must be:

(a) a stable landform
(b) re-profiled to a level consistent with surrounding soils
(c) re-profiled to original contours and established drainage lines; and
(d) vegetated with groundcover which is not a prohibited or restricted pest species , and which is established and growing.

Final Rehabilitation Acceptance Criteria

J7 All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, must be rehabilitated to meet the following final acceptance criteria measured either against the highest ecological value adjacent land use or the pre-disturbed land use:

(a) greater than or equal to 70 per cent of native ground cover species richness
(b) greater than or equal to the total per cent ground cover
(c) less than or equal to the per cent species richness of prohibited or restricted pestspecies
(d) where the adjacent land use contains, or the pre-clearing land use contained, one or more regional ecosystem(s), then:
    (i). at least one Regional Ecosystem(s) from the same broad vegetation group, as demonstrated by the predominant species in the ecologically dominant layer, must bepresent; and,
    (ii). the Regional Ecosystem present in (J7)(d)(i) must possess an equivalent or higher conservation value (biodiversity status) than the Regional ecosystem(s) in either theadjacent land or pre-disturbed land.

Final Rehabilitation Acceptance Criteria in Environmentally Sensitive Areas

J8 Where significant disturbance to land has occurred in an environmentally sensitive area, the following final rehabilitation criteria as measured against the pre-disturbance biodiversity values assessment (required by conditions (J1) and (J2)) must be met:

(a) greater than or equal to 70% of native ground cover species richness
(b) greater than or equal to the total per cent ground cover
(c) less than or equal to the per cent species richness of Prohibited or restricted pest species
(d) greater than or equal to 50% of organic litter cover
(e) greater than or equal to 50% of total density of coarse woody material; and
(f) all predominant species in the ecologically dominant layer, that define the pre-disturbance regional ecosystem(s) are present.

SCHEDULE K – NOTIFICATION

K1 The administering authority must be notified through the Pollution Hotline as soon as reasonably practicable, but within 48 hours after becoming aware of:

(a) any unauthorised significant disturbance to land; or

(b) any unauthorised release of contaminants greater than:

(i) 200 L of hydrocarbons; or

(ii) 200 L of stimulation additives; or

(iii) 500 L of stimulation fluids; or

(iv) 1,000 L of brine; or

(v) 5,000 L of coal seam gas water; or

(vi) 10,000 L of sewage effluent;

(vii) 100,000 L of irrigation-quality coal seam gas water, released inside a designated irrigation area authorised by condition (C8)(c).

(c) a potential or actual loss of structural or hydraulic integrity of a dam; or

(d) when the level of the contents of any regulated dam reaches the mandatory reporting level; or

(e) when a regulated dam will not have available storage to meet the design storage allowance on the 1 November of any year; or

(f) any incident where there is a potential or actual loss of well integrity (e.g. when the annulus pressure during stimulation increases by more than 3.5 MPa from the pressure immediately preceding stimulation); or

(g) any detection of restricted stimulation fluids from stimulation fluid monitoring; or

(h) any analyses result from baseline bore, well or stimulation impact monitoring that exceeds awater quality objective for the protection of an environmental value of that water resource; or

(i) any analyses result from groundwater monitoring that exceeds trigger action investigation levels, if provided in this environmental authority.

K2 In the event that a drinking water quality parameter limit is exceeded in *Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water* or *Schedule B, Table 9 – Event based release- Contaminant Limits for Protecting the Environmental Value of Drinking Water,* the following events must occur within 24 hours of becoming aware of any noncompliance:

(a) the administering authority must be notified on the Pollution Hotline; and

(b) the holder of this authority must telephone any affected drinking water service provider;

K3 In the event that a water quality parameter limit is exceeded in *Schedule B, Table 8 – Event-based release – Contaminant monitoring*, the administering authority must be notified on the Pollution Hotline within 24 hours of becoming aware of any noncompliance.

K4 The notification of emergencies or incidents as required by condition (K1) must include but not be limited to the following information:

(a) the environmental authority number and name of the holder;
(b) the tenure type and number where the emergency or incident occurred;
(c) the name and telephone number of the designated contact person;
(d) the location of the emergency or incident (GDA94);
(e) the date and time that the emergency or incident occurred;
(f) the date and time the holder of this environmental authority became aware of the emergency or incident;
(g) details of the nature of the event and the circumstances in which it occurred;
(h) the estimated quantity and type of any contaminants involved in the incident;
(i) the actual or potential suspected cause of the emergency or incident;
(j) a description of the land use at the site of the emergency or incident (e.g. grazing, pasture, forest etc.) and/or the name of any relevant waters and other environmentally sensitive features;
(k) a description of the possible impacts from the emergency or incident;
(l) a description of whether stock and/or wildlife were exposed to any contaminants released and measures taken to prevent access for the duration of the emergency or incident;
(m) any sampling conducted or proposed, relevant to the emergency or incident;
(n) landholder details and details of landholder consultation;
(o) immediate actions taken to control the impacts of the emergency or incident and how environmental harm was mitigated at the time of the emergency or incident; and
(p) whether further examination/root cause analysis is required and if so, the expected date bywhen this examination will be completed and reported to the administering authority.

K5 Within 10 business days following the initial notification under conditions (K1), (K2), (K3) and (K4) unlessa longer time is agreed to by the administering authority, a written report must be provided to the administering authority, including the following (where relevant to the emergency or incident):

(a) the root cause of the emergency or incident;
(b) the confirmed quantities and types of any contaminants involved in the incident;
(c) results and interpretation of any analysis of samples taken at the time of the emergency or incident (including the analysis results of any impact monitoring);
(d) a final assessment of the impacts from the emergency or incident including any actual or potential environmental harm that has occurred or may occur in the longer term as a result of the release;
(e) the success or otherwise of actions taken at the time of the incident to prevent or minimise environmental harm;
(f) results and current status of landholder consultation, including commitment to resolve any outstanding issues / concerns; and
(g) actions and / or procedural changes to prevent a recurrence of the emergency or incident.

Definitions

Key terms and/or phrases used in this document are defined in this section. Where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

"Adjacent Land Use(s)" means the **ecosystem function** adjacent to an area of significant disturbance, or where there is no ecosystem function, the use of the land. An adjacent land use does not include an adjacent area that shows evidence of edge effect.

"Administering Authority" means:

a) for a matter, the administration and enforcement of which has been devolved to a local government under section 514 of the *Environmental Protection Act 1994* the local government; or
b) for all other matters the Chief Executive of the Department of Environment and Science; or
c) another State Government Department, Authority, Storage Operator, Board or Trust, whose role is to administer provisions under other enacted legislation.

"Affected Person" is someone whose drinking water can potentially be impacted as a result of discharges froma dam or their life or property can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

"AHD" means Australian Height Datum and is the datum used for the determination of elevations in Australia.The determination uses a national network of benchmarks and tide gauges and sets mean sea level at zero elevation.

"Alternative Arrangement" means a written agreement about the way in which a particular environmental nuisance impact will be dealt with at a sensitive place, and may include an agreed period of time for which thearrangement is in place. An alternative arrangement may include, but is not limited to, a range of nuisance abatement measures to be installed at the sensitive place, or provision of alternative accommodation for the duration of the relevant nuisance impact.

"Analogue Site" means an area of land which contains values and characteristics representative of an area tobe rehabilitated prior to disturbance. Such values must encompass land use, topographic, soil, vegetation, vegetation community attributes and other ecological characteristics. Analogue sites can be the pre-disturbed site of interest where significant surveying effort has been undertaken to establish benchmark parameters.

"Analytes" means a chemical parameter determined by either physical measurement in the field or by laboratory analysis.

"**Annual Exceedance Probability or AEP**" the probability that at least one event in excess of a particular magnitude will occur in any given year.

"Annual Inspection Report" means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan):

a) against recommendations contained in previous annual inspections reports;
b) against recognised dam safety deficiency indicators;
c) for changes in circumstances potentially leading to a change in consequence category;
d) for conformance with the conditions of this authority;
e) for conformance with the 'as constructed' drawings;
f) for the adequacy of the available storage in each regulated dam, based on an actual observation orobservations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems);
g) for evidence of conformance with the current operational plan.

"Appraisal Well" means a petroleum well to test the potential of one (1) or more natural underground reservoirs for producing or storing petroleum. For clarity, an appraisal well does not include an exploration well.

"Approved Quality Criteria" for the purposes of residual drilling materials, means the residual drilling materialmeet the following quality standards:

Part A In all cases:

Parameter	Maximum concentration
pH	6 - 10.5 (range)
Electrical Conductivity	20 dS/m (20,000 µS/cm)
Chloride*	8,000 mg/L

*Chloride analysis is only required if an additive containing chloride was used in the drilling process.The limits in Part A must be measured in the clarified filtrate of oversaturated solids prior to mixing.

Part B If any of the following metals are a component of the drilling fluids, then for that metal:

Parameter	Maximum concentration
Arsenic	20 mg/kg
Selenium	5 mg/kg
Boron	100 mg/kg
Cadmium	3 mg/kg
Chromium	400 mg/kg
Copper	100 mg/kg
Lead	600 mg/kg

The limits in Part B and Part C refer to the post soil/by-product mix. Part C if a hydrocarbon sheen is visible, the following hydrocarbon fractions:

TPH	Maximum concentration
C6 – C10	170 mg/kg
C10 – C16	150 mg/kg
C16 – C34	1300 mg/kg
C34 – C40	5600 mg/kg
Total Polycyclic Aromatic Hydrocarbons (PAHs)	20 mg/kg
Phenols (halogenated)	1 mg/kg
Phenols (non-halogenated)	60 mg/kg
Monocyclic aromatic hydrocarbons (Total sum of benzene, toluene, ethyl benzene, xylenes including otho, para and meta xylenes) and styrene)	7 mg/kg
Benzene	1 mg/kg

"Areas of Pre-existing Disturbance" means areas where environmental values have been negatively impacted as a result of anthropogenic activity and these impacts are still evident. Areas of pre-disturbance may include areas where legal clearing, logging, timber harvesting, or grazing activities have previously occurred, where high densities of weed or pest species are present which have inhibited re-colonisation of native regrowth, or where there is existing infrastructure (regardless of whether the infrastructure is associated with the authorised petroleum activities). The term 'areas of pre-disturbance' does not include areas that have been impacted by wildfire/s, controlled burning, flood or natural vegetation die-back.

"**Assessed or Assessment**" by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

(a) exactly what has been assessed and the precise nature of that determination;
(b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
(c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
(d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

"Associated Water" means underground water taken or interfered with, if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity under a petroleum authority, such as a petroleum well, and includes waters also known as produced formation water. The term includes all contaminants suspended or dissolved within the water.

"Associated Works" in relation to a dam, means:

(a) operations of any kind and all things constructed, erected or installed for that dam; and
(b) any land used for those operations.

"Australian Standard 2187" means Australian Standard 2187.0:1998 Explosives—Storage, transport and use,Part 0, Australian Standard 2187.1:1998 Explosives—Storage, transport and use Part 1 and Australian Standard 2187.2:2006 Explosives—Storage and use, Part 2 or any updated versions that becomes available from time to time.

"Australian Standard 3580" means any of the following publications:

- AS3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method.
- AS3580.9.6 Methods for sampling and analysis of ambient air Determination of suspended particulate matter PM10 high volume sampler with size-selective inlet Gravimetric method
- AS3580.9.9 Methods for sampling and analysis of ambient air Determination of suspended particulate matter PM10 low volume sampler Gravimetric sampler.

"Australian Standard 4323" means Australian Standard 4323.1:1995 Stationary source emissions method 1: Selection of sampling positions.

"Authority " means an environmental authority.

"Background Noise Level" means the sound pressure level, measured in the absence of the noise under investigation, as the $L_{A\,90,\,T}$ being the A-weighted sound pressure level exceeded for 90 per cent of the measurement time period T of not less than 15 minutes, using Fast response.

"Bed and Banks" for a watercourse or wetland means land over which the water of the watercourse or wetland normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed or banks that is from time to time covered by floodwater.

"Being or Intended to be Utilised by the Landholder or Overlapping Tenure Holder" for significantly disturbed land, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that the landholder or the overlapping tenure holder has a preferred use of the land such that rehabilitation standards for revegetation by the holder of the environmental authority are not required.

For dams, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that

the landholder or the overlapping tenure holder has a preferred use for the dam such that rehabilitation standards for revegetationby the holder of the environmental authority are not required.

"Beneficial use" means

a) with respect to dams, that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:
   - of benefit to that owner in that it adds real value to their business or to the general community,
   - in accordance with relevant provisions of the *Waste Reduction and Recycling Act 2011*,
   - sustainable by virtue of written undertakings given by that owner to maintain that dam, and
   - the transfer and use have been approved or authorised under any relevant legislation. Or,
b) with respect to coal seam gas water, refer to the Department of Environment and Heritage Protection's *Guideline – Approval of Coal Seam Gas Water for Beneficial Use*.

"Bore" means a water observation bore or a water supply bore that is either sub-artesian or artesian.

"Brine" means saline water with a total dissolved solid concentration greater than 40,000 mg/l.

"Brine dam" means a regulated dam that is designed to receive, contain or evaporate brine.

"BTEX" means benzene, toluene, ethylbenzene, ortho-xylene, paraxylene, meta-xylene and total xylene.

"Bund or bunded" in relation to spill containment systems for fabricated or manufactured tanks or containers designed to a recognised standard means an embankment or wall of brick, stone, concrete or other impervious material which may form part or all of the perimeter of a compound and provides a barrier to retain liquid. Since the bund is the main part of a spill containment system, the whole system (or bunded area) is sometimes colloquially referred to within industry as the bund. The bund is designed to contain spillages and leaks from liquids used, stored or processed above ground and to facilitate clean-up operations. As well as being used to prevent pollution of the receiving environment, bunds are also used for fire protection, product recovery and process isolation.

"Business Day" has the meaning in the *Acts Interpretation Act 1954* and *Environmental Protection Act 1994* and means a day that is not—

- a Saturday or Sunday; or
- public holiday, special holiday or bank holiday in the place in which any relevant act is to be or maybe done; or
- a business day that occurs during the period starting on 20 December in a year and ending on 5 January in the following year.

"Category A Environmentally Sensitive Area" means any area listed in Schedule 12, Section 1 of the *Environmental Protection Regulation 2008*.

"Category B Environmentally Sensitive Area" means any area listed in Schedule 12, Section 2 of the *Environmental Protection Regulation 2008*.

"Category C Environmentally Sensitive Area" means any of the following areas:

- Nature Refuges as defined under the *Nature Conservation Act 1992*;
- Koala Habitat Areas as defined under the *Nature Conservation (Koala) Conservation Plan 2006*;
- State Forests or Timber Reserves as defined under the *Forestry Act 1959*;
- Regional parks (resource use area) under the *Nature Conservation Act 1992*;
- An area validated as "Essential Habitat" from ground-truthing surveys in accordance with the Vegetation Management Act 1999 for a species of wildlife listed as endangered or vulnerable under the *Nature Conservation Act 1992*;
- Of Concern Regional Ecosystems that are remnant vegetation identified in the database called 'RE description database' containing Regional Ecosystem numbers and descriptions.

"Certifying or Certify or Certified or Certification" in relation to a dam, means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this Manual, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A))

"Certifying or Certify or Certified or Certification" in relation to any matter other than a design plan, 'as constructed' drawings or an annual report regarding dams means, a Statutory Declaration by a suitably qualified person or suitably qualified third party accompanying the written document stating:

- The person's qualifications and experience relevant to the function;
- that the person has not knowingly included false, misleading or incomplete information in thedocument;
- that the person has not knowingly failed to reveal any relevant information or document to the administering authority;
- that the document addresses the relevant matters for the function and is factually correct; and
- that the opinions expressed in the document are honestly and reasonably held.

"Clearing" for vegetation:

(a) means remove, cut down, ringbark, push over, poison or destroy in any way including by burning, flooding or draining; but
(b) does not include destroying standing vegetation by stock, or lopping a tree.

"Closed-Loop Systems" means using waste on site in a way that does not release waste or contaminants in the waste to the environment.

"Coal Seam Gas Water" means underground water brought to the surface of the earth, or moved underground in connection with exploring for, or producing coal seam gas.

"Commercial species" means species as listed in parts 1, 2 and 3 of Schedule 6 of the *Vegetation Management Regulation 2012*, which are above the diameters / sizes specified in this Schedule for each listed species.

"Consequence" in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

"Consequence Category" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"Construction or Constructed" in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a designplan.

"Control Measure" has the meaning in section 47 of the *Environmental Protection Regulation 2008* and means a device, equipment, structure, or management strategy used to prevent or control the release of a contaminantor waste to the environment.

"Daily Peak Design Capacity" for sewage treatment works, has the meaning in Schedule 2, section 63(4) of the *Environmental Protection Regulation 2008* as the higher equivalent person (EP) for the works calculated using each of the formulae found in the definition for EP.

"Dam" means a land-based structure or a **void** that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and **associated works**.

"Dam Crest Volume" means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

"Design Plan" is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

"Design Storage Allowance or DSA" means an available volume, estimated in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

"Development Well" means a petroleum well which produces or stores petroleum. For clarity, a development well does not include an appraisal well.

"Document" has the meaning in the *Acts Interpretation Act 1954* and means:

- any paper or other material on which there is writing; and
- any paper or other material on which there are marks; and
- figures, symbols or perforations having a meaning for a person qualified to interpret them; and
- any disc, tape or other article or any material from which sounds, images, writings or messages are capable of being produced or reproduced (with or without the aid of another article or device).

"Ecologically Dominant Layer" has the meaning in the Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012) and means the layer making the greatest contribution to the overall biomass of the site and the vegetation community (NLWRA 2001). This is also referred to as the ecologically dominant stratum or the predominant canopy in woody ecosystems.

"Ecosystem Function" means the interactions between and within living and non-living components of an ecosystem and generally correlates with the size, shape and location of the vegetation community.

"Emergency Action Plan" means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure and ensure timely warning to affected persons and the implementation of protection measures. The plan must require dam owners to annually review and update contact information where required.

"Enclosed Flare" means a device where the residual gas is burned in a cylindrical or rectilinear enclosure that includes a burning system and a damper where air for the combustion reaction is admitted.

"Environmental Harm" has the meaning in section 14 of the *Environmental Protection Act 1994* and means any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude,duration or frequency) on an environmental value, and includes environmental nuisance.

Environmental harm may be caused by an activity

(a) whether the harm is a direct or indirect result of the activity; or
(b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.

"Environmental Nuisance" has the meaning in section 15 of the *Environmental Protection Act 1994* and means unreasonable interference or likely interference with an environmental value caused by

(a) aerosols, fumes, light, noise, odour, particles or smoke; or
(b) an unhealthy, offensive or unsightly condition because of contamination; or
(c) another way prescribed by regulation.

"Equivalent Person" or **"EP"** has the meaning under section 3 of the Planning Guidelines For Water Supply and Sewerage, 2005, published by the Queensland Government. It is calculated in accordance with Schedule 2,Section 63(4) of the *Environmental Protection Regulation 2008* where:

- EP = V/200 where V is the volume, in litres, of the average dry weather flow of sewage that can be treated at the works in a day; or
- EP = M/2.5 where M is the mass, in grams, of phosphorus in the influent that the works are designed to treat as the inlet load in a day.

'**Essential Habitat'** for EA Conditions D12 to D17 means vegetation in which a species that is listed under the *Nature Conservation Act 1992* (QLD) as Endangered or Vulnerable has been known to occur. Essential habitat for the GFD project for EA Conditions D12 to D17 is limited to areas mapped in version 3.1 of the Essential Habitat map as provided in Chapter 18 of the Environmental Impact Statement for the Santos Gas Fields Development Project. For all other Conditions under this EA '**Essential Habitat'** has the same meaning as defined in the VM Act.

"Existing" means constructed prior to 13 April 2021.

"Exploration Well" means a petroleum well that is drilled to:

- explore for the presence of petroleum or natural underground reservoirs suitable for storing petroleum; or
- obtain stratigraphic information for the purpose of exploring for petroleum. For clarity, an exploration well does not include an appraisal or development well.

"Flare Pit" has the meaning in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (*ESR/2016/1933)*, and means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted, The flare pit is only used during the drilling and work over process on a petroleum well.

"Flare Precipitant" means waste fluids which result from the operation of a flare.

"Floodplains" has the meaning in the *Water Act 2000* and means an area of reasonably flat land adjacent to a watercourse that:

- is covered from time to time by floodwater overflowing from the watercourse; and
- does not, other than in an upper valley reach, confine floodwater to generally follow the path of the watercourse; and
- has finer sediment deposits than the sediment deposits of any bench, bar or in-stream island of the watercourse.

"Flowable Substance" means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

"Fuel Burning or Combustion Facility" means a permanent fuel burning or combustion equipment which in isolation, or combined in operation, or which are interconnected, is, or are capable of burning more than 500 kg of fuel in an hour.

"GDA" means Geocentric Datum of Australia.

"Geophysical survey" means a systematic collection of geophysical data.

"Great Artesian Basin (GAB) spring" means an area protected under the *Environment Protection and Biodiversity Conservation Act 1999* because it is considered to be a Matter of National Environmental Significance and identified as a:

- community of native species dependent on natural discharge of groundwater from the Great Artesian Basin; or
- Great Artesian Basin spring; or
- Great Artesian Basin discharge spring wetland.

A GAB spring includes a spring vent, spring complex or watercourse spring and includes the land to which water rises naturally from below the ground and the land over which the water then flows.

Note: The Australian Government's Protected Matters Search Tool should be used to get an indication of whether the area of interest may contain an MNES spring.

Note: The GAB springs dataset can be requested from the Queensland Government Herbarium

"Greywater" means wastewater generated from domestic activities such as laundry, dishwashing, and bathing.Greywater does not include sewage.

"Groundwater Dependent Ecosystems (GDE)" means ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.

For the purposes of the environmental authority, groundwater dependent ecosystems do not include those mapped as "unknown".

"Growing" means to increase by natural development, as any living organism or part thereof by assimilation of nutriment; increase in size or substance.

"high value regrowth" vegetation means vegetation located—
(a) on freehold land, indigenous land, or land subject of a lease issued under the *Land Act 1994* for agriculture or grazing purposes or an occupation licence under that Act; and
(b) in an area that has not been cleared (other than for relevant clearing activities) for at least 15 years, if the area is—
  i. an endangered regional ecosystem; or
  ii. an of concern regional ecosystem; or
  iii. a least concern regional ecosystem.

"Holder" means any person who is the holder of, or is acting under, that environmental authority.

"Hydraulic fracturing" means a technique used to create cracks in underground coal seams to increase the flow and recovery of gas or oil out of a well. It involves pumping a fluid, comprised largely of water and sand, under pressure, into a coal seam. This action fractures the coal seam which provides a pathway that increases the ability for gas to flow through the coal.

"Hydraulic Performance" means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)*.

"Hydraulic Testing" means the testing of a geological formation to evaluate the hydrogeological characteristics of the formation.

"Impulsive (for noise)" means sound characterised by brief excursions of sound pressure (acoustic impulses) that significantly exceed the background sound pressure. The duration of a single impulsive sound is usually less than one second.

"Incidental Activity" for this environmental authority means an activity that is not a specified relevant activity and is necessary to carry out the activities listed in Schedule A, Table 1 – Scale and Intensity for the Activities.

"Infrastructure" means plant or works including for example, communication systems, compressors, powerlines, pumping stations, reservoirs, roads and tracks, water storage dams, evaporation or storage ponds and tanks, equipment, buildings and other structures built for the purpose and duration of the conduct of the petroleum activity(ies) including temporary structures or structures of an industrial or technical nature, including,for example, mobile and temporary camps.

Infrastructure does not include other facilities required for the long term management of the impact of those petroleum activities or the protection of potential resources. Such other facilities include dams other than water storage dams (e.g. evaporation dams), pipelines and assets, that have been decommissioned, rehabilitated, and lawfully recognised as being subject to subsequent transfer with ownership of the land.

"$L_{Aeq,adj,\ 15mins}$" means the A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within any 15 minute period has the same square sound pressure as a sound level that varies with time.

"Lake" means:

- a lagoon, swamp or other natural collection of water, whether permanent or intermittent; and
- the bed and banks and any other element confining or containing the water.

"Land Degradation" has the meaning in the *Vegetation Management Act 1999* and means the following:

- soil erosion
- rising water tables
- the expression of salinity
- mass movement by gravity of soil or rock
- stream bank instability
- a process that results in declining water quality.

"Landholders' Active Groundwater Bores" means bores that are able to continue to provide a reasonable yield of water in terms of quantity for the bores authorised purpose or use. This term does not include monitoring bores owned by the administering authority of the *Water Act 2000*.

"Levee" means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

"Limited Impact Camps" mean accommodation camps that:

- are temporary (no more than 6 months);
- are located within pre-existing areas of clearing or significant disturbance;
- are up to 2 ha or located within well sites; and
- may involve sewage treatment works that are no release works or release works that involve an irrigation release within pre-existing areas of clearing or significant disturbance.

"Limited Impact Petroleum Activities" means petroleum activities that are located within areas that are not a regional ecosystem and:

- are single well sites (includes observation, pilot, injection and production wells) greater than 1 ha;or

- are multi-well sites greater than 1 ha; and
- may involve construction of new access tracks that are required as part of the construction or servicing a petroleum activity that can be lawfully carried out within an ESA or its protection zone; and
- may involve upgrading or maintenance of existing roads or tracks; and
- may include power and communication lines; and
- may include gas gathering lines from a well site to the initial compression facility; and
- may include water gathering lines from a well site to the initial water storage or dam.

"Limited petroleum activities" mean any low impact petroleum activity, and:

- single well sites (includes observation, pilot, injection and production wells) up to 1 ha and associated infrastructure (water pumps and generators, sumps, flare pits or dams) located on the well site or up to 1.25 ha if the well pad includes the use of a tank (minimum 1ML) for above ground fluid storage,
- multi-well sites up to an additional (in addition to single well site above) 0.25 ha per additional welland associated infrastructure (water pumps and generators, sumps, flare pits, dams or tanks) located on the well site to a maximum of 3 ha,
- well sites >1 ha when the well site intersects a slope of >4 %,
- construction of new access tracks that are required as part of the construction or servicing a petroleum activity that can be lawfully carried out within an ESA or its protection zone
- upgrading or maintenance of existing roads or tracks,
- power and communication lines,
- gas gathering lines from a well site to the initial compression facility,
- water gathering lines from a well site to the initial water storage or dam,
- camps within well site that may involve sewage treatment works that are a no release works,
- activities necessary to achieve compliance with the conditions of the EA in relation to another limited petroleum activity (e.g. sediment and erosion control measures, rehabilitation),
- geophysical, geotechnical, geological, topographic and cadastral surveys (including seismic, sample /test / geotechnical pits, core holes).

"Linear Infrastructure" means powerlines, pipelines, flowlines, roads and access tracks.

"Linear Infrastructure Services" means powerlines, power line stays, communication lines, pipelines, flowlines, roads and access tracks, turn around bays, and other work areas necessary for linear infrastructure construction

"Long Term Noise Event" means a noise exposure, when perceived at a sensitive receptor, persists for a period of greater than five (5) days, even when there are respite periods when the noise is inaudible within those five (5) days.

"lopping" a tree, means cutting or pruning its branches, but does not include —

- removing its trunk; and

- cutting or pruning its branches so severely that it is likely to die.

"Low Consequence Dam" means any dam that is not a high or significant consequence category as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)*.

"Low flow" means flow up to the one month average recurrence interval.

"Low Impact Petroleum Activities" means petroleum activities which do not result in the clearing of native vegetation, earthworks or excavation work that cause either, a significant disruption to the soil profile or permanent damage to vegetation that cannot be easily rehabilitated immediately after the activity is completed.Examples of such activities include but are not necessarily limited to:

- chipholes
- coreholes
- geophysical surveys
- seismic surveys
- soil surveys
- topographic surveys
- cadastral surveys
- ecological surveys
- installation of environmental monitoring equipment (including surface water)

"Mandatory Reporting Level or MRL" means a warning and reporting level determined in accordance with thecriteria in the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) published by the administering authority.

"Manual" in reference to dams means the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) published by the administering authority, as amended from time to time.

"Map of Queensland wetland environmental values" means the statutory map under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. It identifies wetlands of high ecological significance (HES) and general ecological significance (GES) across the state.

"Max $L_{pA, 15\ min}$" means the absolute maximum instantaneous A-weighted sound pressure level, measured over15 minutes.

"Max $L_{pZ, 15\ min}$" means the maximum value of the Z-weighted sound pressure level measured over 15 minutes.

"Medium Term Noise Event" is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than five (5) days and does not re-occur for a period of at least four (4)

weeks. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a difference source or source location.

"Methodology" means the science of method, especially dealing with the logical principles underlying the organisation of the various special sciences, and the conduct of scientific inquiry.

"Mix-Bury-Cover Method" means the stabilisation of residual drilling solids in the bottom of a sump by mixing with subsoil and which occurs in accordance with the following methodology:

- the base of the subsoil and residual solid mixture must be separated from the groundwater table by at least one metre of a continuous layer of impermeable subsoil material (kw=10 8m/s) or subsoil with a clay content of greater than 20%; and
- the residual solids is mixed with subsoil in the sump and cover; and
- the subsoil and residual solids is mixed at least three parts subsoil to one part waste (v/v); and
- a minimum of one metre of clean subsoil must be placed over the subsoil and residual solids mixture; and
- topsoil is replaced.

"Month" has the meaning in the *Acts Interpretation Act 1954* and means a calendar month and is a period starting at the beginning of any day of one (1) of the 12 named months and ending:

- immediately before the beginning of the corresponding day of the next named month; or
- if there is no such corresponding day at the end of the next named month.

"NATA Accreditation" means accreditation by the National Association of Testing Authorities Australia.

"Operational Plan" includes:

(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA);

(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

"Overburden pressure" means the pressure or stress imposed on a layer of soil or rock by the weight of overlying material. The overburden pressure at a depth z is given by $p(z) = p0 + g \int 0 \approx p(z)\, dz$ where p(z) is the density of the overlying rock at depth z and g is the acceleration due to gravity. p0 is the datum pressure, like the pressure at the surface.

"Pipeline Waste Water" means hydrostatic testing water, flush water or water from low point drains.

"Pre-Disturbed Land Use" means the function or use of the land as documented prior to significant disturbance occurring at that location.

"Predominant Species" has the meaning in the Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012) and means a species that contributes most to the overall above-ground biomass of a particular stratum.

"Prescribed Environmental Matter" has the meaning in section 10 of the *Environmental Offsets Act 2014*. Prescribed Environmental Matters for the GFD project are limited to the following Matters of State Environmental Significant:

a) remnant regional ecosystems listed as endangered (VM Act Class)
b) remnant regional ecosystems listed as of concern (VM Act Class)
c) essential habitat for the species listed in schedule D, Table 4;
d) wetlands of general ecological significance.

"Primary Protection Zone" means an area within 200m from the boundary of any Category A, B or C Environmentally Sensitive Area.

"Produced Water" has the meaning in Section 15A of the *Petroleum and Gas (Production and Safety) Act 2004* and means CSG water or associated water for a petroleum tenure.

"Prohibited or Restricted Pest Species" means any pest that is:

(a) a plant or animal, other than a native species of plant or animal, that is:
    (i). invasive biosecurity matter under the *Biosecurity Act 2014 (Qld)*; or

Notes—
1 *See the* Biosecurity Act 2014*, schedule 1, part 3 or 4 or schedule 2, part 2; and*
2 *See the note to the* Biosecurity Act 2014*, schedules 1 and 2.*

    (ii). controlled biosecurity matter or regulated biosecurity matter under the *Biosecurity Act 2014 (Qld);*

    (iii). tramp ants listed in schedule 1 and schedule 2 of the *Biosecurity Act 2014 (Qld)*

(b) a pest declared under a local law by the local government for the Land to be a pest because the pest is causing, or has the potential to cause, an adverse environmental, economic or social impact in all or part of the local government area.

"Quarter" in relation to *Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water*, means the following periods of a calendar year:

- 1 January to 31 March inclusive;
- 1 April to 30 June inclusive;
- 1 July to 30 September inclusive;
- 1 October to 31 December inclusive.

"Receiving wetland" for the purposes of conditions (B18) to (B30) means the receiving water that has the following characteristics: off-stream ephemeral oxbow wetland system subject to grazing land use.

"Reference wetland" means a wetland that has the similar characteristics to the receiving wetland located within 50 km of the receiving wetland.

"Regional ecosystem(s)" has the meaning in the *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 3.2 August 2012) and means a vegetation community in a bioregion that is consistently associated with a particular combination geology, landform and soil. Regional ecosystems of Queensland were originally described in Sattler and Williams (1999). The Regional Ecosystems Description Database (Queensland Herbarium 2013) is maintained by Queensland Herbarium and contains the current descriptions of regional ecosystems.

"Register of Regulated Structures" includes:

(a) Date of entry in the register;
(b) Name of the structure, its purpose and intended/actual contents;
(c) The consequence category of the dam as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933);
(d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;
(e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
(f) For the regulated dam, other than in relation to any levees –
    i. The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
    ii. Coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
    iii. Dam crest volume (megalitres);
    iv. Spillway crest level (metres AHD).
    v. Maximum operating level (metres AHD);
    vi. Storage rating table of stored volume versus level (metres AHD);
    vii. Design storage allowance (megalitres) and associated level of the dam (metres AHD);
    viii. Mandatory reporting level (metres AHD);
(g) The design plan title and reference relevant to the dam;
(h) The date construction was certified as compliant with the design plan;
(i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
(j) Details of the composition and construction of any liner;
(k) The system for the detection of any leakage through the floor and sides of the dam;
(l) Dates when the regulated dam underwent an annual inspection for structural and operational adequacy,and to ascertain the available storage volume for 1 November of any year;
(m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
(n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

"Regulated Structure" means any structure in the significant or high consequence category as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) published by the administering authority. A regulated structure does not include:

- a fabricated or manufactured tank or container, designed and constructed to an Australian Standard thatdeals with strength and structural integrity of that tank or container;
- a sump or earthen pit used to store residual drilling material and drilling fluid only for the duration of drilling and well completion activities;
- a flare pit.

"Rehabilitation or Rehabilitated" means the process of reshaping and **revegetating** land to restore it to a stable landform and in accordance with acceptance criteria and, where relevant, includes remediation of contaminated land. For the purposes of pipeline rehabilitation, rehabilitation includes reinstatement, revegetation and **restoration**.

"Reinstate or Reinstatement" for pipelines, means the process of bulk earth works and structural replacement of pre-existing conditions of a site (i.e. soil surface typography, watercourses, culverts, fences and gates and other landscape(d) features) and is detailed in the APGA Code of Environmental Practice: Onshore Pipelines Revision 4 (2017).

"Remnant vegetation" means vegetation, part of which forms the predominant canopy of the vegetation—

- covering more than 50 per cent of the undisturbed predominant canopy; and
- averaging more than 70 per cent of the vegetation's undisturbed height; and
- composed of species characteristic of the vegetation's undisturbed predominant canopy cover.

"Reporting Limit" means the lowest concentration that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes, the reporting limit is selected as the lowest non-zero standard in the calibration curve. Results that fall below the reporting limit will be reported as "less than" the value of the reporting limit. The reporting limit is also referred to as the practical quantitation limit or the limit of quantitation. For polycyclic aromatic hydrocarbons, the reporting limit must be based on super-ultra trace methods and, depending on the specific polycyclic aromatic hydrocarbon, will rangebetween 0.005 ug/L 0.02 ug/L.

"Residual Drilling Material" means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.

"Resource activity(ies)" has the meaning in section 107(d) of the *Environmental Protection Act 1994.*

"Restoration" means the replacement of structural habitat complexity, ecosystems processes, services and function from a disturbed or degraded site to that of a pre-determined or analogue site. For the purposes of pipelines, restoration applies to final rehabilitation after pipeline decommissioning.

"Restricted stimulation fluids" means fluids used for the purpose of stimulation, including fracturing, thatcontain the following chemicals in more than the maximum amounts prescribed under section 81B of the Environmental Protection Regulation 2008:

- petroleum hydrocarbons containing benzene, ethylbenzene, toluene or xylene; or
- chemicals that produce, or are likely to produce, benzene, ethylbenzene, toluene or xylene as the chemical breaks down in the environment.

The amount of any chemical is not measured in relation to water included in the restricted stimulation fluid. Forclarity, the term restricted stimulation fluids only applies to fluids injected down well post-perforation.

"Revegetation or Revegetating or Revegetate" means to actively re-establish vegetation through seeding orplanting techniques in accordance with site specific management plans.

"Secondary Protection Zone" in relation to a Category A or Category B ESA means an area within 100 metres from the boundary of the primary protection zone.

"Sensitive Place" means:

- a dwelling (including residential allotment, mobile home or caravan park, residential marina or other residential premises, motel, hotel or hostel);
- a library, childcare centre, kindergarten, school, university or other educational institution;
- a medical centre, surgery or hospital;
- a protected area;
- a public park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment;
- a work place used as an office or for business or commercial purposes, which is not part of the petroleum activity(ies) and does not include employees accommodation or public roads; and
- for noise, a place defined as a sensitive receptor for the purposes of the *Environmental Protection (Noise)Policy 2019*.

"Sensitive Receptor" is defined in Schedule 2 of the *Environmental Protection (Noise) Policy 2019*, and means an area or place where noise is measured.

"Short Term Noise Event" is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than eight hours and does not re-occur for a period of at least seven (7) days. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location fora period of one hour or more, even if it originates from a different source or source location.

"Significantly Disturbed or Significant Disturbance or Significant Disturbance to Land or Areas" has the meaning in Schedule 12, section 4 of the *Environmental Protection Regulation 2008*. Land is significantly disturbed if:

(a) it is contaminated land; or

(b) it has been disturbed and human intervention is needed to rehabilitate it:
   i. to a condition required under the relevant environmental authority; or
   ii. if the environmental authority does not require the land to be rehabilitated to a particular condition to the condition it was in immediately before the disturbance.

"Site" means the relevant petroleum activity(ies) to which the environmental authority relates.

"Species Richness" means the number of different species in a given area.

"Specified Relevant Activities" for this environmental activity means an activity that:
(a) but for being carried out as a resource activity, would otherwise be an activity prescribed under section19 of the *Environmental Protection Act 1994* as an environmentally relevant activity; or
(b) stimulation activities; or
(c) extracting material other than by dredging

"Spillway" means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

"Stable" has the meaning in Schedule 5 of the *Environmental Protection Regulation 2008* and, for a site, means the rehabilitation and **restoration** of the site is enduring or permanent so that the site is unlikely to collapse, erode or subside.

"Stimulation" means a technique used to increase the permeability of a natural underground reservoir that is undertaken above the formation pressure and involves the addition of chemicals. In includes hydraulic fracturing/ hydrofraccing, fracture acidizing and the use of proppant treatments.

"Stimulation Fluid" means the fluid injected underground to increase permeability. For clarity, the term stimulation fluid only applies to fluid injected down well post-perforation.

"Stimulation Impact Zone" means a 100m maximum radial distance from the stimulation target location within a gas producing formation.

"Structure" for the purpose of Schedule H means dam or levee.

"Suitably Qualified and Experienced Person" in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional EngineersAct 2002*, and has demonstrated competency and relevant experience:
- for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design
- for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design orengineering hydrology.

"Suitably Qualified Person" means a person who has professional qualifications, training or skills or experience relevant to the nominated subject matters and can give authoritative assessment, advice and analysis to performance relative to the subject matters using the relevant protocols, standards, methods orliterature.

"Suitably Qualified Third Party" means a person who:

(a) has qualifications and experience relevant to performing the function including but not limited to:
   i. a bachelor's degree in science or engineering; and
   ii. 3 years' experience in undertaking soil contamination assessments; and
(b) is a member of at least one organisation prescribed in Schedule 8 of the *Environmental Protection Regulation 2008*; and
(c) not be an employee of, nor have a financial interest or any involvement which would lead to a conflict ofinterest with the holder(s) of the environmental authority.

"Sump" means a pit in which waste residual drilling material or drilling fluids are stored only for the duration of drilling activities.

"Synthetic Based Drilling Mud" means a mud where the base fluid is a synthetic oil, consisting of chemical compounds which are artificially made or synthesised by chemically modifying petroleum components or otherraw materials rather than the whole crude oil.

"System Design Plan" means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

"Third Party Auditor" means a suitably qualified person who is either a certified third party auditor or an internal auditor employed by the holder of the environmental authority and the person is independent of the day to day management and operation of the petroleum activity(ies) covered by this environmental authority.

"Top Soil" means the surface (top) layer of a soil profile, which is more fertile, darker in colour, better structured and supports greater biological activity than underlying layers. The surface layer may vary in depth depending on soil forming factors, including parent material, location and slope, but generally is not greater than about 300mm in depth from the natural surface.

"Total Density of Coarse Woody Material" means the total length of logs on the ground greater than or equal to 10cm diameter per hectare and number of logs on the ground greater than or equal to 10cm diameter per hectare.

"Transmissivity" means the rate of flow of water through a vertical strip of aquifer which is one unit wide and which extends the full saturated depth of the aquifer.

"Valid complaint" means all complaints unless considered by the administering authority to be frivolous, vexatious or based on mistaken belief.

"**Vegetation Management Act 1999 (VM Act) Class**" has the meaning provided in Division 7A of the *Vegetation Management Act 1999.* The VM Act class for each Regional Ecosystem is provided in the *Vegetation Management Regulation 2012*.

"Void" means any constructed, open excavation in the ground.

"Waste and Resource Management Hierarchy" has the meaning provided in section 9 of the *Waste Reduction and Recycling Act 2011* and is the following precepts, listed in the preferred order in which waste andresource management options should be considered:

(a) AVOID unnecessary resource consumption;
(b) REDUCE waste generation and disposal
(c) RE-USE waste resources without further manufacturing
(d) RECYCLE waste resources to make the same or different products
(e) RECOVER waste resources, including the recovery of energy
(f) TREAT waste before disposal, including reducing the hazardous nature of waste
(g) DISPOSE of waste only if there is no viable alternative.

"Waste and Resource Management Principles" has the meaning provided in section 4(2)(b) of the *Waste Reduction and Recycling Act 2011* and means the:

(a) polluter pays principle
(b) user pays principle
(c) proximity principle
(d) product stewardship principle.

"Waste Fluids" has the meaning in section 13 of the *Environmental Protection Act 1994* in conjunction with the common meaning of "fluid" which is "a substance which is capable of flowing and offers no permanent resistance to changes of shape". Accordingly, to be a waste fluid, the waste must be a substance which is capable of flowing and offers no permanent resistance to changes of shape.

"Water monitoring" means all water quality parameters and samples, discharge flow rates, volume of discharge per event, duration of discharge event, flow rate of receiving water for surface water and groundwater level required under conditions (B7), (B26), (B27), (B36), (B41), (B42), (B45) – (B48), and (I11-I13).

"Watercourse" has the meaning in Schedule 4 of the Environmental Protection Act 1994 and means:

1) a river, creek or stream in which water flows permanently or intermittently
   a) in a natural channel, whether artificially improved or not; or
   b) in an artificial channel that has changed the course of the watercourse.
2) Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

"Waters" includes all or any part of a creek, river, stream, lake, lagoon, swamp, wetland, spring, unconfined surface water, unconfined water in natural or artificial watercourses, bed and bank of any waters, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, andunderground water.

"Well infrastructure" means infrastructure required for the construction and completion of a well including but not limited to cellar pits, dams and drill sumps.

"Wetland of General Ecological Significance or general ecologically significant wetland" is a wetland thatmeets the definition of a wetland and that is shown as a wetland of 'general ecological significance' on the Map of Queensland wetland environmental values.

"Wetland of High Ecological Significance" otherwise known as "high conservation value wetland", is a wetland that meets the definition of a wetland and that is shown as a High Ecological Significance wetland on the Map of Queensland wetland environmental values.

"Wet Season" means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

"Well Integrity" means the ability of a well to contain the substances flowing through it.

"Well Site" means a maximum area of land disturbance for the purposes of constructing, installing and operating an exploration, appraisal or development well or such wells as part of a multi-well arrangement and includes well lease infrastructure.

"Wetland" for the purpose of this environmental authority, wetland means:

- areas shown on the Map of Queensland wetland environmental values, which is a statewide statutory map under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*; and
- areas defined under the Queensland Wetlands Program as permanent or periodic / intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six (6) metres, and possess one or more of the following attributes:
  - at least periodically, the land supports plants or animals that are adapted to and dependent

on living inwet conditions for at least part of their life cycle, or
- the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers, or
- the substratum is not soil and is saturated with water, or covered by water at some time.

The term wetland includes riverine, lacustrine, estuarine, marine and palustrine wetlands; and it does not include a Great Artesian Basin Spring or a subterranean wetland that is a cave or aquifer.

"Year" means a period of 12 months.

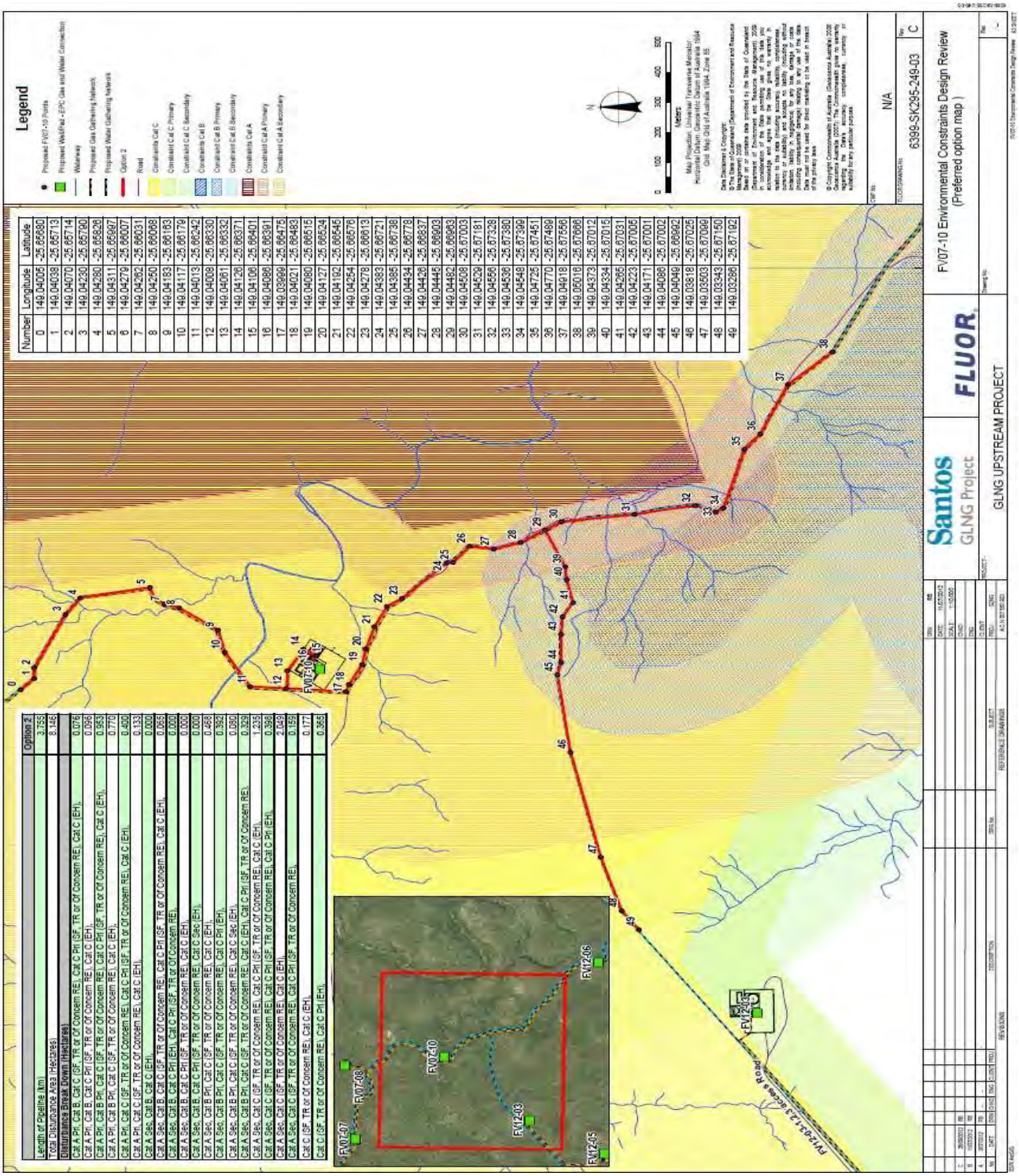
"80th percentile" in relation to release limits means that not more than one (1) of the measured values is to exceed the stated release limit for any five (5) consecutive samples where:

- the consecutive samples are taken over a five (5) month period; and
- the consecutive samples are taken at approximately equal periods.

"95th percentile" in relation to release limits means calculating the 95th percentile of all samples recorded over each 24 hour period for the duration of the release the result of which cannot exceed limits outlined in Schedule B, Table 8.

Appendix 1 - Plans Referenced in Schedule E, Table 2 – Authorised Disturbance

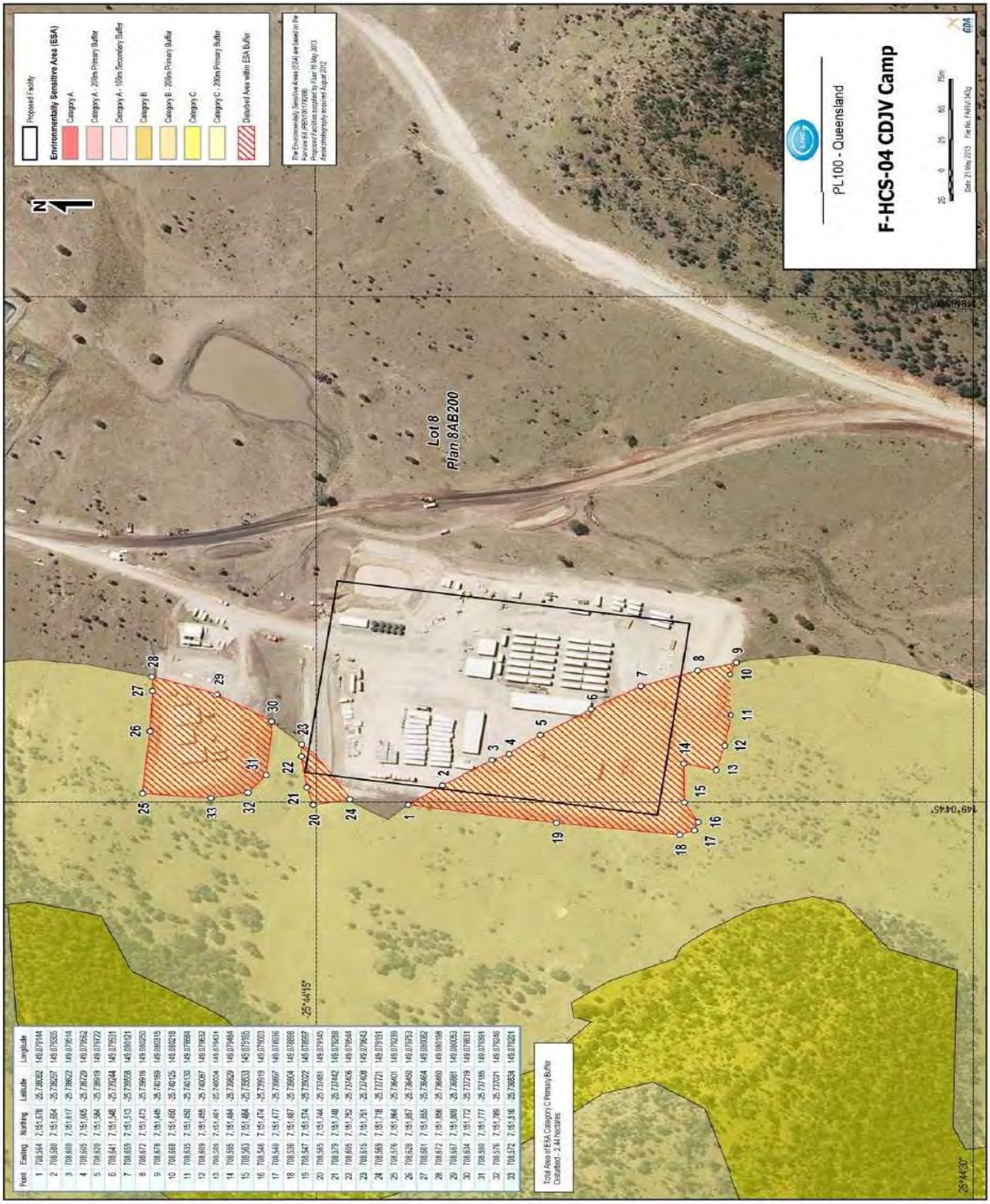
Well Pad FV530/531/532 (FV07-10) and Connecting Flowlines



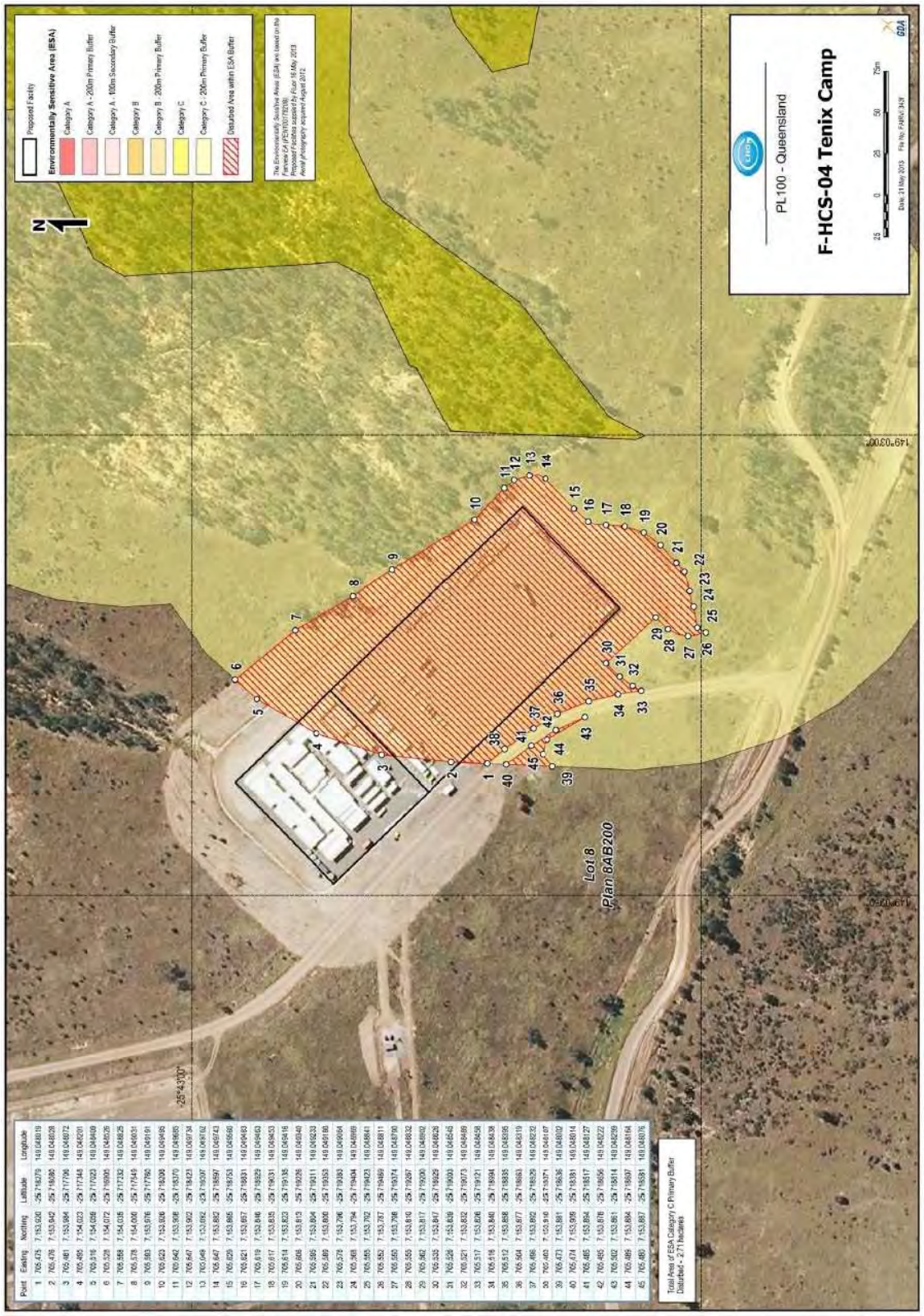
Number	Longitude	Latitude
0	149.04005	-25.66680
1	149.04038	-25.65713
2	149.04070	-25.65714
3	149.04230	-25.65790
4	149.04280	-25.65826
5	149.04311	-25.65997
6	149.04279	-25.66007
7	149.04262	-25.66031
8	149.04250	-25.66088
9	149.04193	-25.66183
10	149.04117	-25.66179
11	149.04013	-25.66242
12	149.04008	-25.66330
13	149.04061	-25.66332
14	149.04126	-25.66371
15	149.04106	-25.66401
16	149.04088	-25.66391
17	149.03999	-25.66475
18	149.04021	-25.66483
19	149.04080	-25.66515
20	149.04127	-25.66524
21	149.04192	-25.66546
22	149.04254	-25.66576
23	149.04278	-25.66613
24	149.04383	-25.66721
25	149.04385	-25.66738
26	149.04434	-25.66778
27	149.04428	-25.66837
28	149.04445	-25.66903
29	149.04482	-25.66983
30	149.04508	-25.67003
31	149.04529	-25.67181
32	149.04566	-25.67328
33	149.04536	-25.67390
34	149.04548	-25.67398
35	149.04725	-25.67451
36	149.04770	-25.67489
37	149.04918	-25.67556
38	149.05018	-25.67668
39	149.04373	-25.67012
40	149.04334	-25.67015
41	149.04265	-25.67031
42	149.04223	-25.67005
43	149.04171	-25.67001
44	149.04098	-25.67002
45	149.04049	-25.66992
46	149.03818	-25.67025
47	149.03503	-25.67088
48	149.03343	-25.67150
49	149.03286	-25.67192

	Option 2
Length of Pipeline (Km)	3.755
Total Disturbance Area (Hectares)	8.145
Disturbance Break Down (Hectares)	
Cat A Prl, Cat B, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.076
Cat A Prl, Cat B, Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.096
Cat A Prl, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.353
Cat A Prl, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C (EH),	0.770
Cat A Prl, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.400
Cat A Prl, Cat C (SF, TR or Of Concern RE), Cat C (EH),	0.133
Cat A Sec, Cat B, Cat C (EH),	0.000
Cat A Sec, Cat B, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.053
Cat A Sec, Cat B, Cat C Prl (EH), Cat C Prl (SF, TR or Of Concern RE),	0.000
Cat A Sec, Cat B, Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	0.000
Cat A Sec, Cat B, Cat C Prl (SF, TR or Of Concern RE), Cat C Sec (EH),	0.000
Cat A Sec, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C Prl (EH),	0.466
Cat A Sec, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C Prl (EH),	0.392
Cat A Sec, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C Sec (EH),	0.080
Cat A Sec, Cat B Prl, Cat C (SF, TR or Of Concern RE), Cat C (EH), Cat C Prl (SF, TR or Of Concern RE),	0.329
Cat A Sec, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C (EH),	1.235
Cat A Sec, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE), Cat C Prl (EH),	0.584
Cat A Sec, Cat C (SF, TR or Of Concern RE), Cat C (EH),	2.047
Cat A Sec, Cat C (SF, TR or Of Concern RE), Cat C Prl (SF, TR or Of Concern RE),	0.159
Cat C (SF, TR or Of Concern RE), Cat C (EH),	0.177
Cat C (SF, TR or Of Concern RE), Cat C Prl (EH),	0.388

CDJV Temporary Workers Camp and Office

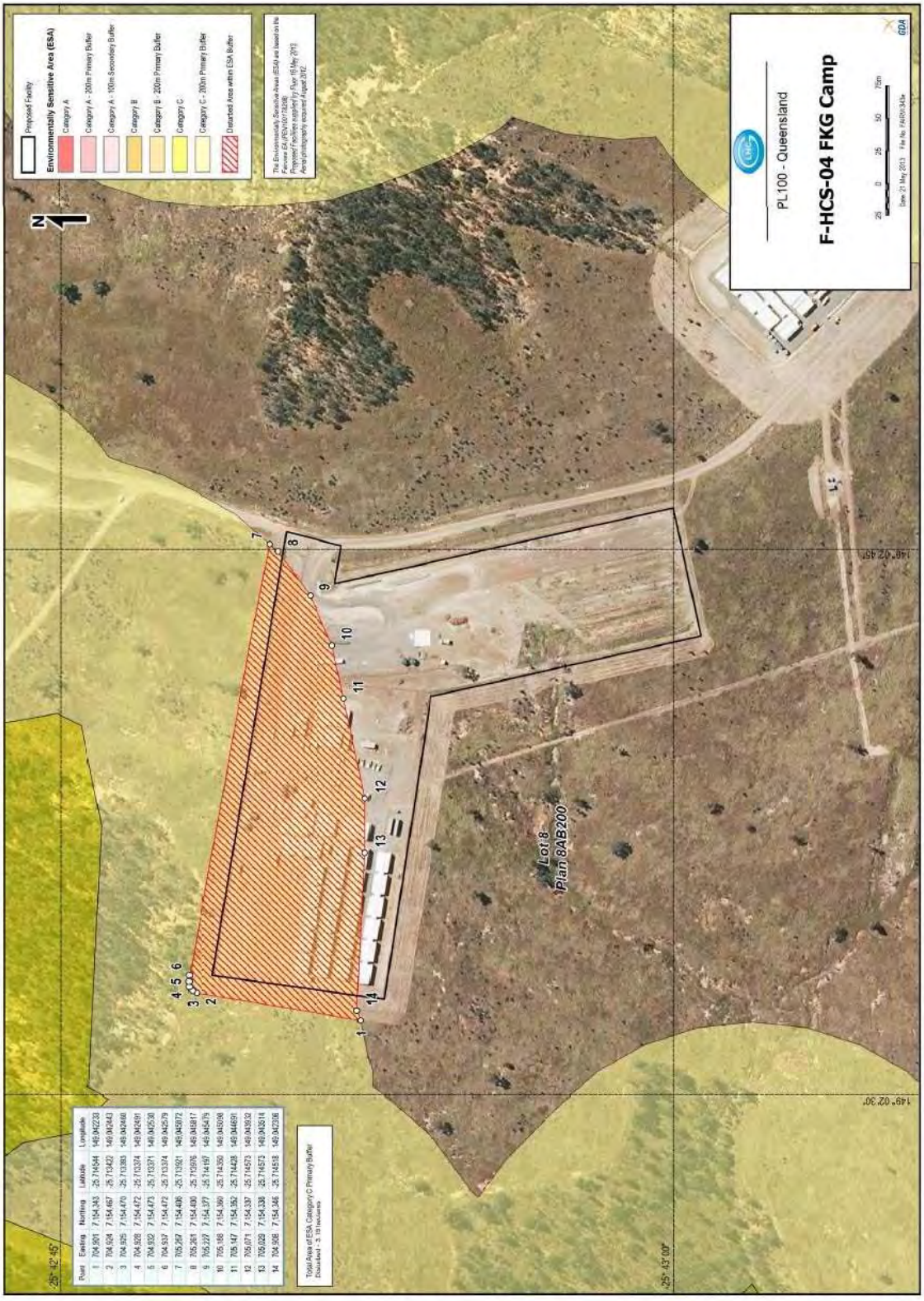


Tenix Temporary Workers Camp



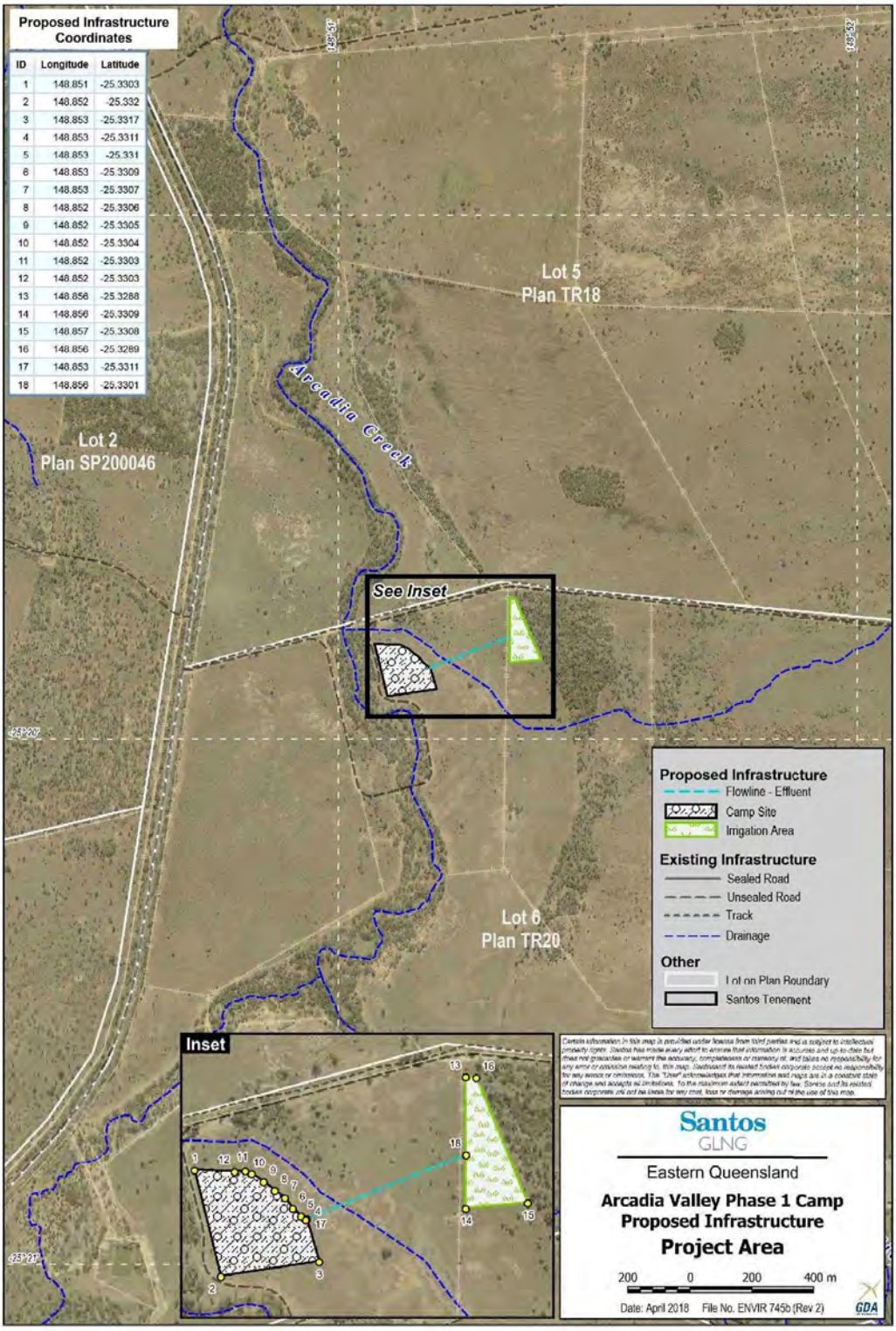
Point	Easting	Northing	Latitude	Longitude
1	765.475	7.153.520	-25.718279	149.048819
2	765.476	7.153.542	-25.718080	149.048828
3	765.481	7.153.584	-25.717706	149.048972
4	765.465	7.154.023	-25.717348	149.049201
5	765.516	7.154.056	-25.717023	149.049469
6	765.529	7.154.072	-25.716905	149.049526
7	765.558	7.154.035	-25.717232	149.049825
8	765.578	7.154.006	-25.717545	149.049931
9	765.593	7.153.976	-25.717792	149.049191
10	765.623	7.153.926	-25.718209	149.049495
11	765.642	7.153.908	-25.718370	149.049685
12	765.647	7.153.902	-25.718423	149.049734
13	765.649	7.153.892	-25.718507	149.049802
14	765.647	7.153.882	-25.718597	149.049743
15	765.629	7.153.866	-25.718753	149.049586
16	765.621	7.153.857	-25.718831	149.049483
17	765.619	7.153.846	-25.718929	149.049463
18	765.617	7.153.835	-25.719031	149.049453
19	765.614	7.153.823	-25.719135	149.049416
20	765.608	7.153.813	-25.719228	149.049340
21	765.595	7.153.804	-25.719311	149.049233
22	765.589	7.153.800	-25.719353	149.049186
23	765.578	7.153.796	-25.719393	149.049094
24	765.563	7.153.794	-25.719404	149.049066
25	765.555	7.153.792	-25.719423	149.049041
26	765.552	7.153.787	-25.719469	149.048811
27	765.550	7.153.798	-25.719374	149.048790
28	765.555	7.153.816	-25.719267	149.048832
29	765.562	7.153.817	-25.719260	149.048892
30	765.535	7.153.847	-25.719029	149.048828
31	765.526	7.153.858	-25.718930	149.048845
32	765.521	7.153.832	-25.719073	149.049489
33	765.517	7.153.826	-25.719121	149.049458
34	765.518	7.153.840	-25.718994	149.048838
35	765.512	7.153.858	-25.718835	149.048395
36	765.504	7.153.877	-25.718663	149.048319
37	765.486	7.153.892	-25.718529	149.048232
38	765.483	7.153.916	-25.718371	149.048167
39	765.473	7.153.881	-25.718636	149.048102
40	765.474	7.153.909	-25.718391	149.048014
41	765.465	7.153.894	-25.718517	149.048127
42	765.465	7.153.876	-25.718656	149.048222
43	765.502	7.153.861	-25.718814	149.048299
44	765.486	7.153.884	-25.718607	149.048164
45	765.480	7.153.887	-25.718591	149.048076

FKG Temporary Workers Camp



Point	Easting	Northing	Latitude	Longitude
1	704,901	7,154,343	-25.714494	149.042233
2	704,924	7,154,467	-25.713422	149.042443
3	704,925	7,154,470	-25.713383	149.042460
4	704,928	7,154,472	-25.713374	149.042491
5	704,932	7,154,473	-25.713371	149.042530
6	704,937	7,154,472	-25.713374	149.042579
7	705,267	7,154,486	-25.713321	149.045872
8	705,261	7,154,490	-25.713285	149.045817
9	705,227	7,154,377	-25.714197	149.045479
10	705,188	7,154,360	-25.714350	149.045098
11	705,147	7,154,352	-25.714428	149.044691
12	705,071	7,154,337	-25.714573	149.043932
13	705,029	7,154,338	-25.714573	149.043514
14	704,966	7,154,346	-25.714518	149.042886

Castle Hill Camp and Effluent Irrigation Area



END OF ENVIRONMENTAL AUTHORITY

Appendix B EPBC Approval

Appendix C REMP Certification

Appendix D REMP Monitoring Procedures

The REMP monitoring procedures presented below are based on, and consistent with, methods presented in the Monitoring and Sampling Manual (DES 2018).

The hydrological components of the REMP (i.e. discharge and water depth) are monitored daily by automated gauging stations at the specified sites. Hydrographs of the release volumes recorded at the discharge location and stream flow data recorded at gauging stations will be produced for the entire year.

The procedures for monitoring of geomorphological, sediment and biological components of the REMP are presented below.

Geomorphological Component – Bank Stability

Bank stability will be monitored using the Sustainable Rivers Audit physical habitat methodology (MDBC 2004), which is consistent with the methodology used in the Environmental Impact Statement (EIS) for the Santos GLNG Project (which includes the FPA) and the methods used in the baseline surveys. The assessment will include characterisation of the following bank features at each site:

- bank shape
- bank stability, noting areas of erosion or bank failure
- bed stability
- artificial bank protection measures
- factors affecting bank stability
- valley shape
- channel shape, and
- channel and wetted width.

A visual record of the left and right banks at each site will be made using photographs, with left and right banks determined while facing downstream

Results of field observations of bank stability will be tabulated for each site along with comments about the stability of the bank, and any changes of bank stability over time. Photographs of banks at each site will also be included in bank stability reporting for each survey.

Sediment Monitoring

Where the water is shallow (<0.5 m deep), sediment samples will be collected from the top 0.30 m of sediment on the bed using a stainless steel trowel, with the sediments transferred directly into the sampling jar provided by a NATA accredited analytical laboratory.

Where the water is deep or the sediment is too soft to walk in, surface sediment from the bed (to 0.30 m depth) will be collected using a stainless steel corer. Any core samples will be emptied into a bucket or other intermediate container, which has been thoroughly washed with ambient site water prior to sampling. The sediment will be mixed thoroughly and placed into the sample jar using a stainless steel trowel.

Field sampling will be undertaken by a suitably trained and competent person in accordance with Australian / New Zealand Standard AS/NZ5667.12 Guidance on Sampling of Bottom Sediments, and the Handbook for Sediment Quality Assessment (Simpson et al. 2005). In summary:

- powderless gloves will be used when collecting all sediment samples, and care will be taken not to touch the inside of any sampling containers, or to place open bottles / jars or their lids onto the ground or other potentially contaminated surfaces
- sediment samples will be collected straight into the sample bottle wherever possible, and the bottles will not be rinsed prior to sample collection
- if the sample cannot be collected straight into the sample bottle, the container it is collected in (such as a stainless steel bucket or other form of sampler) will be thoroughly rinsed with ambient site water to ensure is not contaminated
- a field duplicate will be collected from one site during each sampling event, to assess within site variation
- samples will be placed into an esky with ice and should be kept refrigerated until delivered to the laboratory within the appropriate holding time (as advised by the analytical laboratory)
- a chain of custody form will be completed for all samples sent to the laboratory for analysis, and
- samples will be analysed by a NATA-accredited laboratory, and laboratory duplicates will be analysed in accordance with NATA-accredited protocols.

Sediment quality data will be entered, and the results reviewed after each survey. This review will include comparisons of sediment quality at each site with the local sediment quality guidelines to give preliminary indication of any changes to sediment quality in the receiving environment. If the concentration of a parameter is below the local sediment

guideline, then sediment quality is considered to be low risk for that parameter and no further action is required. If the concentration of a parameter is higher than the local guideline, then further investigation of background levels for that parameter in the area would be required.

At the end of each annual reporting period, the median, 80th percentile and 100% percentile for each parameter for each water type will be calculated, and compared to the local sediment quality guidelines. If the median concentration of a parameter is below the local sediment guideline, then sediment quality is considered to be low risk for that parameter and no further action is required. If the median percentile concentration of a parameter is higher than the local guideline, then further investigation of background levels for that parameter in the area would be required. If the median percentile concentration of a parameter is consistently higher than the local guideline, then further investigation of background levels for that parameter in the area would be required. If the 80th percentile concentration of a parameter is consistently higher than the local guideline, then further investigation of background levels for that parameter in the area would be required. If the 100% percentile concentration of a parameter is higher than the 100% percentile of baseline data, then further investigation of factors affecting the bioavailability of that parameter may be required (ANZG 2018).

Macroinvertebrate Monitoring

Seven macroinvertebrate samples will be collected from 'clean' edge habitat at each site using a Surber sampler that has a square 0.3 m x 0.3 m frame and 250 µm mesh size. The location of samples will be random within each site. Each sample will be collected with one edge of the Surber sampler parallel to and within a few centimetres of the water's edge. The substrate within the Surber sampler frame will be disturbed (large rocks will be cleaned or organisms inside the Surber net and finer substrates will be gently disturbed by hand or a tool) and the sample will be collected by sweeping the net up through the disturbed area. The sample will be transferred into a screw-top jar and preserved using ethanol to be transported back to the laboratory and identified to the lowest practical taxonomic level (family in most cases).

Macroinvertebrate sampling will be undertaken by a trained ecologists and will be completed in accordance with the Smartrivers methodology (Smart Rivers 2013).

Individuals from two of the commonly occurring invertebrate species (*Macrobrachium australiense* and *Caridina* spp.) will be examined for signs of potential calcium and magnesium deficiencies: the strength, apparent thickness and colour of the exoskeletons and shells will be recorded, and the reproductive status of specimens will be recorded.

Macroinvertebrate samples will be processed in accordance with the National River Health Program protocols outlined in Monitoring and Sampling Manual 2009 (DERM 2009). Enumeration and identification of samples will be done by trained and accredited ecologists. Sorting, enumeration and data entry will be cross checked by a second ecologist for 10% of the samples. An error rate of > 10% will be considered unacceptable and will result in a further 10% of samples being checked by a second ecologist, and so on.

The following indices will be calculated for the macroinvertebrate communities at each site:

- *abundance*; abundance is the total number of individuals in a sample. The abundance of each family, and the overall abundance of macroinvertebrates, will be calculated for each site.
- *taxonomic richness*; taxonomic richness is the number of taxa (in this assessment, generally families). Taxonomic richness is a basic, unambiguous and effective diversity measure. However, it is affected by arbitrary choice of sample size. Where all samples are of equal size, taxonomic richness is a useful tool when used in conjunction with other indices. Richness does not take into account the relative abundance of each taxon, so rare and common taxa are considered equally.
- *PET richness*; while some groups of macroinvertebrates are tolerant to pollution and environmental degradation, others are sensitive to these stressors (Chessman 2003). Plecoptera (stoneflies), Ephemeroptera (mayflies), and Trichoptera (caddisflies) are referred to as PET taxa, and they are particularly sensitive to disturbance. There are typically more PET families within sites of good habitat condition and water quality than in sites of degraded condition. PET taxa are often the first to disappear when water quality or environmental degradation occurs (EHMP 2007). The lower the PET score (i.e. number of families within the Plecoptera, Trichoptera and Ephemeroptera orders), the greater the inferred degradation.
- *SIGNAL-2 scores*; SIGNAL-2 (Stream Invertebrate Grade Number — Average Level) (Chessman 2003) scores are also based on the sensitivity of each macroinvertebrate family to pollution or habitat degradation. Each macroinvertebrate family has been assigned a grade number between 1 and 10 based on their sensitivity to various pollutants, and SIGNAL-2 scores are weighted for abundance. A low number means that the macroinvertebrate is tolerant of a range of environmental conditions, including common forms of water pollution (e.g. suspended sediments and nutrient enrichment).

These indices will be calculated for each site, and the median for each calculated for each water type. Where the median for an index complies with or is higher than the local biological guideline for that water type, then it is considered that there is no impact to

macroinvertebrate communities. Where the median for an index is lower than the local biological guideline for a water type, then multivariate statistical analysis of macroinvertebrate data that conforms to a before-after-control-impact (BACI) design may be needed. Where this test indicates an impact to macroinvertebrate communities in the receiving environment, then further investigation to the factors that influence macroinvertebrate communities may be needed.

Fish

Fishing will involve two fyke nets set overnight at each site, with one net being of fine mesh size (approximately 4 mm) and the other being of a larger mesh size (approximately 10 mm). Nets will be set facing upstream and downstream directions at all sites, and nets will be set to ensure that air-breathing species (e.g. turtles) have access to the surface at all times, with floats also used to ensure air-breathing species can access the surface.

The sampling of fishes will be conducted under appropriate General Fisheries Permits and Animal Ethics Approvals.

At each site, the species present and the abundance of each species by life history stage (juvenile, intermediate, adult) will be recorded and the apparent health of individuals will be noted. Identifications of fish will be made in the field by experienced ecologists. Specimens that cannot be identified in the field will be euthanized and returned to the laboratory for identification and if necessary they will be sent to the Queensland Museum for a confirmed identification. Any exotic species caught will be recorded and euthanized in accordance with ethics approvals.

The richness of native and exotic fish species will be determined for each water type (observed number of species), and this will be compared to the expected number of species for that water type (i.e. the local biological guideline for fish) as a ratio. Where the ratio ≥ 1, then it is considered that there has been no impact to fish. Where is ratio < 1, then the diversity of fish is lower than expected, and an investigation of the factors affecting fish communities may be needed.

Turtles

Survey of turtles will involve two fyke nets set overnight at each site, with one net being of fine mesh size (approximately 4 mm) and the other being of a larger mesh size (approximately 10 mm). Nets will be set facing upstream and downstream directions at all sites, and nets will be set to ensure that air-breathing species (e.g. turtles) have access to

the surface to breathe at all times, with floats also used to ensure air-breathing species can access the surface. Additionally, two baited cathedral traps will be securely set over-night at each site, ensuing turtles and other air-breathing species have access to the surface to breathe at all times. Finally, snorkelling the full 100 m length of each site will also be used to survey turtles, recording observations of turtles.

The sampling of turtles will be conducted under appropriate Scientific Permits and Animal Ethics Approvals.

At each site, the species present and the abundance of each species will be recorded and the apparent health of individuals will be noted. Identifications of turtles will be made in the field by experienced ecologists.

Raw turtle data for all species will be tabulated and compared to baseline data.

Appendix E Synthesis of Baseline Water Quality Data from Site DRR2 on Hutton Creek

Table E.1 Synthesis of baseline data for water chemistry parameters for Hutton Creek (site DRR2 or S16A)

Parameter	Units	LOR	5th %ile	20th %ile	80th %ile	95th %ile	Count
Physical Chemical							
Dissolved Oxygen - Field	mg/L	–	7.82	8.16	12.85	16.10	4
Electrical Conductivity @ 25°C	µS/cm	1.00	413.80	437.20	871.00	948.60	5
pH - Field	pH Unit	–	7.01	7.38	8.40	8.69	6
Suspended Solids	mg/L	5.00	19.20	34.80	132.60	164.40	5
Turbidity - Field	NTU	–	0.00	0.00	302.40	534.60	5
Nutrients							
Ammonia as N	mg/L	0.01	0.01	0.02	0.08	0.10	5
Total Nitrogen as N	mg/L	0.10	1.00	1.30	1.82	1.88	5
Total Metals and Metalloids							
Boron	µg/L	50.00	<50	<50	102.00	108.00	5
Zinc	µg/L	5.00	<5	7.70	18.20	18.80	5
Dissolved Metals and Metalloids							
Boron	µg/L	50.00	<50	53.00	114.00	126.00	5
Zinc	µg/L	5.00	<5	<5	8.00	8.00	5

Appendix F Full Baseline Range

Table F1 Baseline Maximum for Water Quality Parameters

Parameter	Unit	Waterbody	Dawson River	Hutton Creek
		Maximum	Maximum	Maximum
Temperature	ºC	11.46 – 35.02	12.0 – 31.5	15.5 – 35.6
Dissolved oxygen	mg/L	4.36 – 14.23	3.40 – 11.60	7.7 – 17.2
Electrical conductivity	µS/cm	968	1215	797
pH	unit	6.8 – 9.0	7.5 – 8.3	6.9 – 8.8
Suspended solids	mg/L	318	67	175
Turbidity	NTU	611	864	612
Ammonia as N	mg/L	0.74	0.09	0.1
Total nitrogen	mg/L	13.4	1.5	1.9
Boron (total)	mg/L	0.20	0.17	0.11
Zinc (total)	mg/L	0.029	0.013	0.019
Boron (dissolved)	mg/L	0.18	0.70	0.13
Zinc (dissolved)	mg/L	0.043	0.024	0.008

Baseline range presented for temperature, dissolved oxygen and pH.

Table F2 Baseline Maximum for Sediment Quality Parameters

Parameter	Unit	Waterbody	Dawson River	Hutton Creek
		Maximum	Maximum	Maximum
Aluminium (Al)	mg/kg	16800	12800	18500
Arsenic (As)	mg/kg	6	5	8
Boron (B)	mg/kg	27.5	13.5	26.9
Cadmium (Cd)	mg/kg	<LOR	<LOR	<LOR
Chromium (Cr)	mg/kg	26.8	70.3	19.4
Copper(Cu)	mg/kg	19	12	18
Iron (Fe)	mg/kg	23900	19000	32000
Lead (Pb)	mg/kg	25.1	15	23.5
Manganese (Mn)	mg/kg	1020	545	705
Mercury (Hg)	mg/kg	0.8	<LOR	<LOR
Nickel (Ni)	mg/kg	30.4	296	15
Selenium (Se)	mg/kg	<LOR	<LOR	<LOR
Zinc (Zn)	mg/kg	74	46	68

Table F3 Full Baseline Range of Macroinvertebrate Indices

Index	Waterbody		Dawson River		Hutton Creek	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Abundance	16	512	15	411	1	590
Taxonomic Richness	3	15	6	25	1	20
PET Richness	0	2	0	6	0	3
SIGNAL-2 Scores	2.36	3.64	2.57	4.41	2	3.38