ATP 2059 Coal Seam Gas Water Management Plan

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REVISION HISTORY

Revision	Revision Date	Document Status	Revision Comments	Author	Approved By
0	October 14 2022	Final	Document creation	KCB	
1	July 2023		Updated to include additional monitoring points	KCB	
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1. INTRODUCTION

1.1. ATP 2059 – Project Description

Senex Energy Pty Ltd (Senex), on behalf of its subsidiary Senex Assets Pty Ltd, proposes to develop, operate, decommission and rehabilitate new coal seam gas (CSG) wells and associated infrastructure on Authority to Prospect (ATP) 2059 (referred to herein as ATP 2059 or the Project).

ATP 2059 covers an area of approximately 18 km^2 and is located approximately 14 km southwest of Wandoan in Southern Queensland as presented in Figure 1.1.

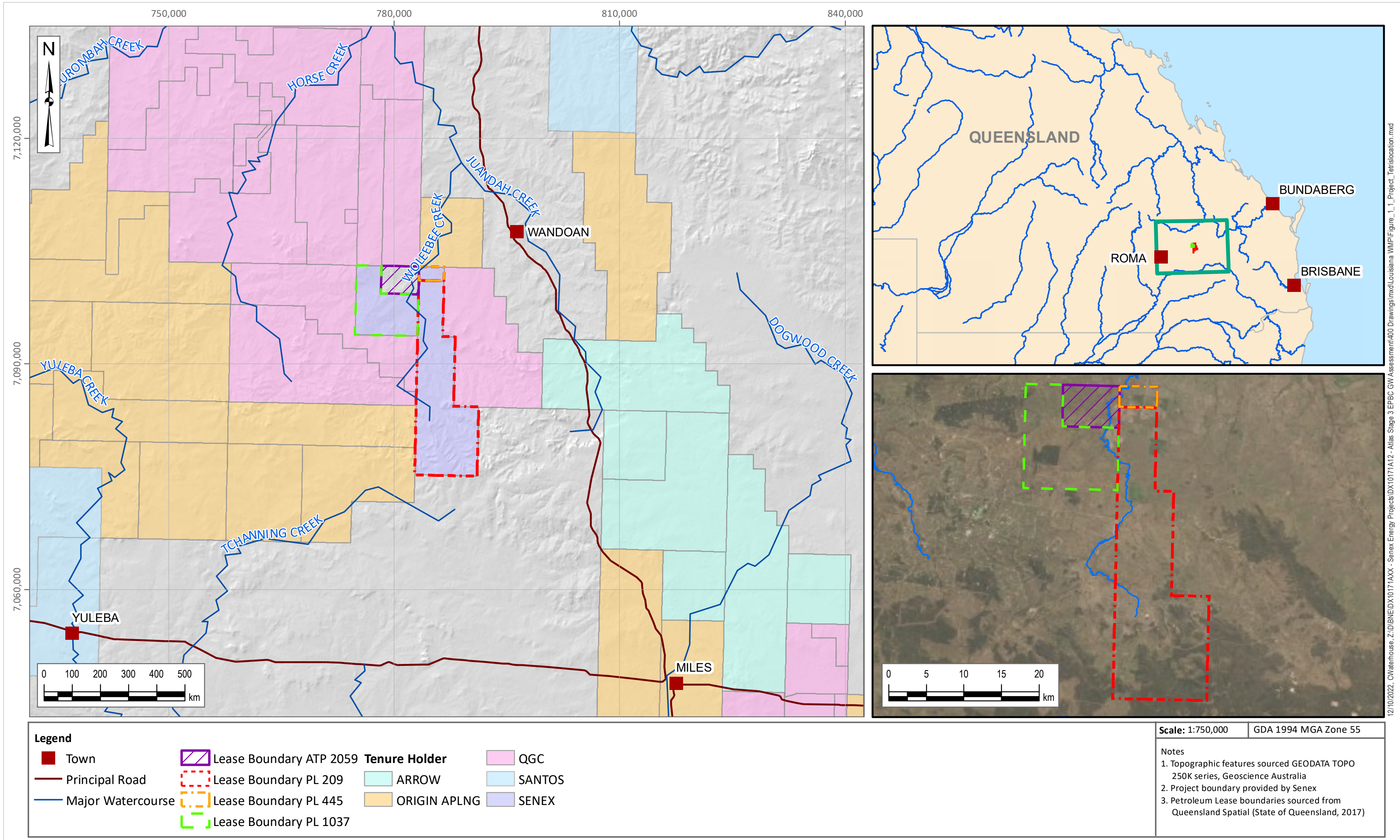
Proposed production activities and infrastructure are expected to include the following components:

- Up to 31 CSG production wells;
- Gas and water gathering lines;
- Water separation infrastructure;
- Water storage and water management facilities;
- Access roads and tracks;
- Maintenance facilities, workshop, construction support and administration buildings (during construction and operation);
- Temporary accommodation;
- Utilities – power generation, water supply;
- Communications; and
- Borrow pits.

ATP 2059 is located adjacent to Senex's existing Project Atlas, which comprises operational CSG fields and associated infrastructure on PL 1037. Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 will integrate with existing infrastructure constructed as part of Project Atlas. As such, details of the project components, including location and size, will be progressively determined over the life of ATP 2059 based on the integration with the existing Project Atlas infrastructure. This integration is aimed at reducing the potential impacts of ATP 2059.

Senex also plan to develop gas wells to the east of ATP 2059 within PL 445 and PL 209. Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 may integrate with future infrastructure within PL 445 and PL 209.

Figure 1.1: ATP 2059 Location within the Surat Cumulative Management Area (OGIA)



1.2. Aims and Objectives of the Plan

The Coal Seam Gas Water Management Plan (CWMP) covers all activities associated with managing produced water from the project area once the water has been recovered to the ground surface; including managing saline waste by-product (brine) resulting from treating produced water.

The aim of the CWMP is to provide a tool to assist Senex personnel to manage produced water and avoid any potential impacts. The plan sets objectives to maximise the beneficial use of water and identify any potential impacts that may require mitigation.

Other key objectives of the CWMP include:

- Providing a transparent document outlining Senex's philosophy and approach to water management;
- Ensuring strict adherence to regulatory policy;
- Documenting the risks and challenges in relation to CSG water management;
- Providing a strategic management tool adaptive to changes in:
  - Source water quantity and quality;
  - Demand, location and volume;
  - Technology;
  - Environmental receptors/constraints; and
  - Community concerns, and regulatory requirements.
- Provide a strategy for water monitoring to minimise impacts to environmental receptors.
- Allowing for continual improvement and implementing good practice CSG water management.

The CWMP will consider managing CSG water for the life of the project and will be updated as required so that the most appropriate and effective management approach is applied.

1.3. Definitions and Acronyms

APGA	Australian Pipelines and Gas Association
ATP	Authority to prospect
ATW	Access to work
BoM	Bureau of Meteorology
CMA	Cumulative management area
CSG	Coal seam gas, where gas is stored within coal deposits or seams

CWMP	Coal seam gas water management plan
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DoEE	Department of Environment and Energy
E&A	Exploration and appraisal
EA	Environmental authority
EOW	End of waste
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESA	Environmentally sensitive areas
EV	Environmental value
FEED	Front end engineering and design
FSV	Full storage volume
GDE	Groundwater dependent ecosystem
HDPE	High density polyethylene
MNES	Matters of National Environmental Significance
MOV	Maximum operating volume
MSES	Matters of State Environmental Significance
OGIA	Office of Groundwater Impact Assessment
Petroleum Act	*Petroleum Act 1923* (Qld), the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
PL	Petroleum lease granted under the *Petroleum Act 1923* (Qld) or the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
PPL	Petroleum Production Licence granted under the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
Project Area	means the coal seam gas field, approximately 18 km^2 on ATP 2059
SCA	Strategic cropping area

Surat Basin	Means the sedimentary geological basin of Jurassic to Cretaceous in southern Queensland and northern New South Wales
TD	Total depth
TDS	Total dissolved solids
WCM	Walloon Coal Measures (the target gas production unit)
WQO	Water quality objectives
WSA	Water supply agreement
WTF	Water treatment facility

2. REGULATORY FRAMEWORK

This CWMP has been prepared in accordance with key policies and legislation in Queensland for managing CSG produced water to which Senex strictly adheres. A summary of the key policies and legislation relevant to development of ATP 2059 is provided in the following sections.

2.1. Petroleum and Gas (Safety and Production) Act 2004

The *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020) is an Act relevant to exploring for, recovering and transporting by pipeline, petroleum and fuel gas, and ensuring the safe and efficient undertaking of those activities. The key purpose of this Act is to facilitate and regulate the undertaking of responsible petroleum activities and the development of a safe, efficient, and viable petroleum and fuel gas industry.

This act identifies underground water rights for petroleum tenures, and states that the holder of a petroleum tenure may take or interfere with underground water in the area of the tenure if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity for the tenure. There is no limit to the volume of water that may be taken under the underground water rights and the tenure holder may use associated water for any purpose within, or outside, the area of the tenure.

2.2. Environmental Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Commonwealth of Australia 2022a) is the central piece of environmental legislation at the Commonwealth level. It provides for the protection of environmental values, including matters of national environmental significance (MNES). Actions that are likely to have a significant impact on MNES are subject to the assessment and approval process under this Act. Water resources in relation to large coal mining and CSG development projects are a MNES. The Project may have potential to have a significant impact on water resources and as such Senex self-referred the Project (as part of the Atlas Stage 3 Gas Project which also includes wells to be developed in PL445 and PL 209 and supporting infrastructure in PL 1037) to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) in November 2022. On the 19th of May 2023, the delegate for the Minister for the Environment and Water decided that the development across PL 445, PL 209 and ATP 2059 is a ‘Controlled Action’ and requires approval under the EPBC Act. The controlling provisions were identified as (i) Listed threatened species and communities and (ii) A water resource, in relation to coal seam gas development and large coal mining development.

The regulatory guideline relevant to ATP 2059, developed from the amendment to the EPBC Act identifying water resources as being a MNES, is the Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (Commonwealth of Australia 2022b).

2.3. Water Act 2000

The *Water Act 2000* (State of Queensland 2021b) is intended to provide for the sustainable management of water and the management of impacts on underground water, among other purposes. The Water Act provides a framework for the following:

- The sustainable management of Queensland's water resources by establishing a system for the planning, allocation and use of water;
- The sustainable and secure water supply and demand management for the south-east Queensland region and other designated regions;
- The management of impacts on underground water caused by the exercise of underground water rights by the resource sector; and
- The effective operation of water authorities.

The Act includes water in a watercourse, lake or spring, underground water (or groundwater), overland flow water, or water that has been collected in a dam.

The Water Act 2000 provides for managing impacts on underground water caused by the exercising of underground water rights by resource tenure holders, which are regulated under the Petroleum and Gas (Production and Safety) Act 2004. The Act also outlines the requirements for make good agreements, associated with impacts to underground water.

2.4. Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) (State of Queensland 2022) has an objective to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

Table 2.1 presents the primary requirements for the management of CSG water from the EP Act and identifies the sections in this CWMP to address each requirement.

Table 2.1: EP Act (State of Queensland 2022) Requirements (S126) and Report Section Reference

EP Act - S126 - Requirements for site-specific applications - CSG activities			CWMP Section Reference
1)	A site-specific application for a CSG activity must also state the following:		
	a)	The quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity;	Section 3.1
	b)	The flow rate at which the applicant reasonably expects the water will be generated;	Section 3.1
	c)	The quality of the water, including changes in the water quality the applicant reasonably expects will happen while each relevant CSG activity is carried out;	Section 3.2 & Section 5.4
	d)	The proposed management of the water including, for example, the use, treatment, storage or disposal of the water;	Section 0
	e)	The measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of the management of the water, including, for example, criteria for each of the following:	Section 6
		(i) The quantity and quality of the water used, treated, stored or disposed of;	
		(ii) Protection of the environmental values affected by each relevant CSG activity;	Section 5 & Section 6
		(iii) The disposal of waste, including, for example, salt, generated from the management of the water; and	Section 6
	f)	The action proposed to be taken, if any, if the management criteria are not complied with, to ensure the criteria will be able to be complied with in the future.	Section 6

EP Act - S126 - Requirements for site-specific applications - CSG activities	CWMP Section Reference
2) The proposed management of the water cannot provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless:	
a) The application includes an evaluation of the following: (i) Best practice environmental management for managing the CSG water; and (ii) Alternative ways for managing the water; and b) The evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water.	Not relevant as no CSG evaporation dams are proposed.

2.4.1 Environmental Protection (Water) Policy 2009

Under the EP Act 1994, the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) was established as subordinate legislation to achieve the object of the Act in relation to Queensland Waters. The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* is achieved by:

- Identifying environmental values (EVs) and management goals for Queensland waters;
- Stating water quality guidelines and water quality objectives (WQOs) to enhance or protect the EVs;
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

Further details on EVs are provided in Section 5.5.

2.4.2 CSG Water Management Policy 2012

The *CSG Water Management Policy 2012* (State of Queensland 2012) primary objective is associated with the management and use of CSG water under the EP Act 1994. The role of the policy is to:

- Clearly state the government's position on the management and use of CSG water;
- Guide CSG operators in managing CSG water under their environmental authority; and
- Ensure community understanding regarding the government's preferred approach to managing CSG water.

3. CSG WATER PRODUCTION

This section of the CWMP describes the anticipated volume and quality of water expected to be produced from the ATP 2059 Project.

3.1. CSG Water Production

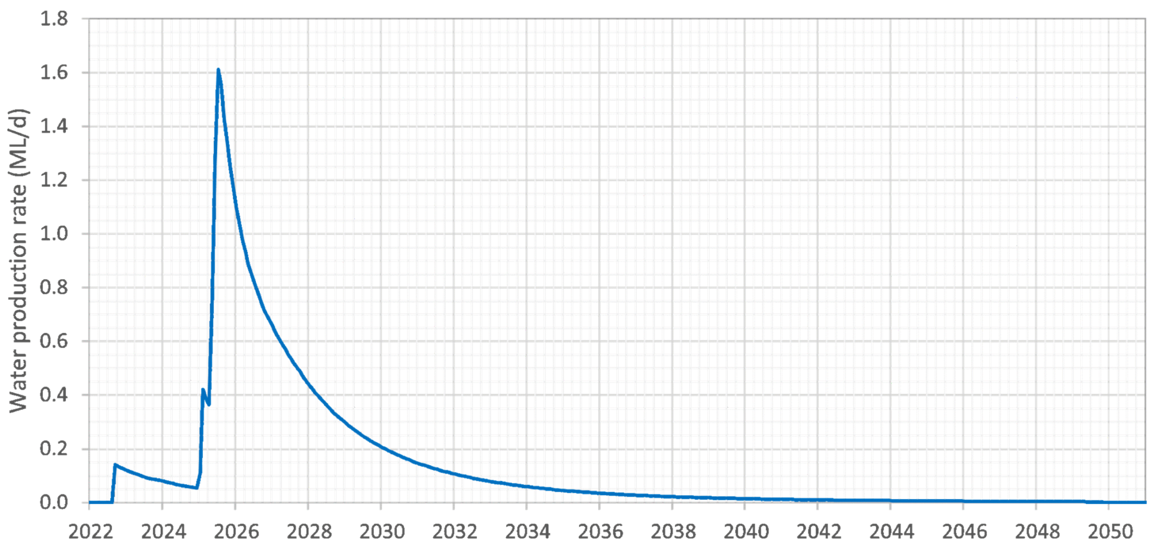
CSG water will be produced as a by-product of depressurisation of coal seams to produce CSG for ATP 2059. The target coal seams are the Walloon Coal Measures (WCM).

Produced water volumes and rates have been modelled using Senex's analytical reservoir model, with probabilistic distributions applied to several key reservoir parameters (i.e., permeability, porosity, and net coal) to generate well type curves and water production forecasts. Some uncertainty is inherent in any analytical model, this uncertainty is addressed through the probabilistic distributions and further certainty will be gained as CSG wells are drilled and tested as part of appraisal programs and as field development proceeds. As Senex acquires more production data, the model will be enhanced with historical matching of actual production data, resulting in revised production forecasts being produced. These revised production forecasts will be incorporated into the water balance model along with the actual observations of water disposal volumes, rainfall, and dam levels.

Senex has confidence that this integrated and iterative approach will ensure that produced water is managed responsibly, and beneficial use is optimised. Type Curves[1] will be updated throughout the life of the project as more information becomes available.

Figure 3.1 presents the CSG water production profile forecast for ATP 2059. Peak CSG water production is expected to occur in 2025.

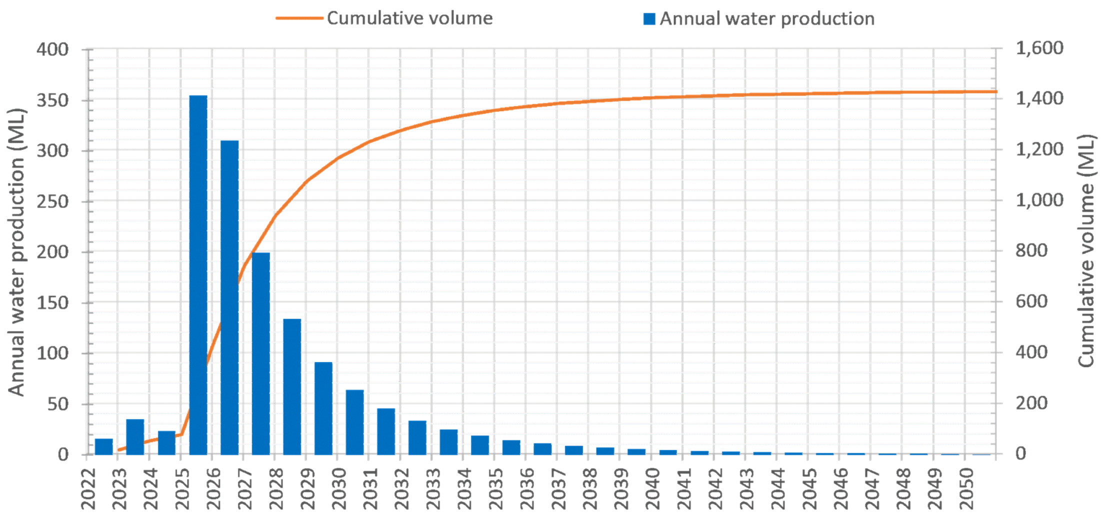
Figure 3.1: ATP 2059 Forecast Water Production



[1] A type curve is the water production profile for the life of a well for a well that is representative of the gasfield. This type curve is then cumulatively multiplied over time, in line with the development schedule, to provide an estimate of the overall gasfield water production profile.

Figure 3.2 presents the annual water production forecast and cumulative water production. The total volume of water forecast to be produced over the development lifetime (~30 years) is approximately 1.4 GL.

Figure 3.2: ATP 2059 Annual Water Production



3.2. CSG Water Quality

There is no water quality data for the WCM from the ATP 2059 area. Data related to the site-specific water quality will become available as CSG wells are drilled as part of appraisal programs and into production and will be incorporated into the model and updated accordingly. A summary of the regional characteristics associated with the WCM are provided below.

The produced water quality from the WCM can vary from fresh to saline. OGIA (2016a) indicate that in general, the total dissolved solids (TDS) of the WCM within the Surat Cumulative Management Area (CMA) ranges from 30 to 18,000 mg/L, with a mean TDS of 3,000 mg/L. OGIA (2016a) also report that available samples from existing CSG bores in the Surat CMA at significant depth show distinct characteristics with negligible concentrations of calcium, magnesium and sulfate, and higher concentrations of sodium and fluoride, compared with the other formations.

Table 3.1 presents analysis results from the groundwater database (GWDB) for 24 WCM samples within 25 km of ATP 2059. Most of these samples are from third-party groundwater bores located to the north of ATP 2059. Table 3.2 presents analysis results from PL 1037.

Table 3.1: Summary of WCM Water Quality from Available GWDB Samples within 25 km of ATP 2059

Parameter	Unit	Count	Min	Max	Median	Average
EC	μS/cm	12	1,900	13,400	8,010	7,310
pH	-	15	5.5	8.8	7.7	7.7
Sodium Adsorption Ratio (SAR)		24	7.6	171	81	81
TDS	mg/L	18	883	17,733	5,176	5,645
Sodium	mg/L	24	262	6,860	2,024	2,651
Potassium	mg/L	4	4.3	16.3	5.9	8.1
Calcium	mg/L	24	7.9	344.3	33.5	81.1
Magnesium	mg/L	24	2.9	162.9	10.7	31.4
Bicarbonate (HCO_3)	mg/L	16	30	862	512.0	512.3

Parameter	Unit	Count	Min	Max	Median	Average
Carbonate (CO_3)	mg/L	12	15	343.2	198.8	168.1
Chloride	mg/L	24	375	11,454	2,904	4,014
Fluoride	mg/L	15	0.2	2.2	0.8	0.9
Sulfate	mg/L	16	1.0	57	4.0	8.7

Table 3.2: Summary of WCM Water Quality from PL 1037

Parameter	Unit	Min	Max	Average
EC	µS/cm	8,780	12,500	10,039
pH	-	8.4	9.1	8.8
SAR		107	163	128
TDS	mg/L	5,500	8,120	6,477
Sodium	mg/L	1,920	2,900	2,300
Potassium	mg/L	13	63	50
Calcium	mg/L	4	18	10
Magnesium	mg/L	6	9	7
HCO_3 as $CaCO_3$	mg/L	480	700	550
CO_3 as $CaCO_3$	mg/L	23	280	150
Chloride	mg/L	2,700	4,160	2,300
Fluoride	mg/L	1.1	1.8	1.4
Sulfate	mg/L	<1	2	1.2

4. CSG WATER MANAGEMENT

4.1. CSG Water Management Strategy

The CSG water management strategy for ATP 2059 has been developed based on the Department of Environment and Heritage Protection (DEHP) (now the Department of Environment and Science (DES)) prioritisation hierarchy. This hierarchy is presented in the Coal Seam Gas Water Management Policy (DEHP 2012). The prioritisation hierarchy for managing and using CSG water is:

Priority 1 – CSG water is used for a purpose that is beneficial to one or more of the following:

- The environment;
- Existing or new water users; or
- Existing or new water-dependent industries.

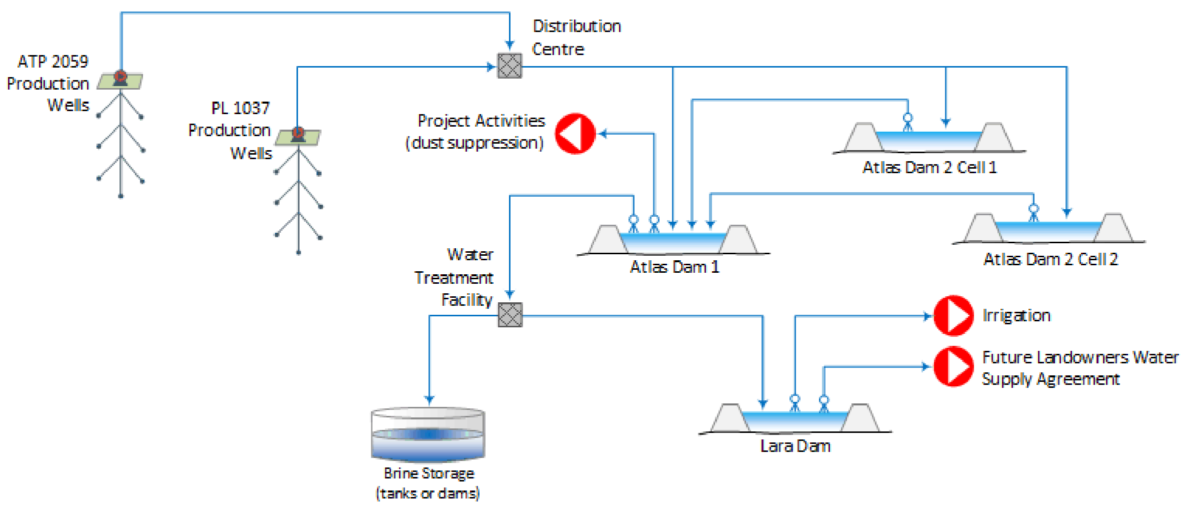
Priority 2 – After feasible beneficial use options have been considered, treating and disposing of CSG water in a way that firstly avoids, and then minimises and mitigates, impacts on EVs.

4.2. Water Management Infrastructure

4.2.1 Overview

This section provides an overview of the infrastructure proposed to manage CSG produced water. As detailed in Section 1.1, water management infrastructure for ATP 2059 is expected to include water gathering systems from the producing wells, brine and produced water storages, including aggregation dams and brine tanks, and irrigation dams. Where practical, the water management infrastructure required for ATP 2059 will integrate with existing Project Atlas infrastructure in PL 1037. A schematic of the existing PL 1037 wells and any additional water management infrastructure required for ATP 2059, is presented in Figure 4.1, with each component summarised in the following sections.

Figure 4.1: Water Management Infrastructure Schematic (ATP 2059 and PL 1037)



4.2.2 Infrastructure Location Planning

The exact locations of additional water management infrastructure within the ATP 2059 area are not yet known. However, to avoid, minimise and manage potential impacts across the ATP 2059 area, and to support well field layout for all surface infrastructure, including wells and gathering pipelines, Senex will implement the 'Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development' (OPS-ATLS-EN-PLN-001; Senex 2023) (the Constraints Protocol). The Constraints Protocol aims to ensure that infrastructure siting:

- Considers biodiversity values and environmental constraints, such as sensitive receptors, when selecting preferential locations; and aligning with planning principles to avoid, minimise, mitigate, and then manage potential environmental impacts; and
- Identifies any additional external environmental approvals required and that those are secured prior to the commencement of construction activities.

The Constraints Protocol also recognises that, in addition to environmental constraints, landholder, engineering, and cultural heritage constraints must be considered during infrastructure siting.

The process involves a desktop constraints analysis, site surveys, post-survey environmental constraints analysis, and preparing a report that includes a list of site-specific environmental conditions and associated constraints maps. These are included in the final Access to Work (ATW) documentation, issued upon sign-off by the Project Manager to relevant staff and contractors prior to commencing construction.

4.2.3 CSG Production Wells, Water Gathering and Distribution System

CSG water production is required as part of the CSG extraction process. Groundwater is abstracted (pumped) from CSG production wells to depressurise the target production coal seams. Depressurisation generates gas flow and sustains a groundwater flow from the well to maintain the target producing operational pressure for each CSG production well.

Flow from the well is separated into water and gas by either:

- Wellbore separation (where water is pumped up the tubing and produced gas flows to the surface in the annulus of the well); or
- Where wellbore separation is ineffective, a surface separator may be installed that will separate any hydrocarbons from the produced water.

Each well will have a wellhead gas and water metering package to achieve real-time continuous gas and water metering. Instantaneous monitoring can assist with the early identification of any issues at the wellheads.

CSG production wells will be drilled and constructed in accordance with the 'Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland' (State of Queensland 2019a).

Gas and water from the wellsite will be delivered to gas and water processing facilities via separate underground high density polyethylene (HDPE) pipelines operating as low-pressure gas and water gathering systems. Gathering systems shall be designed and installed in accordance with APGA Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 4.0 (APGA 2016).

All produced water will initially be collected from the water gathering systems into existing PL 1037 aggregation dams (Section 4.2.4).

4.2.4 Operational Water Storage Facilities

As detailed in Section 1.1, CSG produced water storage facilities for ATP 2059 will use existing Project Atlas infrastructure in PL 1037 which includes:

- Aggregation dams for storing untreated CSG produced water:
    - Atlas Dams 1 and 2: existing purpose-built earthen dams comprising an impervious liner. Atlas Dam 1 has a storage capacity of 330 ML and Atlas Dam 2 is a dual celled dam with storage capacities of 330 ML and 550 ML in Cells 1 and 2, respectively.
- Irrigation dams located adjacent to dedicated irrigation areas:
    - Lara Dam: existing irrigation dam with a storage capacity of 100 ML.
- Brine storage tanks.
    - Brine Tanks 1 and 2: existing brine tanks each with a full storage volume (FSV) of 57 ML, a maximum operating volume (MOV) of 44 ML and a surface area of 1.65 ha; and
    - Additional brine storage: two brine tanks or a brine dam (with a comparable storage volume and surface area) required to meet the PL 1037 forecasted production rate (refer to Section 4.5).

Any additional CSG water storage or brine dams associated with ATP 2059 (i.e., if required and in addition to the PL 1037 dams and brine tanks) will be designed and assessed using the 'Manual for Assessing Hazard Categories and Hydraulic Performance of Structures' prepared by DES (DES 2016a). If a dam is identified to be in the 'significant 'or 'high-hazard' category, it is considered a regulated dam and detailed dam design reports must be submitted to DES following granting of the EA (that provides in principle approvals of dam construction).

The following will apply with respect to any regulated dams required for the Project:

- Senex will design dams in accordance with relevant legislation and Queensland standards and DES guidelines;
- Senex will submit dam designs separately and specifically for registration;
- An independent third-party will be engaged to certify dams to ensure design, construction and hydraulic performance meet the design plan;
- Dams will be constructed under the supervision of a suitably qualified and experienced person and in accordance with the relevant DES schedule of conditions relating to dam design, construction, inspection and mandatory reporting requirements;
- Senex will implement a seepage monitoring program for water storage dams, where required. The seepage monitoring program will identify infrastructure and procedures that are in place to detect loss of containment as early as possible;

- Senex will routinely monitor water quality in dams, and in the respective dam's shallow groundwater monitoring bores, installed as part of the seepage monitoring program (if required);

- Senex will monitor dam levels to provide early warning of overtopping and / or unidentified water losses; and

- Senex will monitor the integrity and assess the available storage of dams annually.

Any low-hazard dams required for CSG water storage will be designed in accordance with accepted engineering standards. The dams will be designed with a floor and sides comprising material capable of containing the water for the life of the project.

The following will apply with respect to any additional brine storages associated with ATP 2059 (i.e., if required and in addition to existing PL 1037 brine tanks 1 and 2):

- Senex will design storages in accordance with relevant legislation and accepted Australian engineering standards.

- Senex will implement a seepage monitoring program for any additional brine storages, where required. The seepage monitoring program will identify infrastructure and procedures that are in place to detect loss of containment as early as possible.

- Senex will monitor storage levels to provide early warning of overtopping and / or unidentified water losses; and

- Senex will monitor the integrity and assess the available storage of storages annually.

4.2.5 Water Management Process

The water management process for the produced water is (also shown in Figure 4.1):

- Water from the ATP 2059 gathering system will be transferred to the centrally located aggregation dams including the existing Atlas Dams 1 and 2 on PL 1037.

- The existing Project Atlas water treatment facility (WTF) on PL 1037 consisting of pre-filtration, pre-treatment pH adjustment (if required), membrane filtration, reverse osmosis and calcium addition will treat water from the aggregation dams. The existing WTF has a treatment capacity of approximately 1.5 ML/d, with approximately 88% recovery. The treatment capacity of the existing WTF will be increased to 4.5 ML/d to ensure adequate capacity for the produced water from the existing Project Atlas. Additional water from PL 445 and PL 209 will be accommodated within the expanded existing WTF.

- Treated water (permeate) will be transferred to third-party irrigation dams including the existing Lara Dam on PL 1037. Additional untreated water may be blended into permeate in the irrigation dam where possible without compromising the quality of the water in relation to its suitability for irrigation.

- An alternative to treatment of the produced water may be blending with fresh water sourced from a third-party, to provide water of a suitable quality for irrigation.

- Blended water will be provided to third-parties for use on pivot and fixed irrigators on pasture grass or crops.

- Brine from the water treatment process will be stored in brine storages (including the existing Brine Tanks 1 and 2), from where it will be further concentrated via solar evaporation to a concentrated slurry or solid salt. Where appropriate, salt or salt slurry will be trucked from site and disposed of at a Regulated Waste Facility. Further detail related to brine and salt management is included in Section 4.4.

4.3. Water Management Options

The water management strategy and associated schematic for ATP 2059 (Figure 4.1), has been developed to beneficially use water. This includes providing produced water for the following activities:

- Project activities, such as drilling and completions, dust suppression, etc; and

- Landowner Water Supply Agreements (WSA), including water for irrigation and stock watering.

4.3.1 Project Activities

Where practical, Senex will use untreated produced water to support ongoing development / construction activities such as: dust suppression; drilling; well completions and workovers; facilities construction; and hydro-testing gathering networks.

Any untreated produced water used as part of project activities will be undertaken in accordance with the following which have been designed to ensure protection of the environment:

- ‘End of Waste Guideline’ (DES 2022)

- ‘Streamlined Model Conditions for Petroleum Activities’ (DES 2016b); and

- Project EA, particularly Schedule G (water) and Schedule B (waste), which provides specific conditions related to beneficial use for irrigation, dust suppression and construction.

The general beneficial use approval document establishes the criteria for using untreated produced water for dust suppression, construction, and landscaping and vegetation requirements. Compliance with water quality criteria is required to use untreated produced water for landscaping and vegetation; however, no criteria are specified for dust suppression and construction. Using produced water for dust suppression and construction purposes will be undertaken with consideration to Senex’s ‘Environmental Management Plan – Project Atlas Stage 3’ (SENEX-ATLAS-EN-PLN-015).

Untreated produced water from ATP 2059 is expected to be used for dust suppression (up to 30 ML/yr or 0.1 ML/d for PL 1037 and ATP 2059).

4.3.2 Landowner Water Supply Agreements

Senex anticipates using the CSG produced water for beneficial use by establishing Landowner Water Supply Agreement (WSAs). An estimate of current groundwater use in the vicinity of the Project area is ~1,345 ML/year (see section 5.4.2), which includes groundwater abstraction for stock and domestic and agricultural purposes (OGIA 2017b).

Senex also plan to support beneficial re-use of a portion of the CSG produced water volume from the Project through supporting third-party sustainable irrigation practices. Senex is aware that agricultural users have different water demand profiles and water requirements, with some requiring water for stock watering and others for irrigation. For these reasons, Senex plan to adopt a portfolio management approach to water management, identifying the opportunity to address beneficial use demands with anticipated produced water volumes. It is noted that the CSG produced water can be used to address periodic local water shortages (e.g. during periods of drought).

Prior to providing produced water to any third-party irrigation schemes, Senex will address the requirements of the 'End of Waste Guideline' (DES 2022).

4.4. Brine and Salt Management

The DEHP Hierarchy within the *CSG Water Management Policy* (DEHP 2012) also provides a prioritisation hierarchy for managing saline waste, which comprises:

- 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 of brine is addressed through the State Environmental Authority requirements in Schedule B (waste) and Schedule I (dams). These schedules also address spills, leaks, and seepage monitoring and management. Senex's approach to any brine management will remain consistent with industry accepted practice.

Treatment of produced water via RO will produce treated water (permeate) and RO reject (brine). Brine will be transferred from the WTF to the brine storages, which are and will be located taking consideration of the Queensland requirements for buffers around watercourses, MNES, matters of state environmental significance (MSES) and environmentally sensitive areas (ESAs).

Based on a median salt concentration of 5,176 mg/L TDS (Table 3.1), it is anticipated that approximately 5 tonnes of salt per mega litre of produced water will be generated. Brine requires specific considerations for storage and disposal and will be stored in engineered storages, constructed to contain the entire production of brine from the Project. The brine storages will be designed and constructed under the supervision of a suitably qualified and experienced person and in accordance with the relevant Australian standards relating to tank or dam design, construction, and inspection. This includes but is not limited to AS 3735-2001 concrete structures for retaining liquids and the ANCOLD guidelines for dams.

Stored brine will undergo solar evaporation resulting in a highly concentrated slurry or solid salt. Where appropriate this concentrate will be transferred to a Regulated Waste Facility for disposal. Senex will continue to investigate cost effective and / or commercial saline disposal alternatives.

Site rehabilitation requirements are addressed in Schedule J (Rehabilitation) of the EA. Senex will be responsible for the rehabilitation of any dams or infrastructure under the approval or, where appropriate, transferring dams to landholders in accordance with the approved EA conditions and, ensuring no legacy issues develop following the cessation of Project production.

4.5. Water Balance

A water balance model has been developed in GoldSim to determine timing for the long-term water management strategy for ATP 2059. The model has been designed and configured to simulate the operation of the existing PL 1037 water management system (as detailed in Figure 4.1) with the ability to add in additional water management infrastructure as/if required due to the increased water production forecasts (i.e., PL 1037 plus ATP 2059 water production forecast). The model uses:

- Combined water production forecasts for PL 1037 and ATP 2059 as presented in Figure 4.2 based on the 2022 forecasts.
- Existing Project Atlas water storage volumes and surface areas (i.e., Atlas Dams 1 and 2, Brine Tanks 1 and 2, and Lara Dam).
- Rainfall and evaporation – based on SILO Data Drill historical rainfall data, Morton's lake and wet evaporation data and dam surface area.
- Dust suppression – based on 0.1 ML/d which is reduced by 50% if a daily rain event of 5-10 mm occurs and by 100% if a daily rain event of >10 mm occurs.
- Irrigation use – based on irrigation rates of 6 ML/yr/ha for an irrigation area of 105 ha (i.e., centre pivots 1 to 4) which is also reduced by 50% if a daily rain event of 5-10 mm occurs and by 100% if a daily rain event of >10 mm occurs.

The water balance model uses a probabilistic simulation approach where long-term daily climate data for the region from 1889 to 2021, is disaggregated into 130 continuous climate sequences over the ATP 2059 lifetime (31 years) (i.e., sequence 1 (S1): 1889 – 1919 inclusive, S2: 1890 – 1920, S3: 1891 – 1921.S103: 1991 – 2021). This results in 103 distinct solutions for each time step within the 31-year simulation period, with statistics used to present the results in terms of exceedance percentiles. For example, P5 represents the 5th percentile of non-exceedance where there is a 5% chance of water volumes being less because of dry climate conditions (or a 95% chance of volumes being greater), P50 represents the 50th or median percentile because of average climate conditions and P95 represents the 95th percentile non-exceedance where there is a 95% chance of water volumes being less because of wet climate conditions (or a 5% chance of volumes being greater). This monitors the resilience of the model under different climatic conditions.

The water balance model is based on a daily timestep and considers the changing volume over time in the aggregation dams, brine tanks and irrigation dam. Storage curves are referenced to determine the changing free water surface and corresponding daily evaporation rate, with Morton's lake evaporation rates from the wet surface areas, considered in each time step.

The water balance model provides a prediction of stored water volumes over time using the water production forecast and can be used to estimate the timing that additional storage or beneficial use applications may be required.

Senex does not propose to discharge to watercourses, however, should this disposal option be required in the future, Senex would pursue the necessary EPBC approval and an amendment to the EA supported by the necessary site-specific studies to support the applications.

Outcomes of the modelling, using 103 climate scenarios, are provided in Figure 4.3 to Figure 4.5 for the median and wet climate conditions (i.e., P50 and P90).

Results from water balance modelling conclude that to provide sufficient containment under the P95 climate scenario, augmentation of the existing PL 1037 water management infrastructure is recommended as follows:

- PL 1037 water production forecast:
    - Additional brine storage (online 2024 and required because the current PL 1037 water production forecast is expected to be larger than the water production forecast used in the original approval):
        - Two additional brine tanks (i.e., four brine tanks in total) each with a fsv of 57 ml, mov of 44 ml and a surface area of 1.65 ha; or
        - Brine dam with a comparable storage volume and surface area.
- PL 1037 plus ATP 2059 water production forecast:
    - Increase WTF capacity up to 2.5 ML/day from 2024.
    - Additional brine storage (online 2024):
        - One additional brine tank (i.e., five brine tanks in total) with a fsv of 57 ml, mov of 44 ml and surface area of 1.65 ha; or
        - Brine dam with a comparable storage volume and surface area.
    - Increase irrigation area from Lara Dam from 105 ha up to 125 ha which includes the additional 20 ha associated with the future centre pivot 5 also from 2024 onwards.

Understanding of well performance will improve as ATP 2059 progresses, and more production data becomes available. It is important and highly recommended that the water balance modelling and proposed changes to the existing water management infrastructure on PL 1037 be updated as further production data becomes available and if the PL 1037 or ATP 2059 water production rates change.

Figure 4.2: ATP 2059 and PL 1037 Water Production Rates and Cumulative Volume

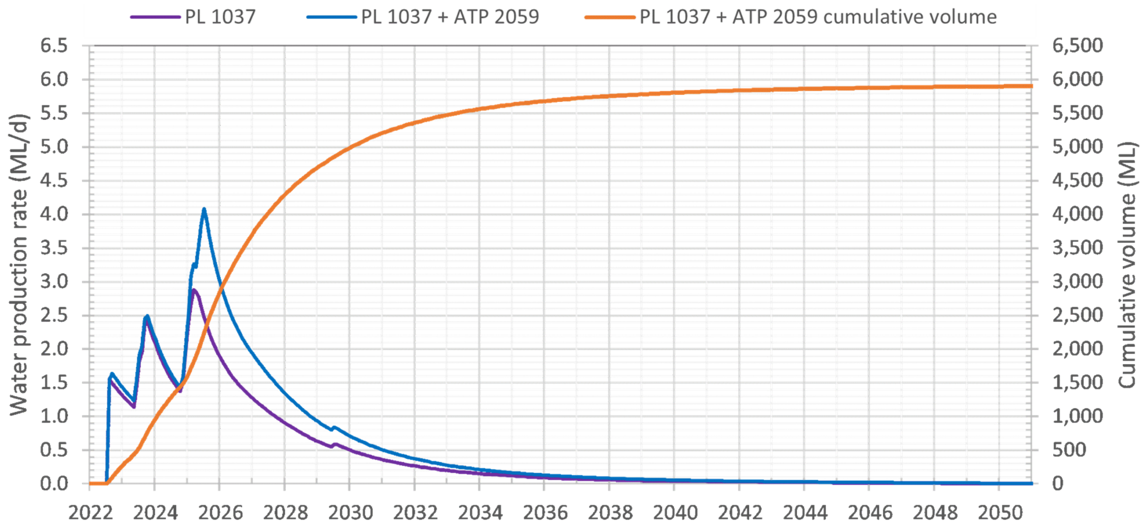


Figure 4.3: Water Balance Model Results – Atlas Dams 1 and 2 (P50 and P95)

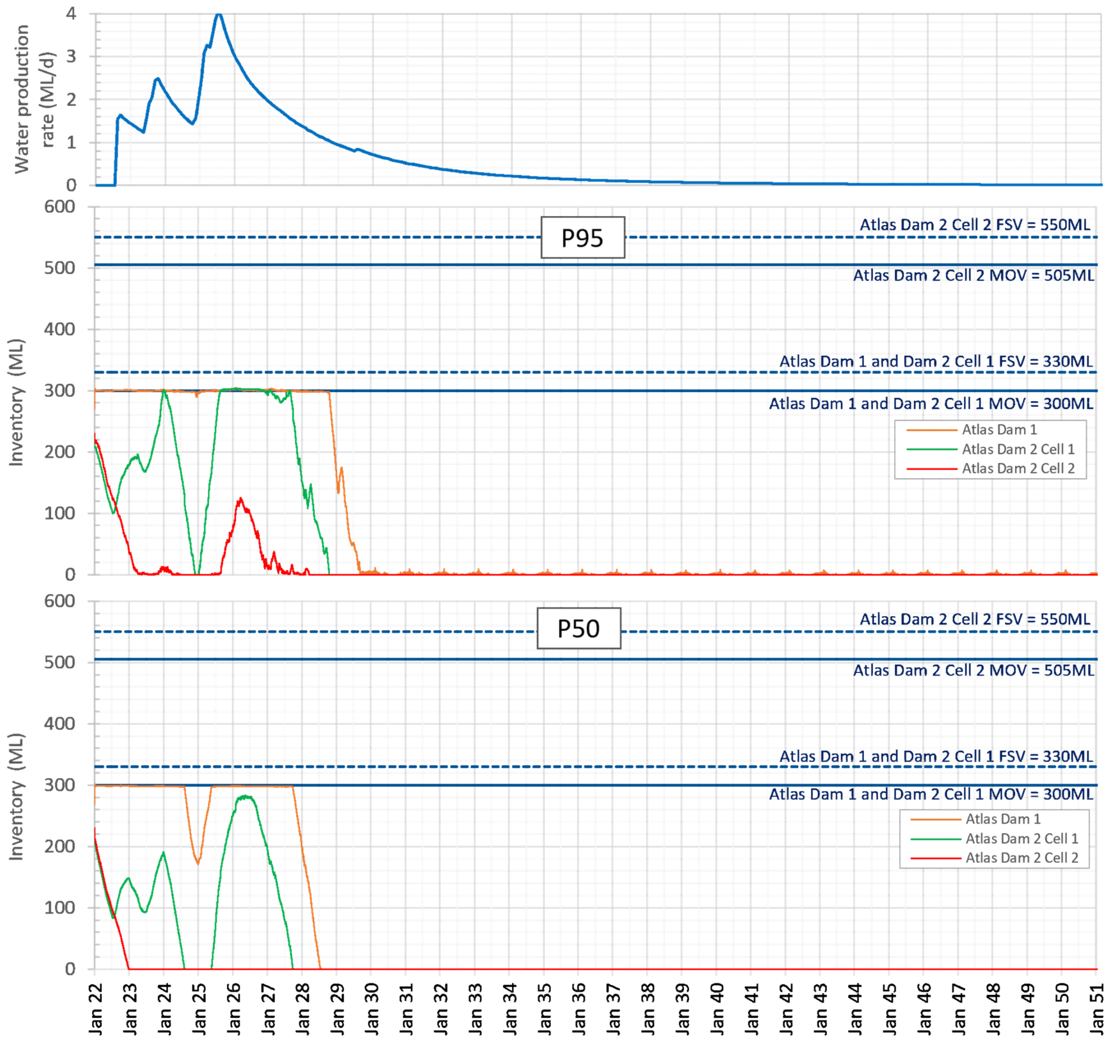


Figure 4.4: Water Balance Model Results – Brine Tanks (P50 and P95)

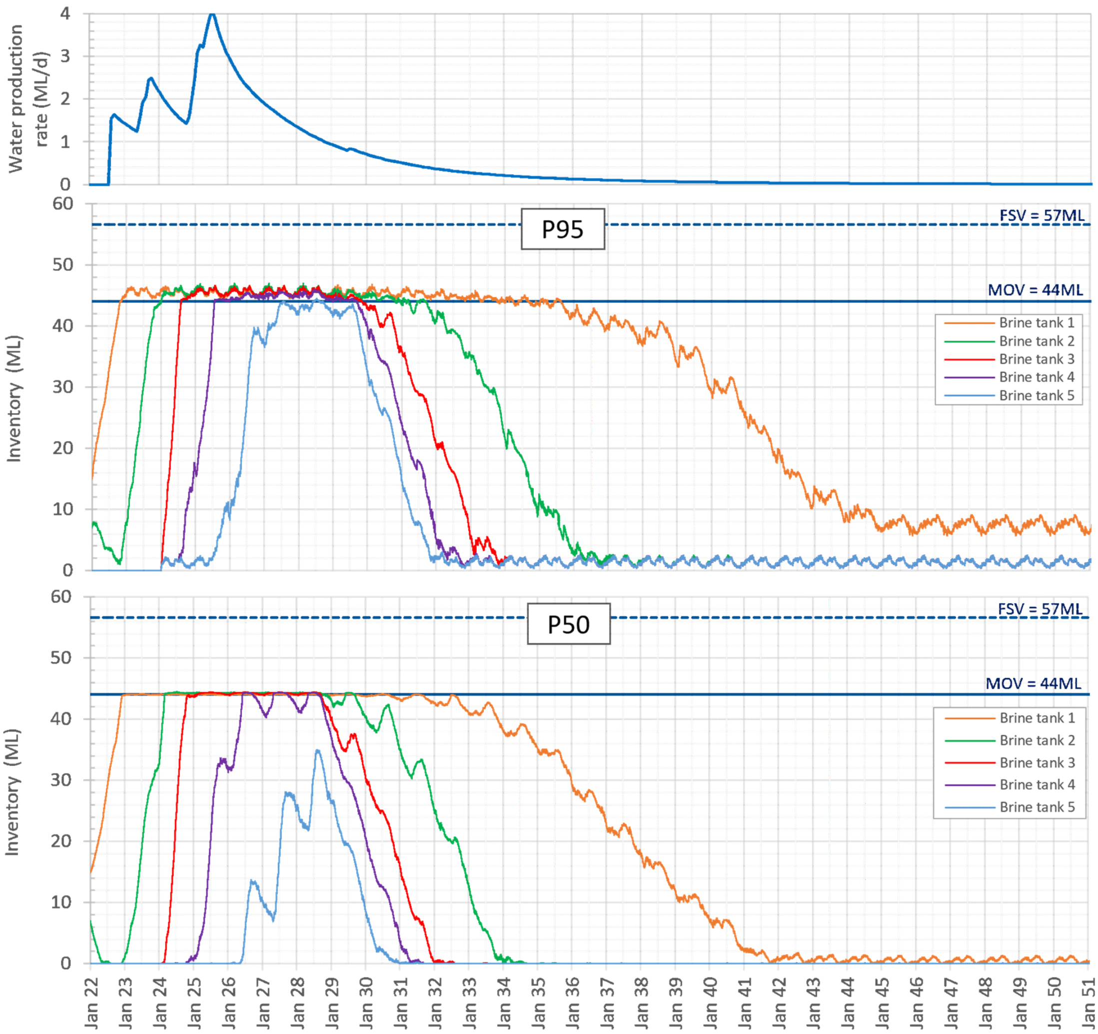
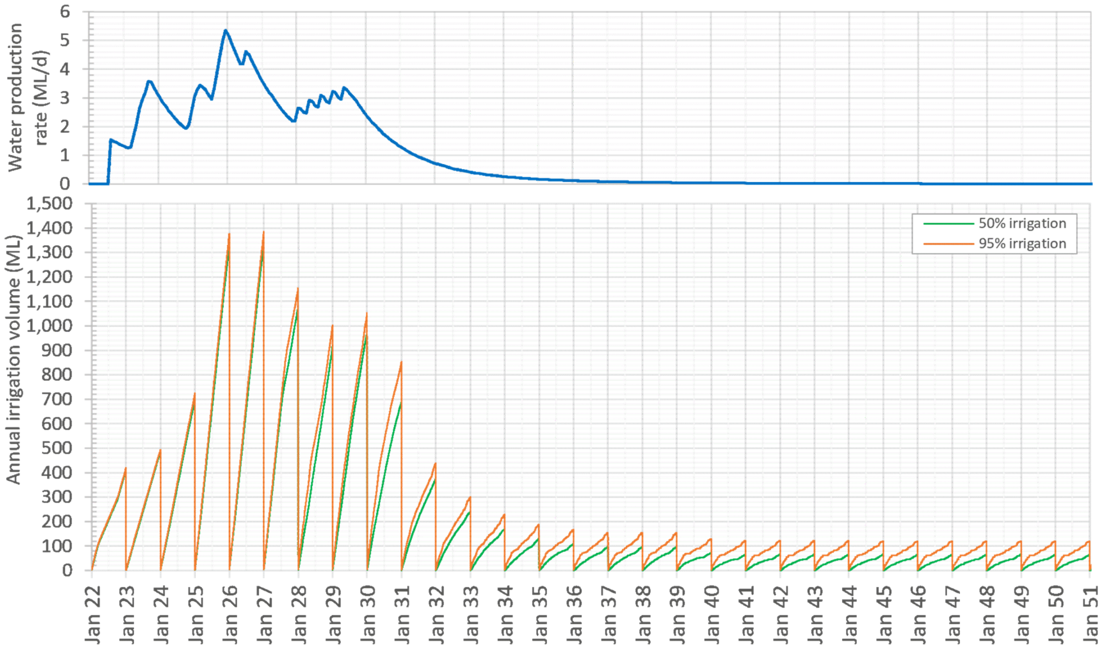


Figure 4.5: Water Balance Model Results – Beneficial Re-use (P50 and P95)



5. EXISTING ENVIRONMENT AND ENVIRONMENTAL VALUES

5.1. Climate

The climate of the Project area is classified as subtropical with no dry season, using the modified Köppen classification system (BoM 2005).

A summary of the climate statistics (sourced from the BoM) are detailed below for the climate station at Roma Airport[2] (43091), with rainfall statistics for Wandoan Post Office (35014):

- Mean maximum temperatures range between 34.6°C in the summer months and 20.4°C in the winter months. Mean minimum temperatures range between 20.1°C in the summer months and 3.8°C in the winter months.
- Daily evaporation rates are generally high and exceed rainfall throughout the year.
- In general, the highest rainfall occurs during December to February, with the lowest rainfall occurring during April to September (Table 5.1).

Table 5.1: Climate Statistics for Roma Airport and Wandoan Post Office, Site Numbers 43091 and 35914 (BoM 2022a; 2022b)

Statistic Element	Roma Airport (43091)			Wandoan Post Office (35014)	SILO[1]
	Mean maximum temperature (°C)	Mean Minimum temperature (°C)	Mean Rainfall (mm)	Mean Rainfall (mm)	Mean evaporation (mm)
Period of Record	*1992 to 2022*	*1992 to 2022*	*1985 to 2022*	*1955 to 2022*	*1960 to 2023*
January	34.6	21.0	66.9	83.4	236.9
February	33.0	20.0	89.6	76.3	190.0
March	31.6	17.5	58.9	53.9	187.1
April	28.2	12.4	31.9	36.4	139.5
May	23.9	7.6	32.1	35.4	99.2
June	20.5	5.2	29.0	33.7	74.9
July	20.4	3.8	21.3	28.9	81.2
August	22.8	4.7	22.4	26.9	113.0
September	26.8	9.3	25.2	28.9	157.0
October	30.0	13.6	49.8	51.7	200.5
November	32.3	17.2	60.4	64.7	217.8
December	33.6	19.4	77.6	94.7	238.7
Annual	**28.1**	**12.6**	**567.7**	**590.1**	**161.3**

1. SILO is an enhanced synthetic climate database that provides daily time series data for point locations and comprises actual station records augmented by interpolated estimates where observed data are missing.

[2] Temperature and evaporation data not available for Wandoan Post Office climate station

5.2. Land

5.2.1 Topography and Drainage

Elevations across ATP 2059 range between 250 mAHD[3] and 290 mAHD. Topographic highs are located towards the northwest and southwest of ATP 2059. ATP 2059 is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin.

5.2.2 Regional Geology

ATP 2059 overlies two distinct, but interconnected geological basins, the Permo-Triassic Bowen Basin and the Jurassic-Cretaceous Surat Basin. The Surat Basin occupies approximately 180,000 km^2 of southeast Queensland and is connected to the Eromanga Basin in the west, the Clarence-Moreton Basin in the east and Mulgildie Basin to the northeast (KCB 2016).

The Surat Basin comprises predominantly Jurassic to Cretaceous aged alternating sandstone, siltstone and mudstone layers. This sequence, at its maximum, is more than 2,500 m thick in the Mimosa Syncline to the west of ATP 2059. ATP 2059 targets the WCM; a thick sequence of siltstone, mudstone and fine-to-medium-grained sandstone that contains the main CSG producing coals in the Surat Basin. While the total thickness of the WCM can be up to 650 m, the average thickness of this unit is approximately 300 m and the total coal thickness is generally less than 30 m (OGIA 2016a).

5.2.3 Land Use

Land use within and surrounding ATP 2059 is predominantly focused on primary agricultural resources. Rural/agricultural production associated with cattle grazing and feed-lotting along with petroleum activities are the dominant land uses within the region. The majority of ATP 2059 is currently freehold.

The Juandah State Forest is located 1.7 km southwest of ATP 2059 in PL 1037, comprising an area of approximately 398 ha. In addition, the eastern extent of the Hinchley State Forest (25 ha) is located within the northern extent of the PL 1037, 2.5 km west of ATP 2059.

The Jackson Wandoan road, which is also a travelling stock route, passes through the ATP.

The tenure is surrounded by existing petroleum tenures held by Shell (QGC) and Australia Pacific LNG. There are a range of mining projects present in the greater region, which are at varying stages of development, as well as an exploration permit for greenhouse gas over the ATP.

Approximately 89% of the ATP is mapped as Strategic Cropping Area (SCA), an “area of regional interest” under the Regional Planning Interests Act 2014 (RPI Act). There are no other areas of regional interest located within the ATP. Senex will comply with the requirements of the RPI Act.

[3] Metres above Australian Height Datum

5.2.4 Environmentally Sensitive Areas

Within ATP 2059, there are Category B and C Environmentally Sensitive Areas (ESA) (DEHP 2016c) as summarised in *Table 5.2*.

Table 5.2: Environmentally Sensitive Areas within the Production Area

ESA Matter	Comment
Category B ESA that are 'endangered' regional ecosystems – regrowth and remnant (Biodiversity Status)	There are areas of remnant and regrowth vegetation that are endangered regional ecosystem (biodiversity status) within the ATP.
Category C ESA that are 'of concern' regional ecosystems	There are 'of concern' regional ecosystems (biodiversity status) within the ATP. The majority of 'of concern' regional ecosystems are associated with riparian areas.

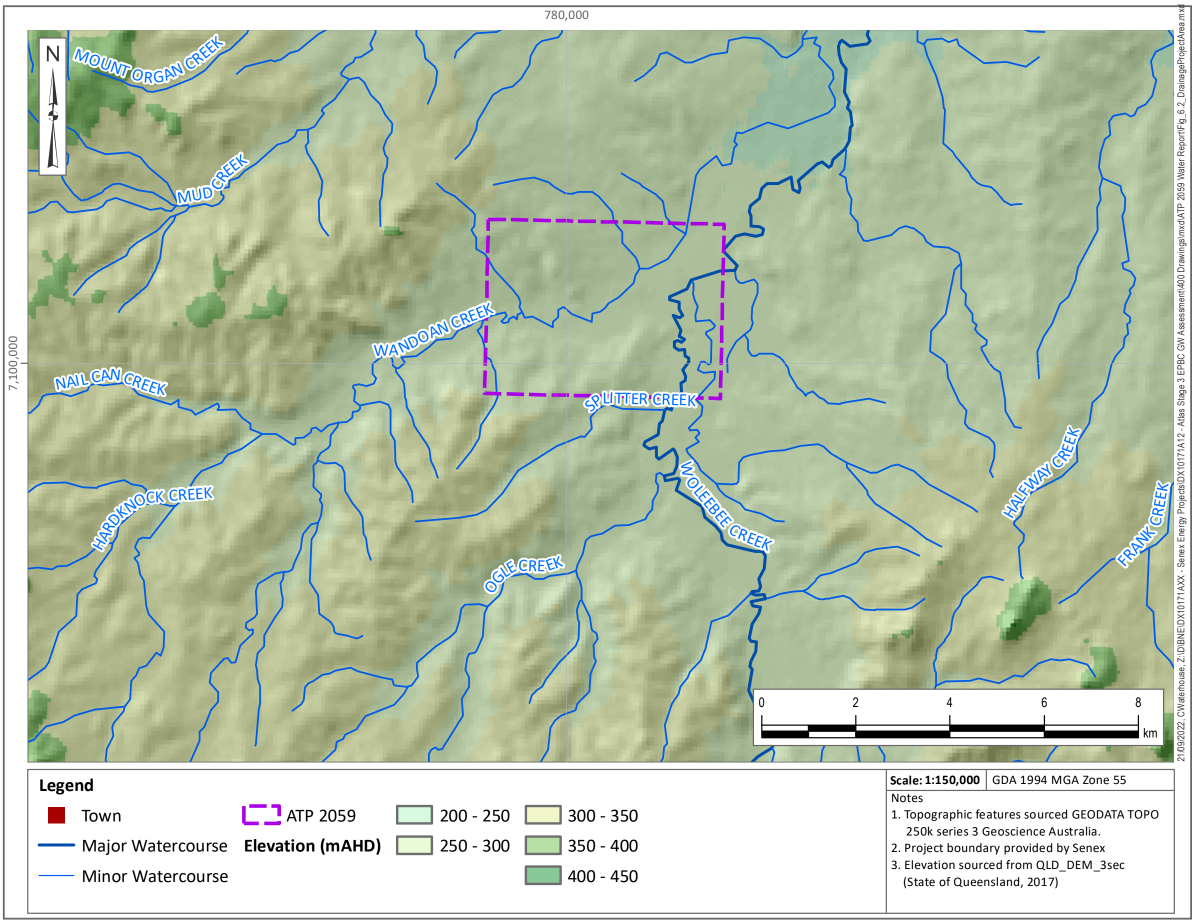
5.3. Surface Water

ATP 2059 is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. Key watercourses within the vicinity of ATP 2059 include Wandoan Creek, which flows northeast from its headwaters flanking the south-eastern boundary of ATP 2059 to join Woleebee Creek off-lease to the northeast (Figure 5.1). Woleebee Creek flows north along the eastern boundary of ATP 2059.

The watercourses across ATP 2059 are characteristically ephemeral and typically flow only during significant runoff events, likely due to being located in higher reaches of the catchments with limited runoff area. Watercourses within ATP 2059 are classified as Stream Orders 1 to 5 using the Strahler method, with the majority being Stream Order 1 (minor streams) (State of Queensland 2021a). Woleebee Creek is Stream Order 5.

Catchments within the Upper Dawson River sub-basin are influenced by anthropogenic activities including land use, riparian management, water infrastructure and point source releases.

Figure 5.1: Drainage within ATP 2059



5.3.1 Aquatic Ecology

Aquatic ecology identified in ATP 2059 was associated with a series of disconnected remnant pools. The aquatic species associated with these pools are common and widespread in central Queensland streams. The aquatic ecosystems in the area are impacted by grazing and cropping land uses with disturbed riparian areas and elevated sediment and nutrient inputs. However, the aquatic habitat in ATP 2059 has local value on a tributary scale, with persistent waterholes providing important refugia for aquatic fauna and flora during dry conditions. These refugia are sensitive to impacts, given the inability for biota to move to better conditions during dry periods, but they already experience high levels of suspended sediments and nutrient inputs from existing land uses.

5.4. Hydrogeology

ATP 2059 is located within the geographical extent of the Surat Basin, a basin of Jurassic-Cretaceous age, which is underlain by the Permo-Triassic Bowen Basin. Cenozoic-age formations are present overlying the Surat Basin formations. The surface geology within the vicinity of ATP 2059 is shown in Figure 5.2.

The Surat Basin forms part of the Great Artesian Basin (GAB), which is comprised of several aquifers and confining aquitards. Aquifers of the Surat Basin are a significant source for water used for stock, public water and domestic supply. The hydrostratigraphy of the Surat and Bowen Basin (OGIA 2021a) are shown in Figure 5.3.

The main aquifers within the GAB, from the deepest to the shallowest, are the Precipice Sandstone, Hutton Sandstone, Springbok Sandstone, Gubberamunda Sandstone, Mooga Sandstone and Bungil Formation. These aquifers are typically laterally continuous, have significant water storage, are permeable and are extensively developed for water supply. However, in some areas, they have more of the character of aquitards than aquifers (OGIA 2016b). The major aquitards are the Evergreen Formation, Eurombah Formation, Westbourne Formation, Surat Siltstone and Griman Creek Formation (Figure 5.3). WCM is the target formation for CSG production for ATP 2059.

ATP 2059 is situated in an area where the Gubberamunda Sandstone and Westbourne Formation outcrop. The WCM outcrop is mapped as occurring ~17 km north of ATP 2059.

North-south and west-east oriented cross sections are presented in Figure 5.4: Geological Cross Sections (Surat CMA Geological Model (OGIA 2021a)), with the section locations provided on Figure 5.2. These sections show the hydrostratigraphic units dipping towards the south from the outcrop. Generally, all units are laterally extensive and continuous across the Project area.

Quaternary-age alluvium has been mapped as occurring within ATP 2059 and is associated with Wandoan, Woleebee and Woleebee Creeks as shown Figure 5.2. The alluvium generally occurs as narrow bands bounding the creeks and increases in lateral extent towards the northeast of ATP 2059 as Wandoan Creek flows into Woleebee Creek.

Figure 5.2: Regional Surface Geology Map

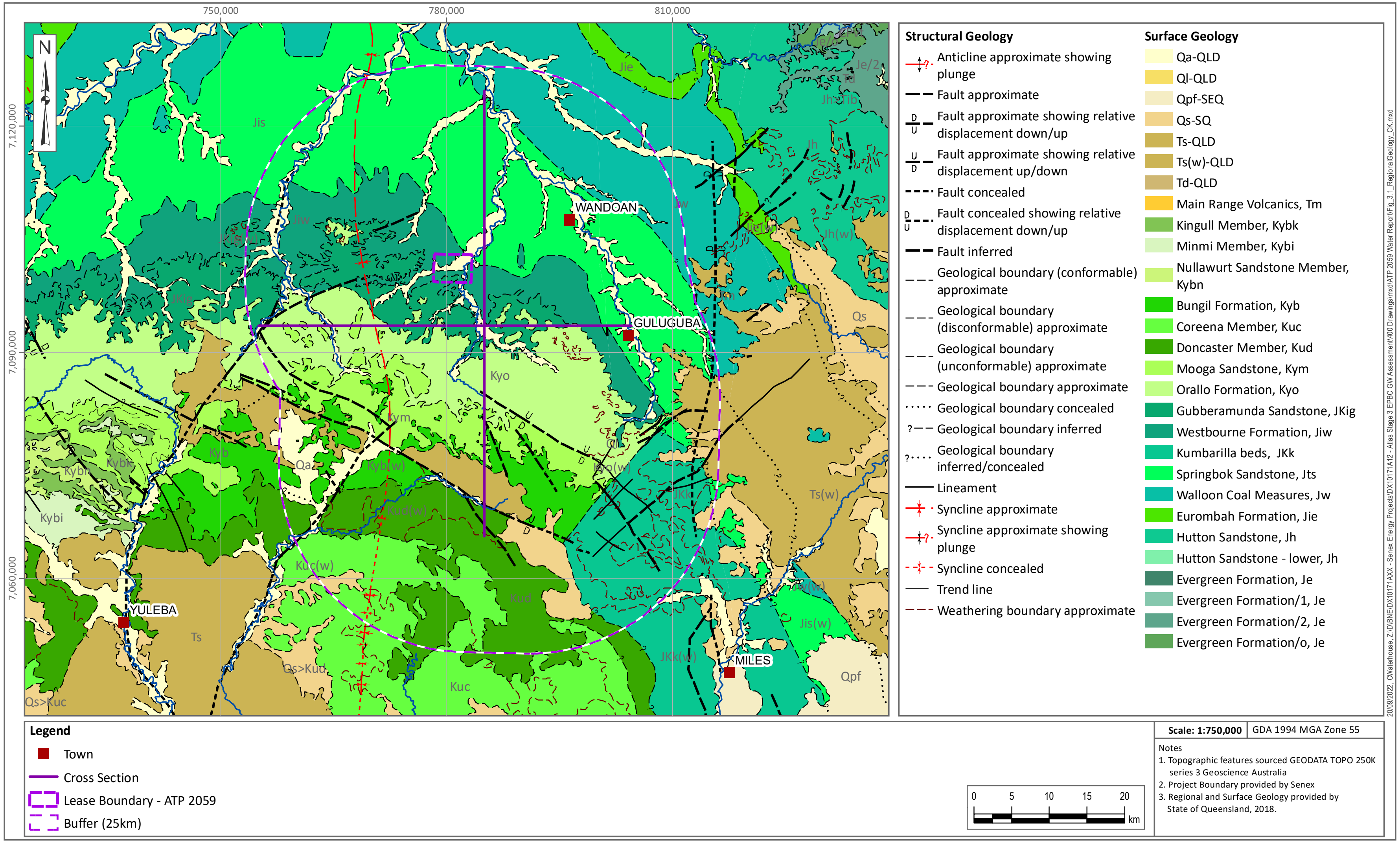


Figure 5.3: Regional Hydrostratigraphy (OGIA 2021a) with Relevant Hydrostratigraphic Units Indicated

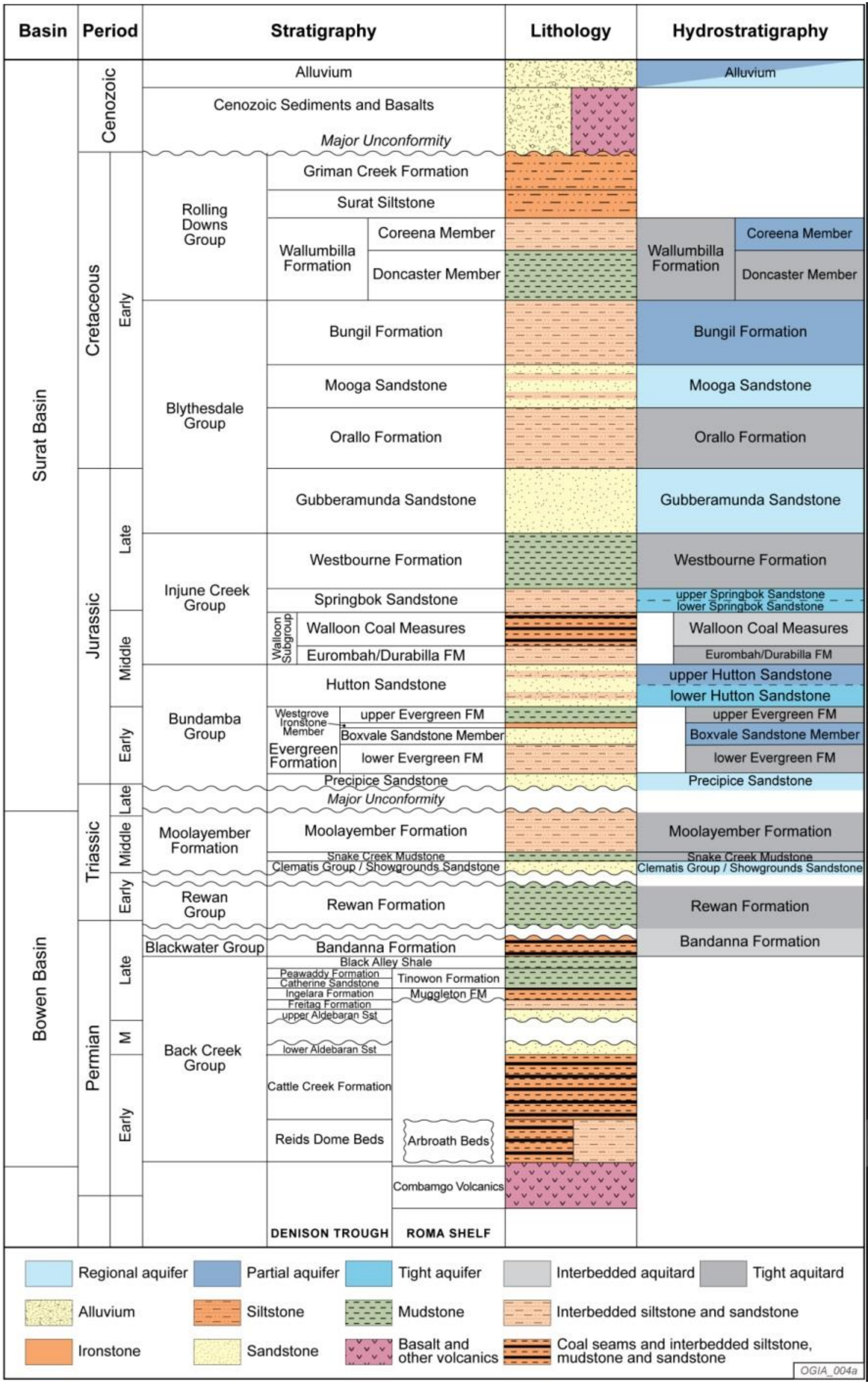
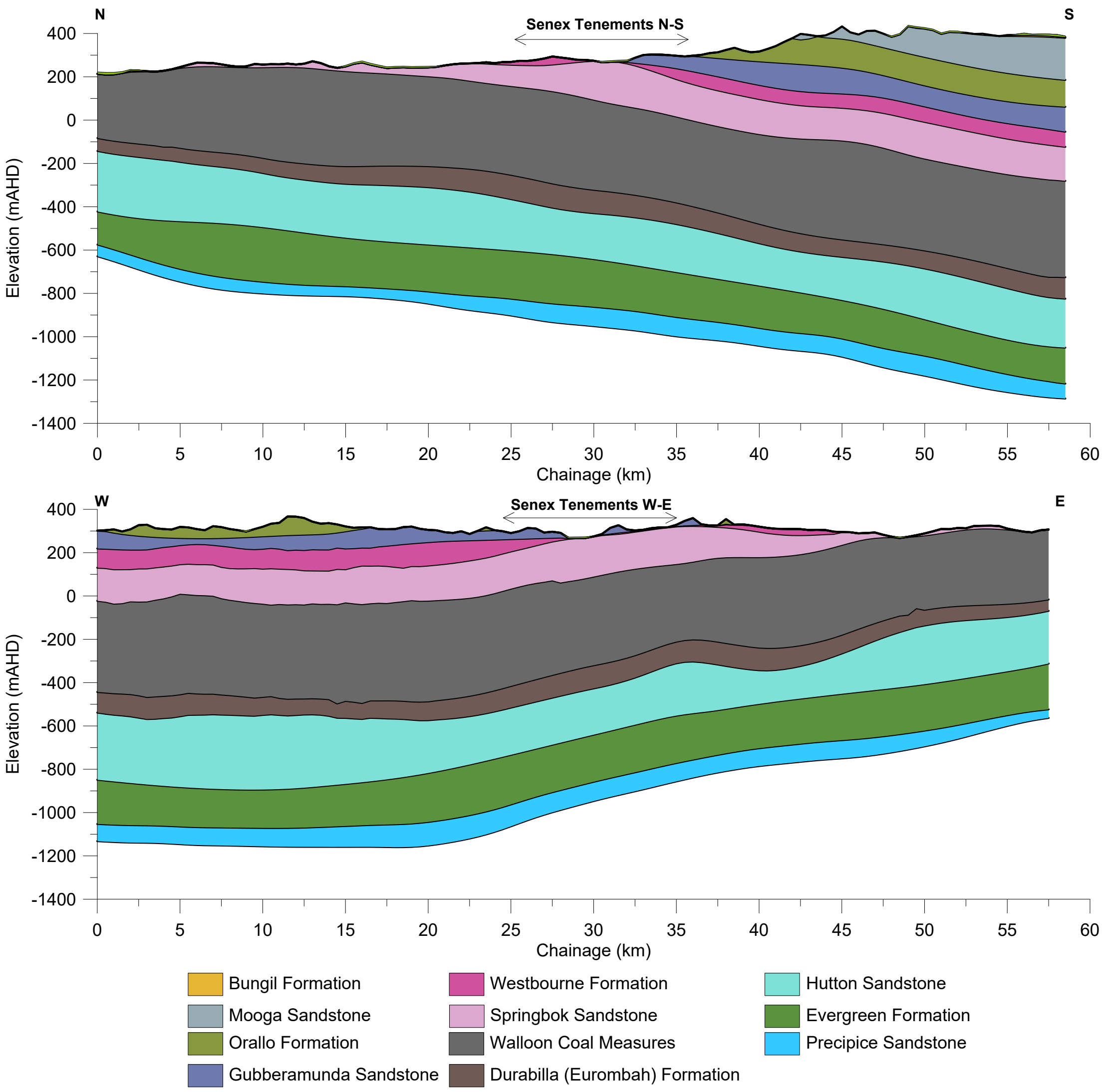


Figure 5.4: Geological Cross Sections (Surat CMA Geological Model (OGIA 2021a))



5.4.1 Groundwater Quality

Table 5.3 presents a summary of the regional groundwater chemistry associated with each hydrostratigraphic unit occurring within the ATP 2059 area from OGIA (2016c). Generally, Total Dissolved Solids (TDS) is used as an indicator of salinity and displays a broad range across the Basin.

Table 5.3: Summary of Regional Groundwater Chemistry for Each Hydrostratigraphic Unit

Hydrostratigraphic Unit	OGIA (2016a) Description
Orallo Formation	Fresh to saline conditions with TDS ranging from 75 to 20,000 mg/L, mean of 1,700 mg/L.
Gubberamunda Sandstone	Fresh to brackish water. Mean TDS of 450 mg/L with a range of between 70 and 7,500 mg/L. Mean TDS ranges between 480 to 1,160 mg/L, depending on location category.
Westbourne Formation	Characterised by fresh to saline groundwater (TDS mean of 1,500 mg/L), ranging from 150 to 19,000 mg/L.

Hydrostratigraphic Unit	OGIA (2016a) Description
Springbok Sandstone	Fresh to brackish water quality, with a mean TDS of 1,000 mg/L (ranging between 200 and 7,000 mg/L).
WCM	Fresh to saline groundwater, TDS ranges from 30 to 18,000 mg/L, with a mean TDS of around 3,000 mg/L.
Hutton Sandstone	TDS ranges from 70 to 16,000 mg/L, with a mean TDS of around 1,600 mg/L, low salinity calcium and magnesium bicarbonate type water in the recharge areas, to a relatively high-salinity sodium-chloride type water in discharge areas.
Evergreen Formation	Low salinity (TDS) and concentrations of sodium and chloride, TDS ranges from 80 to 670 mg/L, with a mean TDS of around 260 mg/L.
Precipice Sandstone	Precipice Sandstone has the freshest groundwater in the Surat CMA, salinity ranges from 50 to 850 mg/L with a mean salinity (TDS) of 193 mg/L.

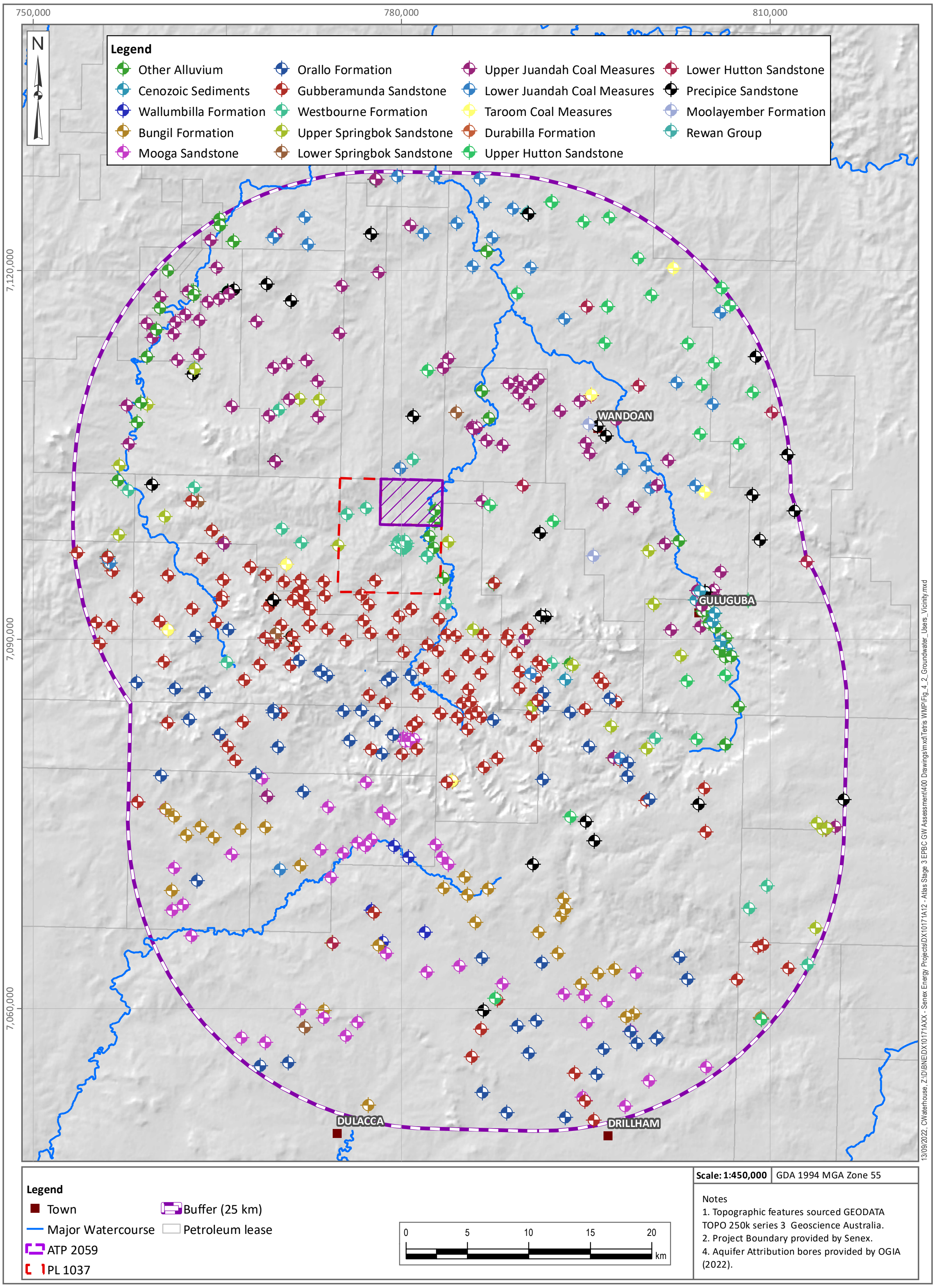
5.4.2 Groundwater Use

Groundwater occurring within the vicinity of ATP 2059 is associated with aquifers of the Surat Basin, which forms part of the GAB. Groundwater is used within the vicinity of the Project site for stock and domestic, agriculture and town water supply purposes.

Groundwater in the GAB is managed within the *Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017* (State of Queensland 2017), under the Water Act 2000.

There are 410 registered third-party groundwater bores that have been identified (within a 25 km radius of ATP 2059) as being used for water supply purposes (OGIA 2022). The location of all existing registered bores is shown on Figure 5.5.

Figure 5.5: Location of Groundwater Users within the Vicinity of ATP 2059



5.4.3 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined by Department of Environment and Energy (DoEE) (2015) as:

'Natural 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 (Richardson et al. 2011). The broad types of GDE are (Eamus et al. 2006):

- Ecosystems dependent on surface expression of groundwater,
- Ecosystems dependent on subsurface presence of groundwater, and
- Subterranean ecosystems.'

Potential surface expression GDEs and subsurface GDEs are mapped by DES (2018) as potentially being present in the vicinity of ATP 2059 (Figure 5.6). These generally correspond with the location of the mapped alluvium associated with Wandoan and Woleebee Creeks within the ATP 2059 area and Horse Creek and Juandah Creek further afield.

There is one watercourse spring within the ATP 2059 area associated with Wandoan and Woleebee Creeks. These watercourse springs are identified as being associated with the alluvium. These are noted as springs of interest but not currently affected or listed as a mitigation site (OGIA 2021b).

Table 5.4: UWIR Watercourse Spring Details

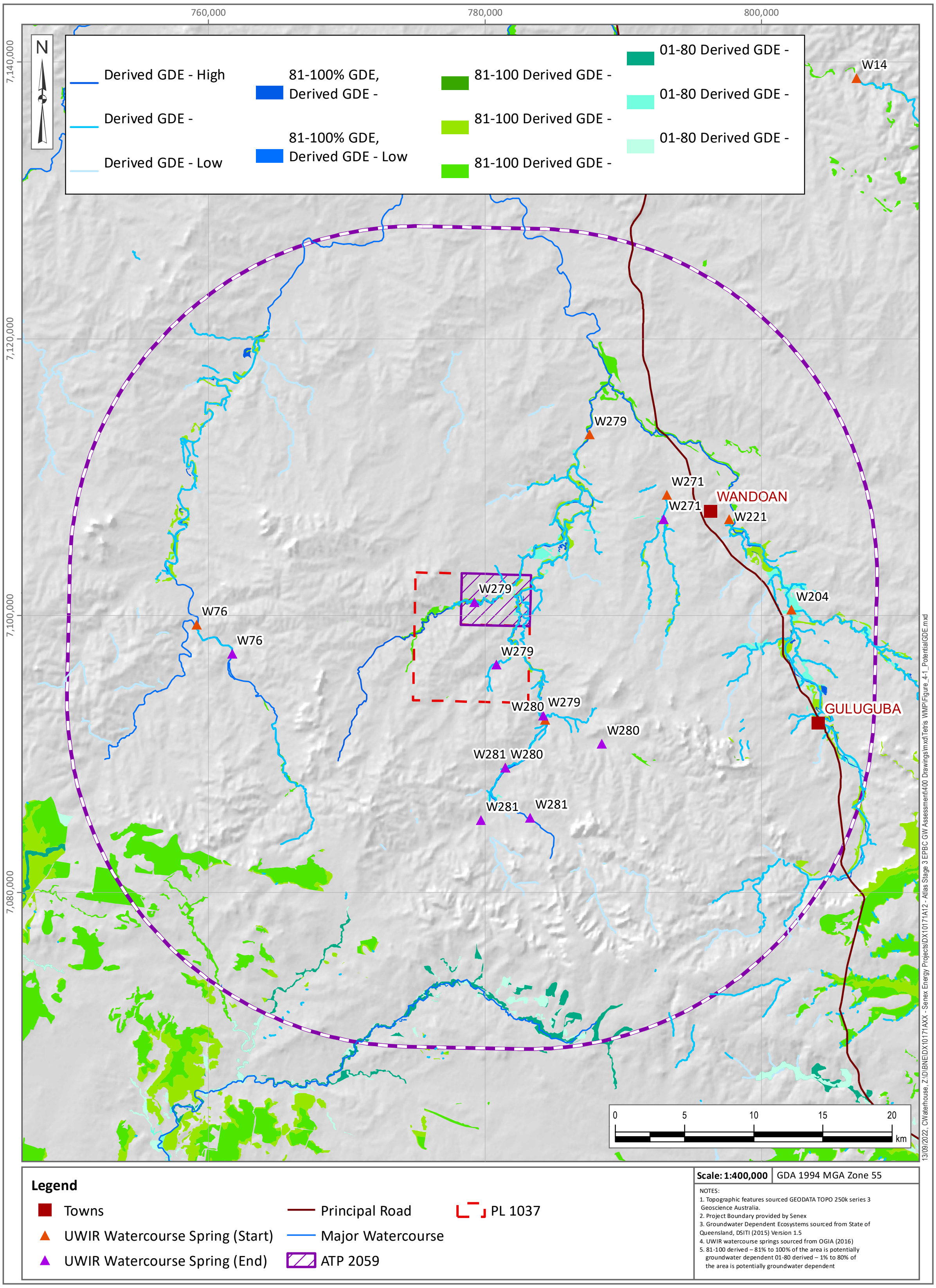
Site Number	Name	Source Aquifer
W279	Woleebee Creek	Allluvium

A report published by OGIA in 2017 re-maps potential gaining streams (or baseflow-fed reaches, watercourse springs) within the Surat CMA (OGIA 2017a). This report identified sections of Woleebee Creek, Horse Creek and Juandah Creek as potentially gaining streams.

Reaches of Woleebee Creek within the ATP 2059 area were assessed during the Senex field verification program in June/July 2018 (KCB 2018). The assessment was conducted during the dry season and no flow was observed within the area surveyed. Pools of water were encountered in the lower reaches of Woleebee Creek which were considered to be rainfall derived surface water, based on their turbid appearance and field water quality (547 µS/cm). The field verification identified that there is unlikely to be significant baseflow provided to this creek, and surface water losses from the creeks to the alluvium are likely. Senex monitoring bores have confirmed the lack of groundwater within the alluvium, even during the wet season. Water in the alluvium is likely to be restricted to locations directly adjacent to creeks. The field verification also concluded that based on the difference between the alluvial groundwater and surface water major ion chemistry signatures, and groundwater chemistry signatures from the Surat Basin units, groundwater within the alluvium is not considered to be sourced from the underlying Surat Basin unit (Westbourne Formation).

Terrestrial GDEs mapped in the vicinity of ATP 2059 (DES 2018) are also considered to source groundwater from the shallow alluvium, rather than the underlying Surat Basin units.

Figure 5.6: Location of UWIR Watercourse Springs and Mapped Potential GDEs



5.5. Environmental Values and Water Quality Objectives

5.5.1 Environmental Values – Water

The EP Act 1994 (State of Queensland 2023) defines an EV as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

As detailed in Section 2, the EP Act*,* the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) was established as subordinate legislation to achieve the object of the Act in relation to Queensland Waters. The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* is achieved by:

- Identifying EVs and management goals for Queensland waters; and
- Stating water quality guidelines and WQOs to enhance or protect the EVs; and
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) provides defined EVs and WQOs for the Dawson River sub-basin under Schedule 1 of the policy (State of Queensland 2013a). EVs for the Upper Dawson are presented in Table 5.5 and includes both the values for surface water and groundwater. The WQ1308 plan (State of Queensland 2013b) that accompanies the policy indicates that the ATP 2059 area is located on the southern tributaries of the Upper Dawson (Taroom area).

Table 5.5: EVs for the Dawson River Sub-Basin waters within the vicinity of ATP 2059 (State of Queensland 2013a)

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Upper Dawson—Taroom area (WQ1308)												
Southern tributaries—developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Groundwater	✓	✓	✓	✓			✓		✓	✓	✓	✓
Undeveloped areas	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

5.5.1.1. Water Quality Objectives (WQOs)

WQOs for groundwater are provided to protect EVs (State of Queensland 2013a). A summary of the WQOs for groundwater in the Upper Dawson are provided below:

- WQOs for aquatic ecosystems applicable to groundwater where groundwater interacts with surface water, the groundwater quality should not compromise identified EVs and WQOs for those waters.
- For drinking water, local WQOs exist which relate to before and after water treatment and are based on a number of guidelines / legislation including the Australian Drinking Water Guidelines (NHMRC 2021).
- WQOs to protect or restore indigenous and non-indigenous cultural heritage will be consistent with relevant policies and plans.
- For irrigation, WQOs exist for metals, pathogens and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on guidelines presented in ANZG (2018).
- For farm use / supply, objectives are as per the guidelines in ANZG (2018).

WQOs for surface water are also provided to protect EVs (State of Queensland 2013a). A summary of the relevant WQOs for surface water in the Upper Dawson are provided below:

- Where the aquatic ecosystem has high ecological value the WQO is to maintain the existing water quality, habitat, biota, flow and riparian areas.
- For the upper Dawson River sub-basin waters and main trunk the aquatic ecosystem is described as moderately disturbed and specific water quality guidelines have been produced (Table 2 of State of Queensland 2013).
- For the protection for human consumption, objectives as per the Australian drinking water guidelines (ADWG, 2011) (NHMRC 2021)and Australia New Zealand Food Standards Code (Commonwealth of Australia 2017).
- For suitability for industrial use there are no WQOs as water quality requirements vary within the industry.
- For secondary contact and visual recreation, objectives as per NHMRC (2021).
- For drinking water, local WQOs exist which relate to before and after water treatment and are based on a number of guidelines / legislation including the ADWG (NHMRC 2021).
- WQOs to protect or restore indigenous and non-indigenous cultural heritage will be consistent with relevant policies and plans.
- For irrigation, WQOs exist for metals, pathogens and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on guidelines presented in ANZG (2018).
- For farm use / supply, objectives are as per the guidelines in ANZG (2018).

- For primary contact recreation objectives as per NHMRC (2021) and for fresh water objectives exist for cynobacteria / algae.

5.5.2 Environmental Values – Other

There are no declared EVs relating to land for ATP 2059. The EVs of the land, relevant to CSG water management within the ATP 2059 area to be protected or enhanced are:

- Integrity of undisturbed land and ecosystems within the ATP 2059 area;
- Integrity of the topsoil as a resource to be used in rehabilitation;
- Stability of disturbed land and ensuring it is non-polluting;
- Integrity of soil stability and structure for erosion protection;
- Suitability of the land for continued agricultural use post-closure;
- Integrity of regional ecosystem communities and the habitat values they provide within the ATP 2059 area;
- Integrity of habitat for endangered, vulnerable, near threatened and special least concern species;
- Integrity of Category B and C ESAs; and
- Integrity of movement corridors provided by riparian zone vegetation.

6. MANAGEMENT, COMPLIANCE AND MONITORING

6.1. Management and Compliance

Senex will implement all produced water and brine management strategies in accordance with the applicable approval conditions and in a manner that ensures protection and maintenance of all relevant EVs.

The EP Act 1994 requires that a site-specific application for a CSG activity must include measurable criteria (termed 'management criteria'), against which the applicant will monitor and assess the effectiveness of the management of all produced water and saline waste associated with the activity. Senex has developed criteria that addresses this requirement (the criteria has been developed following guidance outlined in the DES factsheet ‘CSG water management: Measurable criteria’ (DES 2013)).

The management criteria address:

- The quantity and quality of the water:
  - Used;
  - Treated;
  - Stored; or
  - Disposed of.
- Protection of EVs affected by each relevant CSG activity; and
- The disposal of waste generated from the management of water.

Table 6.1: ATP 2059 Water Management Criteria

Objective	Environmental Values	Tasks	Performance Indicator
No unauthorised disturbance of ESAs due to CSG water management activities	▪ Land ▪ Surface water	Secure disturbance approvals by implementing the 'Environmental Management Plan' (SENEX-ATLAS-EN-PLN-015) and Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development (OPS-ATLS-EN-PLN-001). Finalise infrastructure locations to identify area and location of disturbances. Comply with EA conditions related to disturbance, biodiversity values and ESAs.	Site-specific Ecology Assessment Reports Site-specific Desktop Constraints Reports Compliance with extent of approved disturbance.
No unauthorised releases to the environment from the gathering network	▪ Groundwater ▪ Surface water	Select gathering routes by implementing the 'Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development (OPS-ATLS-EN-PLN-001). Implement the Environmental Management Plan' (SENEX-ATLAS-EN-PLN-015) Develop and implement operation and maintenance plans for gathering networks. Ensure plans includes: ▪ Operational procedures for infrastructure associated with isolation, leakage detection and venting / draining for the CSG production wellhead and gathering network; and ▪ Monitoring procedure for wellhead and gathering network infrastructure. Implement Senex Incident Reporting and Investigation Procedures.	Recorded volume of unauthorised leaks / spills Recorded number of incidents and associated investigations that have been completed.

Objective	Environmental Values	Tasks	Performance Indicator
No unauthorised releases to the environment from non-regulated structures storing CSG water	▪ Groundwater ▪ Surface water	Tanks – construction and maintenance in accordance with EA conditions; install remote monitoring equipment for water levels; and implement leak detection monitoring and site inspections. Ponds – implement site inspection / leak detection monitoring program in accordance with EA requirements (surface water and groundwater seepage). Implement Senex Incident Reporting and Investigation Procedures including but not limited to Atlas Stage 3 Water Monitoring and Management Plan (Senex 2024): ▪ Review monitoring data for identification of trigger exceedances. ▪ Assess and report impact(s), where appropriate, associated with trigger exceedance. ▪ Undertake remedial actions as required.	Recorded volume of unauthorised leaks / spills Recorded detection of unauthorised leaks (i.e., groundwater level rise, groundwater quality changes) Recorded number of incidents and associated investigations.

Objective	Environmental Values	Tasks	Performance Indicator
No unauthorised releases to the environment from regulated structures storing CSG water	▪ Surface water ▪ Groundwater	Design, construct and operate all regulated structures in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016a). Develop and maintain a regulated structure register. Implement a monitoring program to assess structure integrity and groundwater seepage in line with the Atlas Stage 3 Water Monitoring and Management Plan (Senex 2024). Develop and implement a rehabilitation plan for specific regulated structures, including, if required, a brine and salt management plan. Undertake assessment and reporting in accordance with EA requirements including: ▪ Review monitoring data for identification of trigger exceedances. ▪ Assess and report impact(s), where appropriate, associated with trigger exceedance. ▪ Undertake remedial actions as required.	Recorded volume of unauthorised releases from regulated structure Compliance with requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016) Recorded detection of unauthorised leaks (i.e., groundwater level rise, groundwater quality changes) Recorded number of incidents and associated investigations.

Objective	Environmental Values	Tasks	Performance Indicator
Maximise the beneficial use of CSG water	▪ Groundwater ▪ Surface water ▪ Land	Maintain the analytical reservoir model to predict the quantity and quality of water over the duration of ATP 2059 development. Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. Prioritise water use in accordance with the hierarchy defined in the *CSG Water Management Policy* (DEHP 2012). Develop and implement a Water Quality Monitoring Program to confirm if water is fit for beneficial use. Determine requirement for a WTF.	Proportion of untreated CSG water beneficially used. Proportion of treated CSG water beneficially used. Monitoring data which are within the appropriate guidelines for relevant water quality objectives for the designated beneficial use.
Optimise CSG water and brine management	▪ Groundwater ▪ Surface water	Maintain the analytical reservoir model to predict the quantity and quality of water over the duration of ATP 2059 development. Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. Continue to investigate opportunities for CSG water and brine management and prioritise these options in accordance with the *CSG Water Management Policy* (DEHP 2012). Undertake ongoing assessments of optimisation options for CSG water and brine management.	Results from the project water balance identifying the preferred CSG water and brine management options.

6.2. Monitoring

6.2.1 CSG Water and Treated CSG Water Quality Monitoring

Untreated produced water quality will be monitored on a quarterly frequency. The water quality data will be used to:

- Inform the WTF operation; and
- Ensure the water quality is suitable for the designated beneficial use and in accordance water quality objectives in the *End of Waste Code Associated Water (including coal seam gas water)* (DES 2019a), and the *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (DES 2019b), and conditions provided in the 'Streamlined Model Conditions for Petroleum Activities' (DES 2016b) that are aligned with the beneficial use of produced water.

Treated produced water quality will be monitored in accordance with relevant approvals (e.g., End of Waste). The water quality data will be used to:

- Ensure the water quality is suitable for the designated beneficial use or water supply arrangement and in accordance water quality objectives in the End of Waste (EOW) codes (as noted above); and
- Confirm the water treatment method is effectively treating the CSG water.

6.2.2 Water Storage Monitoring

Senex will undertake inspections and monitoring associated with the water storage dams and tanks to assess integrity of the structures and monitor any potential impacts to EVs. The monitoring requirements are provided in Table 6.2. Event-based monitoring will also be undertaken as and when required.

Table 6.2: Water Storage Monitoring Requirements

Activity	Frequency	Reporting
Monitoring and Inspections		
Seepage monitoring program and water quality	Water and quality levels – quarterly.	Any evidence of seepage reported in accordance with EA conditions.
Regulated structure water quality monitoring	Annually	Provided to DES in accordance with relevant EA conditions and Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES 2016a).
Dam embankments and spillways inspection	Annually	Any evidence of deterioration reported in accordance with relevant EA conditions.
Dam compliance inspection	Annual inspection checking dam status, defects, and unsafe conditions, with a comprehensive inspection every five years. The comprehensive	Inspection report submitted to DES in accordance with relevant EA conditions.

Activity	Frequency	Reporting
	inspection covers the annual inspection requirements and a full operational check of all equipment, surveillance data, function check and maintenance inspection.	
Documentation		
Regulated structure register	Completed as dams are constructed and kept up to date at all times	Regulated structure register

6.2.3 Groundwater Monitoring

6.2.3.1. Seepage Monitoring Program (Shallow Groundwater)

Installation and monitoring of shallow groundwater bores surrounding water storage dams will be undertaken to monitor for dam seepage in accordance with the relevant EA conditions, and *'Streamlined Model Conditions for Petroleum Activities'* (DES 2016b). This will be conducted in conjunction with monitoring the water quality within the water storage pond. The seepage monitoring program will:

- Be undertaken by a suitably qualified person, and in accordance with 'Groundwater Sampling and Analysis – A Field Guide' (Sundaram et al. 2009) and the 'Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018);
- Be undertaken on a quarterly basis;
- Ensure all water quality samples are analysed / tested at a laboratory with NATA accreditation;
- Identify water quality associated with the water stored within the dam;
- Identify the background groundwater quality in the vicinity of the dam as a reference site;
- Provide information to develop trigger levels and detection limits associated with dam seepage; and
- Be documented and updated should new containment facilities be constructed.

There are ten existing shallow groundwater monitoring bores present surrounding the water storage dam on PL 1037 monitoring the underlying Westbourne Formation. Monitoring programs will also be developed for other project activities, such as additional water storages, where required.

6.2.3.2. Regional (Deep) Groundwater Monitoring

Regional groundwater monitoring in relation to CSG water production is undertaken through the Surat CMA UWIR Water Management Strategy, however this is outside the scope of this CWMP in relation to the management of CSG water. The Water Monitoring and Management Plan (SENEX-ATLS-EN-PLN-017) outlines the groundwater monitoring Senex undertake on PL 1037, ATP 2059, PL 445 and PL 209.

6.2.4 Land and Soils Monitoring

Senex will undertake land and soil monitoring where CSG water management activities have the potential to significantly impact on EVs.

Senex will undertake Erosion and Sediment Control (ESC) on all significantly disturbed land with reasonable and practicable measures implemented depending on the relative risk of the works and the sensitivity of the receiving environment. The aim is to prevent soil loss and impacts to watercourses and wetlands resulting from events that cause sediment release.

To minimise soil erosion, mass movement and gully erosion, the following specific measures will be implemented:

- Ensure stormwater passes through the site in a controlled manner and at non-erosive flow velocities. Divert clean water from the work site where practical.
- Disturbed soil surfaces are stabilised with the cover targets and within the number of days outlined in Table 4.4.7 of the IECA Best Practice Erosion and Sediment Control guidelines.
- Inspect worksites that have not reached stabilisation cover targets, before expected rainfall events, and after rain events and undertake maintenance where required as per the Erosion and Sediment Control Plan.

In addition, the following monitoring and reporting will be undertaken:

- Construction phase monitoring of soil erosion and sediment controls will be undertaken as required by project specific construction Erosion and Sediment Control Plans.
- ESC monitoring during the operational phase of the Project will comprise monitoring of previously installed ESC controls and established groundcover to ensure that controls remain functional, and groundcover is not reduced.
- Records of all erosion and sediment control monitoring will be maintained by the Senex staff.
- All monitoring and reporting will be in accordance with Environmental Authority conditions.

Where produced water has been applied to land (e.g. dust suppression), and there has been adverse impacts identified such as surface crusting, scalding or poor vegetation growth, further assessment will be undertaken. Assessment will typically involve soil sampling and laboratory analysis of pH, electrical conductivity, chloride, sodicity (i.e. soil cations) and Emersons aggregate stability test. Depending on the findings, soil amelioration may be undertaken to address the issue. Amelioration and amendments will include addition of gypsum for sodicity, organic matter such as manures for poor structure and fertility, elemental sulfur for highly alkaline soils or fertiliser for low nutrients.

6.3. Response Plans and Corrective Actions

Senex is committed to maintaining compliance with management criteria. However, should any incidents or non-compliance of the management criteria occur, Senex will investigate and report on the non-compliance. Findings and recommendations will be adopted to assist with future compliance and enable continual improvement in water management and environmental performance.

Response plans in relation to produced water and brine storages are presented below.

6.3.1 Water Storage Response Plan

Performance Investigations are to be considered based on findings from regulated structure inspections. Performance Investigations focus on assessment of Performance Triggers or Emergency Triggers and can provide data to support the decision to undertake routine maintenance, undertake defect remediation and/or initiate the Emergency Response Plan. A typical Performance Investigation may include:

- Embankment Survey to assess embankment movement.
- Liner Integrity Surveys to identify damage and holes in a liner.
- Liner Degradation Testing to assess degradation of material properties of a liner.
- Geophysical Surveys to assess potential seepage from a regulated structure storage area.
- Groundwater and Soil Chemistry Assessment to assess potential seepage from a regulated structure storage area.

Conditions that are representative of an imminent or actual regulated structure emergency event and that require initiation of the Emergency Response Plan are listed in Table 6-3.

Table 6-3: Emergency Triggers

Emergency Event	Emergency Trigger
Significant loss of regulated structure liner integrity	Sudden or unexplained decrease in water level in the water storage(identified through monitoring of automatic water level sensor data). Monitoring data indicates leakage rates which exceed trigger leakage rates. Monitoring data indicates unusual water level in leak detection sumps and/or shallow groundwater bores. Surveillance inspection identifies evidence of seepage through the dam embankment or tank wall or foundations (e.g. springs, seeps or boggy areas).
Imminent or actual regulated structure overtopping (i.e. spillway discharge)	Water level exceeds mandatory reporting level (MRL) and Bureau of Meteorology weather forecasts indicate heavy rainfall. Regulated structure releasing Water through the spillway.
Imminent or actual regulated structure failure (breach)	Surveillance inspection identifies dam embankment or tank wall failure indicators. Visible flow and particles moving at dam embankment crack or hole.

Typical emergency procedures that can be implemented during a regulated structure emergency event to minimise the economic, environmental, and public safety risks are listed in **Error! Reference source not found.**.

Table 6-4: Emergency Response Procedures for Surface Water Storage

Emergency Event	Emergency Response Procedure	Responsibility
Significant loss of regulated structure liner integrity	All inflows to the regulated structure shall be isolated/redirected.	Senex operations
	Reduce Produced Water level in the regulated structure (if possible).	Senex operations
	Undertake Special Inspection (refer to Section **Error! Reference source not found.**).	Designer
	Specify liner system remediation requirements.	Designer
	Undertake liner system remediation as required.	Senex Maintenance Team or Civil contractor
	Perform investigation of environmental harm.	Environmental Advisor
	Provide report to relevant local authority on environmental harm, if required.	Environmental Advisor
	Close-out emergency trigger response.	Emergency Response Coordinator
Imminent or actual dam overtopping	All inflows to the dam/tank shall be isolated/redirected.	Senex operations
	Reduce Produced Water level in the regulated structure (if possible).	Senex operations
	Undertake Special Inspection[1]	Designer
	Perform investigation of environmental harm.	Environmental Advisor
	Provide report to relevant local authority on environmental harm, if required.	Environmental Advisor
	Undertake design of permanent remediation measures.	Designer
	Construct permanent remediation measures.	Senex Maintenance Team or Civil contractor
	Close-out emergency trigger response.	Emergency Response Coordinator
Imminent or actual regulated structure failure (breach)	Notify downstream landholders and perform evacuations if required.	Emergency Response Coordinator and SES
	All inflows to the regulated structure shall be isolated/redirected.	Senex operations
	Reduce Produced Water level in the regulated structure (if possible).	Senex operations
	Undertake Special Inspection[1]	Designer
	Identify temporary stabilization measures.	Designer
	Construct temporary stabilization measures.	Civil contractor
	Perform investigation of environmental harm.	Environmental Advisor
	Provide report to EHP on environmental harm.	Environmental Advisor
	Undertake design of regulated structure repair works.	Designer
	Undertake dam/tank repair works.	Senex Maintenance Team or Civil contractor
	Close-out Emergency Response Plan	Emergency Response Coordinator

6.3.2 Groundwater Monitoring Response Plan

The Water Monitoring and Management Plan (WMMP) outlines the groundwater monitoring response plan, providing a response framework to an observed change in groundwater quality and levels (data) which may be attributed to CSG produced water.

Groundwater quality triggers for seepage monitoring bores have been developed using the guidelines developed by the Department of Environment, Science, and Innovation (DESI) (DES 2021).

Limit (and trigger) values were derived from default guidelines or site-specific data to derive site-specific groundwater guidelines. In general, the first limit (also referred to as Value A) is the 80th percentile of site-specific groundwater data. Limit A is applied to five consecutive test samples. The second limit is the 95th percentile (also referred to as Value B) of site-specific groundwater data and is applied to three consecutive test samples. Where the site-specific 80th percentile value is not substantially different from default water quality guidelines, or if site-specific values cannot be determined due to insufficient data, the water quality guideline or objective has been adopted

The adopted compliance approach, which is aligned with the Queensland Guidelines (DES 2021), relevant to the seepage bores include:

- Five (5) consecutive values above the Value A (80th percentile) level trigger.
- Any three (3) consecutive exceedances above the Value B (5th percentile) level trigger.

Exceedance of these values will trigger the seepage emergency response procedure as described in Section 6.3.1 above.

6.4. Reporting

6.4.1 Monitoring Results

An annual review of the monitoring undertaken in accordance with the CWMP and EA conditions will be completed.

Water quality results will be reviewed following sampling events against the relevant water quality guidelines and EA conditions and, where required, reported to the appropriate administering authority.

6.4.2 Reviews

A review and update of the CWMP will be periodically undertaken to capture changes to the project description that influences the management of CSG water and / or optimisation of the CSG water and brine management.

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