Westside Corporation Pty Limited

DOCUMENT TYPE **MANAGEMENT PLAN**

DOCUMENT TITLE # Produced Water Management Plan - Petroleum Lease 94

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1. Introduction

This Produced Water Management Plan (PWMP / the Plan) provides a description of the PL 94 development (outlined in section 1.1) (the Project), and details on produced water quantities, storage, treatment and management.

1.1 Project Overview

The Project involves the construction, operation, rehabilitation of the following:

- 600 development wells (the PWMP covers Stage 1 and Stage 2 developments);
- Ancillary linear infrastructure including gas and water infrastructure, access tracks, power lines and communication lines;
- Gas compression facilities as required;
- Water management infrastructure; and
- Other ancillary activities and facilities to support gas field development.

Water will be produced from the Baralaba Coal Seams associated with gas production in accordance with this PWMP. Gas and water will be produced over the approximate 25-year life of the Project.

1.1.1 Location

The Project is located in the Moura-Theodore district of the Banana Shire, Queensland. The area consists of the fields Dawson River, Nipan, Moura, Moura Central and Mungi. The field development occurs as 'pods' within an area extending approximately 36km north to south and up to 8km east to west. Moura is located within the PL94 tenure on the Western boundary and located 3.5km South of the northern PL94 boundary and 33km North of the Southern boundary. The development lies between the western boundary of various Mining Lease (MLs) held by Anglo Coal and the Dawson River. Access to the well fields utilises public roads and associated secondary roads which provide access to local properties. Figure 1 shows the Project location.

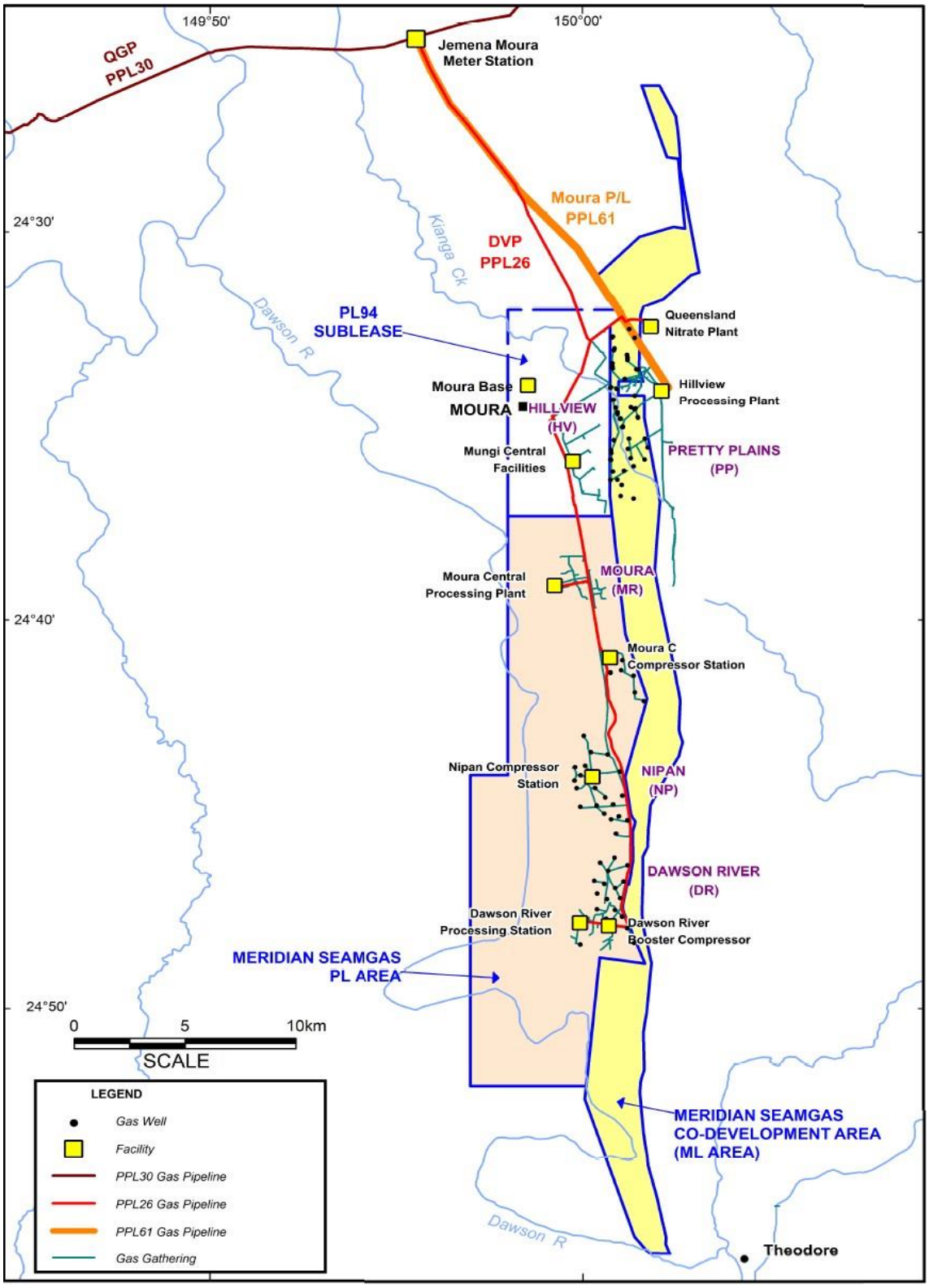


Figure 1 – Project Location

1.2 Objective of the Produced Water Management Plan

This Plan covers all activities associated with managing produced water once it is at surface. The plan outlines how produced water will be managed in accordance with the regulatory framework. In addition, the Plan sets the objectives to maximise the beneficial use of the produced water and identify any potential impacts that may require mitigating. Other objectives of the Plan include:

- Provide a document that sets out the Westside water management philosophy and approach;
- Demonstrate alignment with regulatory policies;
- Document the risks and mitigation measures in relation to produced water management;
- Provide clear information on the base data and management of the produced water including:
    - Source water quantity and quality;
    - Demand location and volume;
    - Available technologies;
    - Environmental receptors and constraints;
    - Address potential community concerns and regulatory requirements.

The Plan considers the management of produced water over the life of the Project. This Plan will be regularly reviewed to adapt to any changes in development or take advantage of advances in the management of produced water in the future.

2. Legislative Framework

This Plan has been prepared in accordance with the key policies and legislation for managing produced water at PL 94. Table 1 provides a summary of the policies and legislation considered in the development of the Plan.

Table 1– Summary of Legislation, Guidelines and Approval Conditions for CSG water Management

Legislation, policy or guideline
Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)
Environmental Protection Act 1994 (Qld) (EP Act)
Environmental Protection (Water and Wetland Biodiversity) Policy 2019
Coal Seam Gas Water Management Policy (EHP 2012)
Petroleum Act 1923 (Qld)
Petroleum and Gas (Production and Safety) Act 2004 (Qld) (P&G Act)
*Waste Reduction and Recycling Act 2011 (*Qld) (WRR Act)
End of Waste Guideline (Qld) (DES, 2016) • *End of Waste Code – Associated Water* • *End of Waste Code – Associated Water for Irrigation*
Water Act 2000 (Qld) (Water Act)
National Water Quality Management Strategy (NWQMS) (AG, 2018)
Australian and New Zealand Guidelines for Fresh and Marine Quality (ANZEC, 2000)
Queensland Water Quality Guidelines (QWQG) (EHP, 2013)
Code of Practice: For the construction and abandonment of petroleum wells and associated bores in Queensland (DNRME, 2019)
Australian Standard AS2885 – Pipelines Gas and Liquid Petroleum
Australian Pipelines and Gas Association Ltd (APGA) Code of Environmental Practice (2017)

3. Water Resource

3.1.1 Produced Water Production

The by-product of gas production of a CSG field is produced water. Gas and water are held in the coal matrix by hydrostatic pressure. To release the gas molecules from the coal matrix the coals need to be de-pressured. Depressurisation is done by pumping the water out of the coal seam, which then allows the gas to desorb from the coals and flow to the surface.

Groundwater is extracted until hydrostatic pressure is reduced to achieve consistent gas flow. Generally water extraction in a well has a steep production curve to a peak, where gas flows are achieved and then the water production sharply declines.

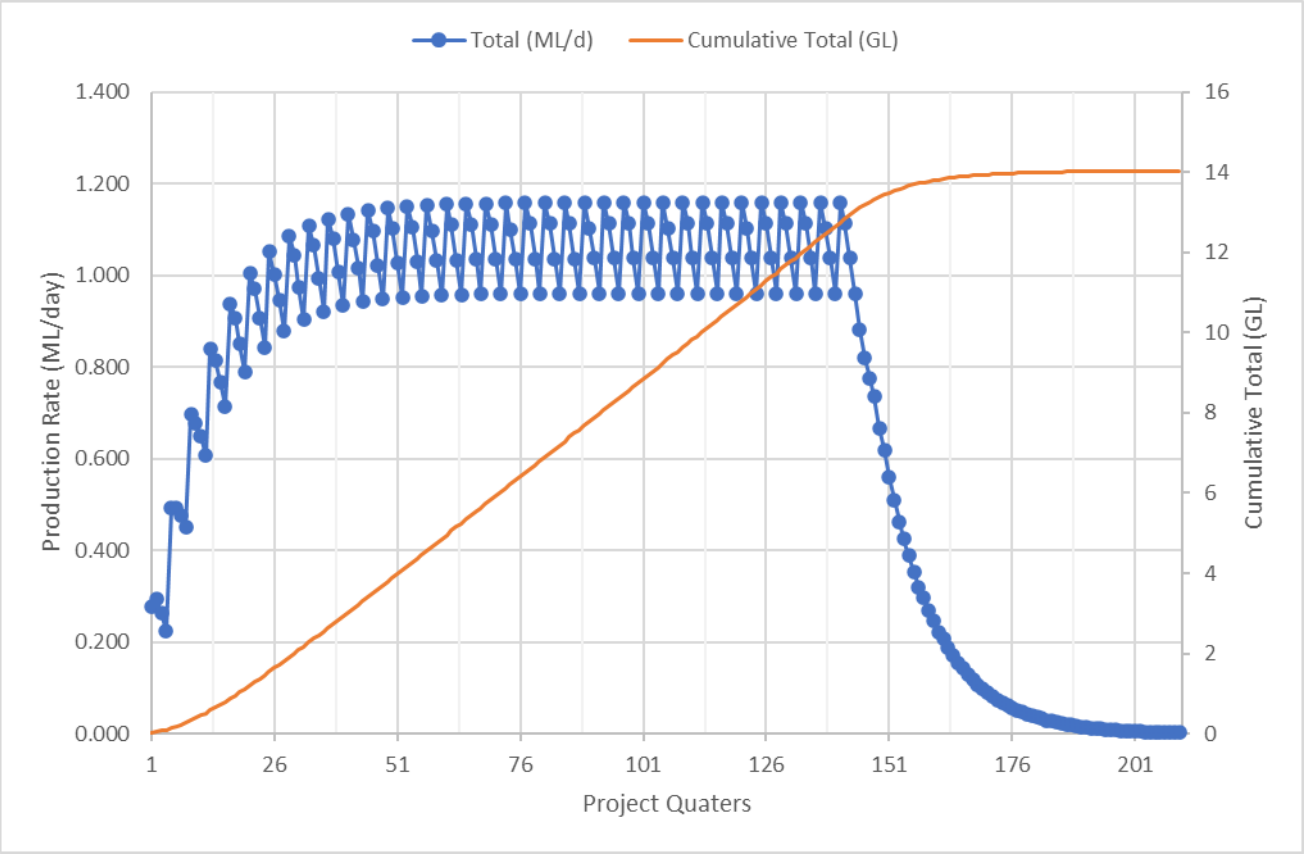
The produced water production characteristics from a gas field can be forecast using established techniques and field data. The forecast (often termed the water production curve) provides the rate and total volume of produced water extracted over a gas field area.

The PL94 field is a relatively mature gas field and the produced water data acquired during the operation of PL94 has been used to predict the volumes of produced water that will be extracted over the life of the Project.

The current water production rate is ~ 480 m3/d across the PL94 field. This baseline flow will be consistent through 2022 until drilling operations increase after a reduction in 2020. **Figure 2** provides the water profile curve for the life of the Project. The peak water production is predicted to occur in Year 17, with a peak rate of ~2.6 ML/day. The estimated cumulative water production volume is also presented in **Figure 2**. The total groundwater that will be abstracted for the duration of the Project is estimated at ~32.4 GL. The water profile of each well peaks quickly and drop offs quickly making the profile flat ranging between 2.2 and 2.6ML per year for the majority of the Project.

> The water profile will be updated as the Project progresses to ensure the water management scenarios are fit for purpose.

Figure 2 – Produced water production for PL94



3.1.2 Produced Water Quality

The quality of produced water from the proposed wells will be a function of the underlying formations. Groundwater quality of the Baralaba Coal Measures collected over a number of years shows there is a wide range of water quality within the coal seams. It also shows water quality to be a Na/Mg - Cl dominated saline water type. Accordingly, produced water from these coal measures is high in salinity (see **Table 2**).

Table 2 - Groundwater Quality in the Baralaba Coal Measures[1]

Parameter	Unit	Range
pH	Range	7.3 – 8.8
EC	µS/cm	5010 – 15 400
TDS	mg/L	2000 – 14 000
SO_4	mg/L	<1 – 690

[1] Data collected for the PL94 UWIR dated 11 June 2019 and UWIR annual reports.

Parameter	Unit	Range
Ca	mg/L	6.7 – 505
Cl	mg/L	1743 – 6231
Mg	mg/L	1.5 – 216
Na	mg/L	1163 – 4400
K	mg/L	9.5 – 150
CO3	mg/L	1.4 – 165
HCO3	mg/L	771 – 3258
Total alkalinity	mg/L	580 – 980

3.2 Current Produced Water Management

The current water management program at Westside has a mix of beneficial use applications, storage and water treatment. The current produced water management program is suitable for the volumes of water that are currently produced. Figure 3 provides an overview of the water management infrastructure for the Moura field as well as tank capacity and indicative flows.

Figure 4 provides an overview of the water management infrastructure for the Dawson River and Nipan fields as well as tank capacity. The current water management program relies on tank storage and beneficial uses for the treated, raw and retentate water. The end use of the water has several scenarios:

- Water produced in the Moura field is aggregated in the Above Ground Storage Tanks (AGST) and used for beneficial uses.
- Water from the Dawson River and Nipan Fields is aggregated at the Dawson River AGST and treated at the Dawson water treatment plant. The permeate is stored in tanks for beneficial use. The retentate water is returned to the AGST. Water produced in excess of the plant capacity is beneficially used.

The current beneficial uses include:

- Stock water for local landholders (Westside currently has one beneficial use agreement with local a local landholder)
- drilling activities;
- dust suppression; and
- construction activities.

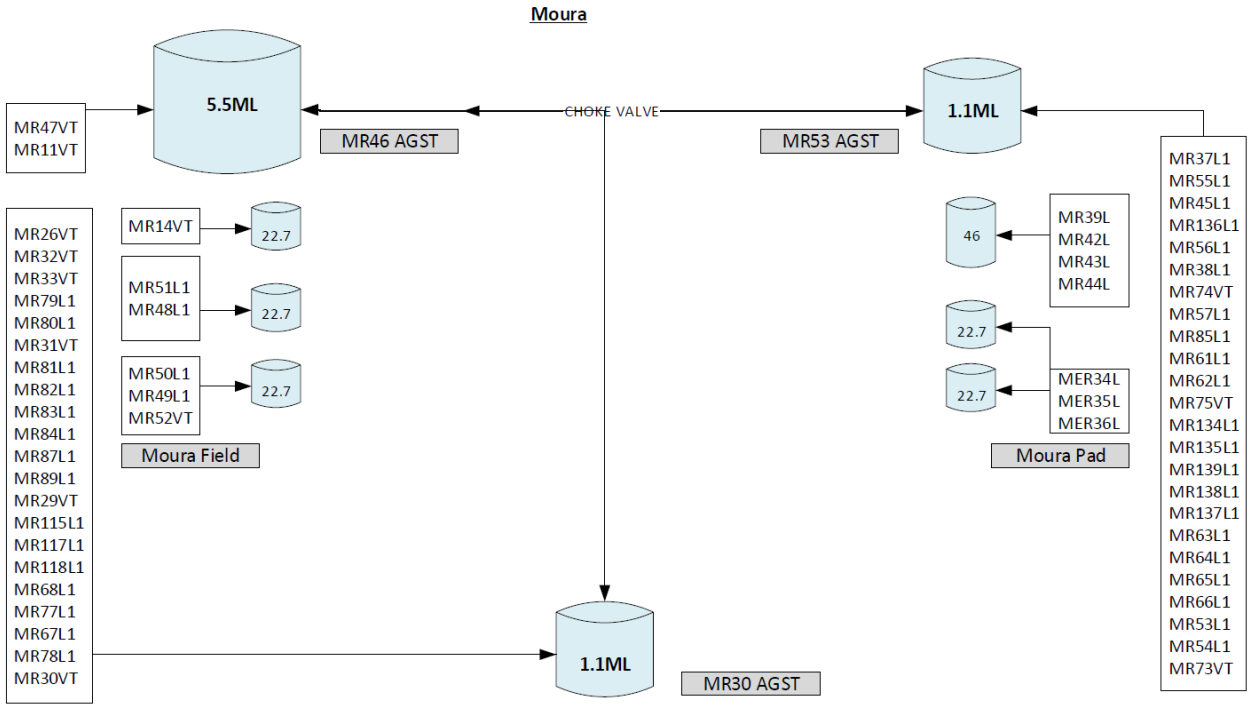


Figure 3– Moura Field Water Network

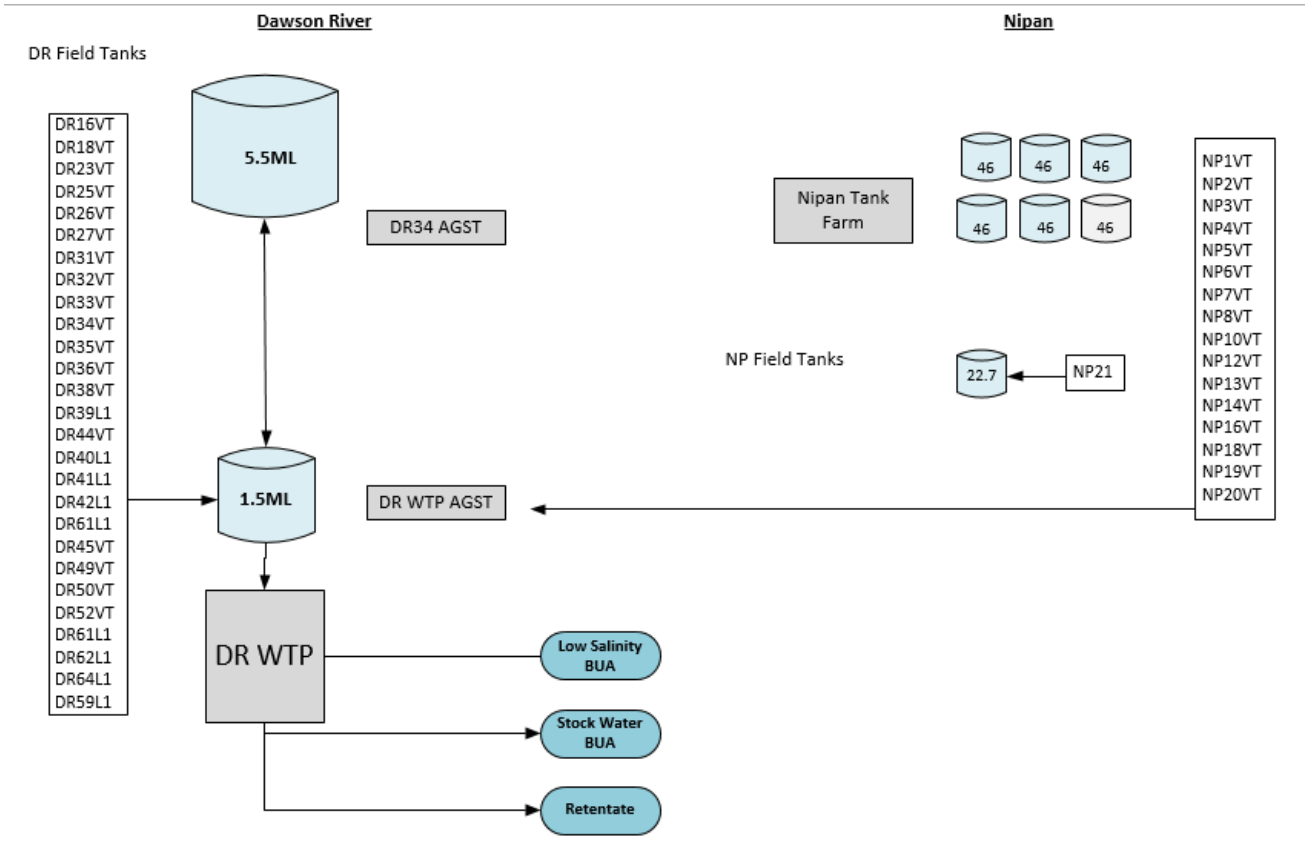


Figure 4– Dawson River and Nipan Field Water Network

3.2.1 Produced Water Management – Water Treatment

The existing Dawson Water Treatment Plant (WTP) receives water from the Dawson and Nipan sections of the gas fields. Currently, approximately 250kL per day is received at the plant. Figure 5 provides an overview of the Dawson River WTP.

The water is received in a 1.5 ML AGST. The water in this tank is dosed with a flocculation and leaves the tank via a clarifying weir. The water is then ozonated and pumped through a hydrocyclone, disc filter, sand filter and bag filter. The filtered water is stored in a balance tank. From the balance tank the water can be pumped either through an ion exchange media (IEX) filtration chain or a reverse osmosis (RO) system. There is additional filtration (sand and granulated activated carbon filter, bag filter and cartridge filters) prior to the water being pumped through the RO membranes.

The Dawson WTP produces 3 types of treated water: low salinity (1,500 µS/cm EC limit), stock BUA water (5,000 mg/L TDS limit) and retentate water (ranges from 10,000 - 20,000 uS/cm). The low salinity is mainly RO water with a shandy of ion exchange (IEX) resin treated water to re-ionise. The stock BUA water is mostly IEX filtered water with a small RO water shandy to reduce salinity. The retentate water is the brine from the

RO units and backwash from the hydrocyclone and sand filters. Water quality tests are performed and recorded daily with portable water quality meters. Laboratory tests are conducted monthly.

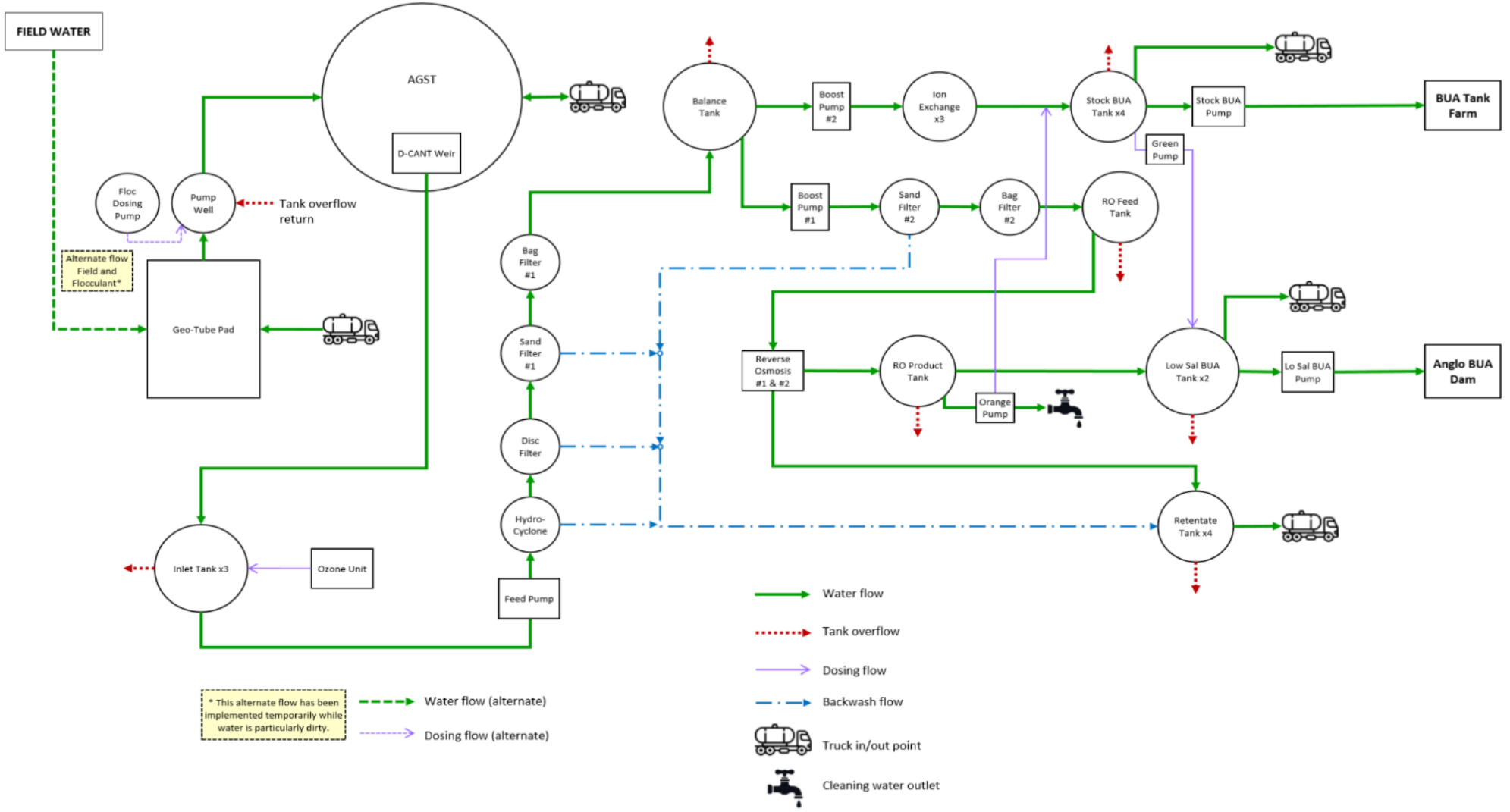


Figure 5 – WTP Overview

3.2.2 Produced Water Management – Raw Water Beneficial Use

Westside maximises the beneficial use of raw produced water as the priority. The water is beneficially used for stock water, construction, drilling and completions and dust suppression.

Westside has a number of wells in the Dawson River Field that meet the water quality requirements under the EOWC for Associated Water to supply produced water for stock water. Westside's priority is to supply all produced water that meets the stock water quality parameters to landowners.

Westside uses produced water in its drilling and completions processes and in construction when needed for compaction.

The Moura-Theodore area can become very dry and dust can be generated by Westside's activities. Westside is proactive in ensuring dust is minimised and does not impact on the community's amenities. Below are the Environmental Authority (EA) conditions for PL 94 that specify how produced water can be used:

> *(B7) Under PL94 EA produced water may be re-used in:*
> *a) drilling and well hole activities; or*
> *b) stimulation activities.*
>
> *(B8) Produced water may be used for dust suppression provided the following criteria are met:*
> *a) the amount applied does not exceed the amount required to effectively suppress dust; and*
> *b) the application:*
> *i. does not cause on-site ponding or runoff*
> *ii. is not applied outside the area being suppressed*
> *iii. does not harm vegetation surrounding the area being dust suppressed; and*
> *iv. does not cause visible salting.*
>
> *(B9) Produced water may be used for construction purposes provided the use:*
> *a) does not result in negative impacts on the composition and structure of soil or subsoils*
> *b) is not directly or indirectly released to waters*
> *c) does not result in runoff from the construction site; and*
> *d) does not harm vegetation surrounding the construction site.*

3.2.3 Produced Water Management – Treated Water Beneficial Use

The Dawson WTP produces two treatment streams, the first is stock water quality water and the second is low salinity water. The stock water quality meets the ANZECC water quality guidelines as per the requirements under the End of Waste Codes – Associated Water. The low salinity water meets the requirements for irrigation water under the End of Waste Code – Associated Water for Irrigation.

Westside has a BUA for stock water in place to take the low salinity water and the stock water quality water from the permeate produced from the water treatment plant. The stock water quality water is delivered via a pipeline to a set of water tanks on the landowner's property.

Water quality tests are completed daily at the water treatment facility to ensure that the water supplied meets the specification requirements of the End of Waste Code – Associated Water (ANZECC water quality guidelines for stock water). Water quality results are uploaded on the operational dashboard Kanepi for review by the Operations team.

3.2.4 Produced Water Management – Retentate/Brine Management

Due to the limited processing and low recovery of the water treatment facility to meet the stock water quality guidelines, the retentate produced is approximately 5,000 - 10,000 uS/cm. The retentate is classified as CSG water as it meets the definition of CSG water, which has a EC of less than 12,000 uS/cm. The water treatment facility produces approximately 70 m3/d of retentate.

The retentate is currently stored in a tank where it can be loaded out for:

- dust suppression, where it meets the definition of CSG water,
- if it does not meet the definition of CSG water it is blended to meet CSG water quality,
- Recirculated through the system,
- or loaded out for disposal.

4. Future Produced Water Management Strategy

Westside has plans to fully develop the PL94 tenure, which will require a water management strategy to support the increased development. The *Coal Seam Gas Water Management Policy 2012* (EHP, 2012) contemplates that developments change over time including the volumes produced from each well, and therefore the solutions will need to be adaptive. To achieve the outcomes of the regulatory framework and the best end use for the water, this Plan considers a number of viable water management options.

This Plan follows the prioritisation hierarchy documented in the *Coal Seam Gas Water Management Policy*:

- Priority 1 – Beneficial Use
  Produced water is used for a purpose that is beneficial to one or more of the following: the environment, existing or new water users and existing or new water dependant industries
- Priority 2 – Disposal
  After feasible beneficial use options have been considered, treating and disposing produced water in a way that firstly avoids, and then minimises and mitigates impacts on environmental values.

4.1 Water Management Infrastructure

With the existing development on PL 94 there is a backbone of water infrastructure in place to be developed upon and expanded. The future development will require additional capacity, transport, storage and

management of the incremental increases of produced water over time. The overarching design of the produced water management is pictured in Figure 6.

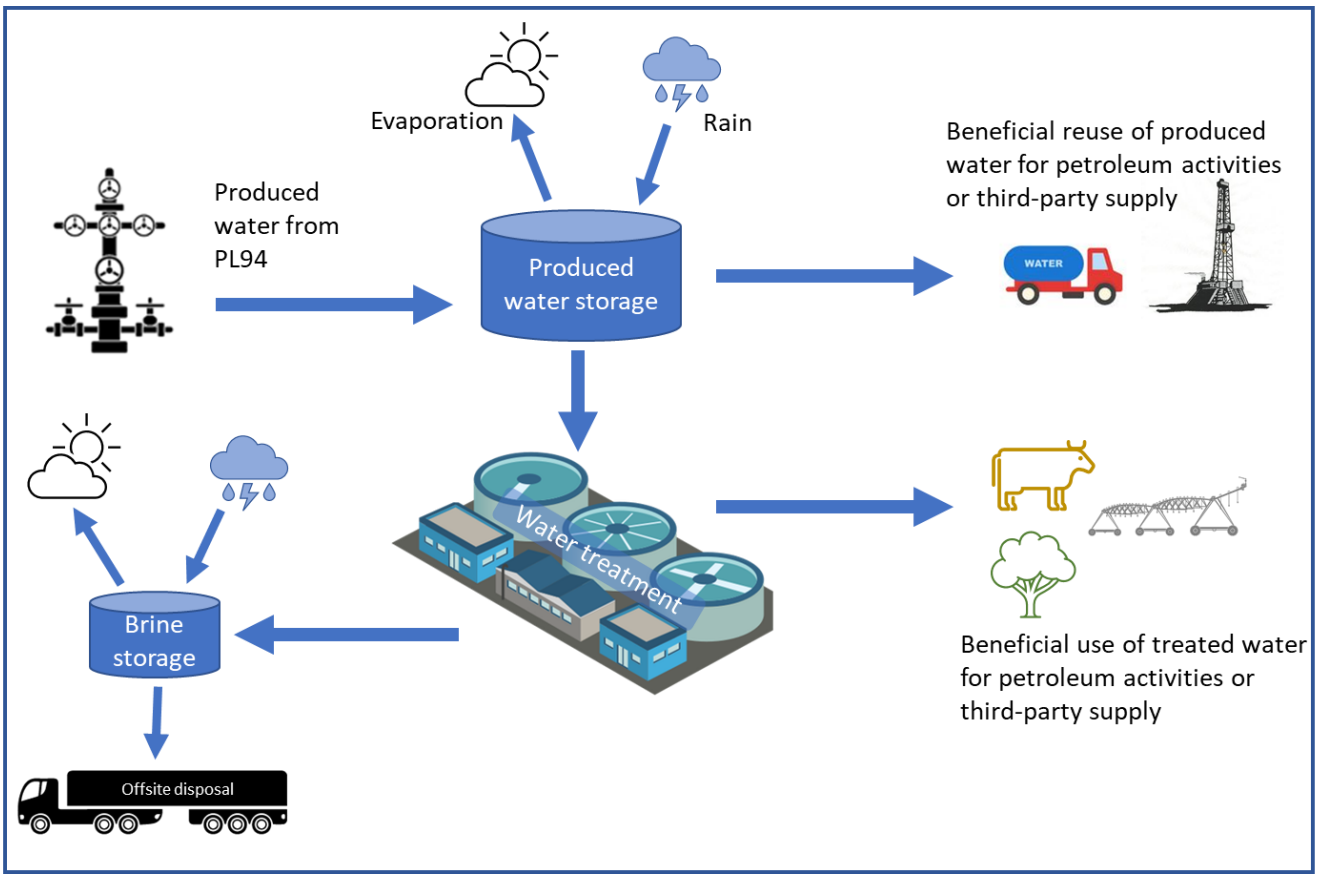


Figure 6 – Overview of the Proposed Produced Water Management

The current produced water management infrastructure is depicted in Figure 3 for the Moura field and Figure 4 for the Dawson River and Nipan fields. The future water management will include an increase in:

- produced water storage;
- water gathering network;
- increased produced water treatment facilities; and
- increase beneficial uses.

The increases in water infrastructure utilise a water balance incorporating the water production forecasts, potential storage surface areas, site rainfall and evaporation and the provision of water for beneficial reuse to develop the field infrastructure to manage the produced water.

4.1.1 Rainfall and Evaporation

Understanding the rainfall and evaporation data for the area is essential for determining the water balance.

Climate monitoring data collected by BOM is available from the Moura Post Office (Station No. 039071) located in the northern area of PL94. The climate of the surrounding region is subtropical, with warm to hot summers and mild winters. According to Enviropacific Services' Due Diligence Investigation Report (6

September 2010), the mean annual rainfall over the catchment varies between 600mm to 750mm. The average annual rainfall at the Moura Post Office Station since 1980 is 685mm, of which the majority falls in the warmer months of the year (November to February).

Mean daily pan evaporation in the summer season reaches 8mm in December and 3mm in June. Average daily evaporation of 5.8mm/day (2117mm/year) exceeds mean rainfall throughout the year, the highest moisture deficit occurring during summer. In order to place recent rainfall years into a historical context, the CRD, a summation of the monthly departures of rainfall from the long-term average monthly rainfall, was calculated as follows:

$$CRD_n = CRD_{n-1} + (R_n - R_{av})$$

Where:

CRD_n	= CRD for a given month
CRD_{n-1}	= CRD for a preceding month
R_{av}	= long-term average rainfall for a given month
R_n	= actual rainfall for given month

The CRD graph for the period 1980 to present is shown in Figure 7 using data from the period 1980-2020. A rising trend in the CRD plot indicates periods of above average rainfall, whilst a falling slope indicates periods when rainfall is below average. The CRD shown on the figure below indicates that the area experienced a period of generally below average rainfall from 1990 until 2009. Above average rainfall has been recorded from 2009 to 2012 followed by average – slightly below average rainfall to present. Rainfall data from the Moura station is not available from the BOM after August 2016 and so this data was produced using patched data from SILO.

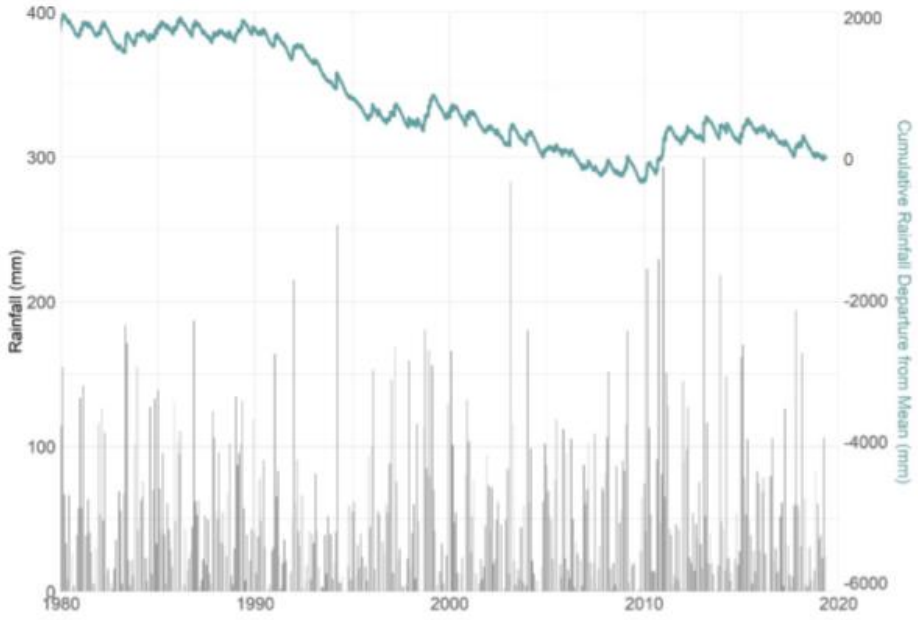


Figure 7 - CRD graph for the Moura area from 1980 to 2020

4.1.2 Produced Water Storage

Water storage is integral to the operations of PL94, as water storages are required to balance the produced water across the PL94 fields. Water storages are used for produced water, treated water and brine. These water storages can come in multiple types of structures including above ground tanks or purpose built earthen dams.

Any produced water earthen storage facility will be assessed and operated in accordance with the Queensland Government's *Manual for assessing consequence categories and hydraulic performance of structures*, and structures which are dams or levees constructed as part of environmentally relevant activities.

During operations of the water storages, adequate freeboard will be in place to manage the variations in water production, beneficial use availability and to manage wet weather.

Currently PL94 has 20ML of produced water storage. The increase in water production as a result of increased drilling activities will require further storage facilities over the life of the Project. Based on the current production profile, rain and evaporation rates and the irrigation scheme proposed for the Project, it is estimated that an additional 5.5ML tank will be required at the water treatment plant as a feedwater tank to the water treatment facility. It is envisioned that all of the PL94 water will be gathered to the Dawson River Field, where it will be either provided as stock water to landholders or treated and delivered for irrigation. The gathering system and management of the produced water will limit the amount of produced water storage required.

4.1.2.1 *Beneficial use storage*

Produced water from PL94 can be used for beneficial uses and is the priority for Westside. The beneficial uses for PL94 include:

- Construction –
  - Drilling and Completions
  - Civils
- Operations –
  - Dust suppression
- Stock water supply (Dawson River and Nipan Fields are the only fields that meet the EOWC – Associated Water without treatment)

Produced water for construction and operation activities will be taken directly from the above ground storage tanks.

Stock water supply is provided to landowners directly from wells that meet the EOWC – Associated Water for stock water. The produced water goes into a tank so that it can be tested in accordance with the EOWC – Associated Water and then it is transferred to landowner tanks.

4.1.1 Production Well and Water Gathering Network

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'* (DNRME, 2019).

To transport the produced water from the production wells to the water facilities, Westside will utilise new and existing gathering infrastructure. Gathering lines are low pressure networks that are buried to a depth that enables unchanged grazing or farming operations.

Gas gathering lines will be designed and constructed to comply with:

- *Australian Standard AS2885 – Pipelines Gas and Liquid Petroleum*
- *Code of Practice: For the construction and abandonment of petroleum wells and associated bores in Queensland* (DNRME, 201)
- *Australian Pipelines and Gas Association Ltd (APGA) Code of Environmental Practice* (2017)

4.1.2 Produced Water Treatment and Beneficial Uses

The future water treatment plant will replace the existing plant or alternatively incorporate the existing plant into the new system.

The proposed new water treatment plant will be able to treat up to 1.5ML/d of produced water and will utilise RO desalination technology to recover 85-90% of the water processed through the facility. The treatment process is presented in Figure 8 and comprises:

- Feed water tank
- Filtration
- Reverse Osmosis
- Brine storage facility
- Produced water tank
- Pumps and irrigation.

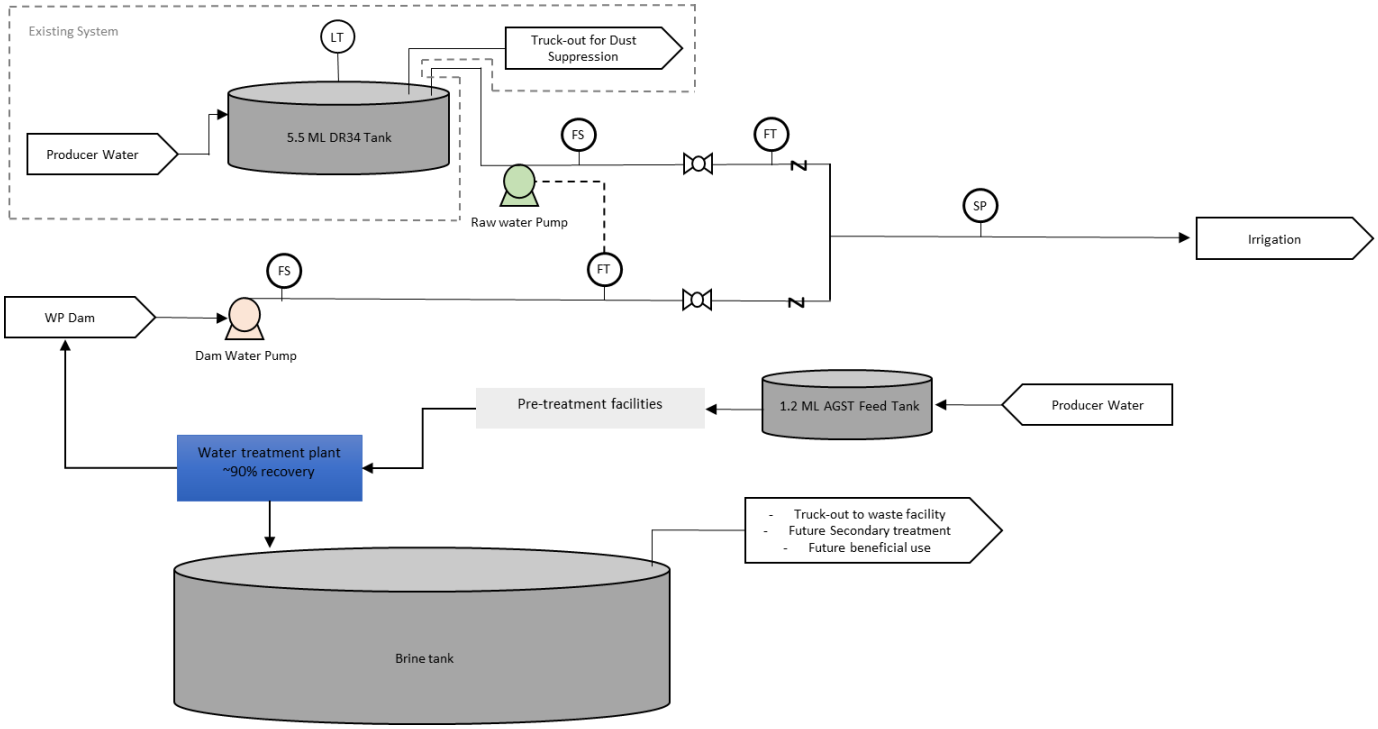


Figure 8 - Water Treatment Plant - simplified process flow diagram

4.1.2.1 *Feed Tank*

Produced water from PL94 is either directed to the 1.2ML feed pond or the 5.5ML DR34 field tank. The feed tank provides a temporary storage prior to the pre-treatment phase of the plant. The feed tank has a clarifying weir and allows for the settlement of course suspended sediments and oxygenate the produced water. As the development progresses, an additional 5.5ML tank is planned to be added to the front of the process to enable additional capacity.

4.1.2.2 *Filtration and disinfection*

On entry to the water treatment plant from the feed tank, produced water is dosed with a monochloramine disinfectant to reduce its propensity to cause biofouling of the subsequent treatment equipment (monochloramine disinfectant is commonly used in domestic water treatment) then transferred to filtration units.

The produced water is passed through a coarse filter then a finer filter to remove any particles or suspended sediments that did not settle out within the feed pond and to remove any biological organisms that may have been introduced during this temporary storage period.

4.1.2.3 *Reverse Osmosis*

For the PL94 Project area, RO desalination has been selected as the primary treatment method. RO desalination is a proven technology in Australian CSG applications when all key selection variables are objectively considered. Where high-quality treated water is required, RO desalination has, to date, has been the preferred technology as the most cost-effective and practical treatment process once all regulatory

requirements, practical operability, and commercial considerations have been evaluated. As new treatment technologies emerge, they will be assessed by Westside and considered for any future water treatment requirements, or for retrofitting to existing assets, if proven viable.

RO desalination uses hydraulic pressure to overcome osmotic pressure to draw water through the RO membrane. Most dissolved salts and other trace elements are rejected by the membrane thus generating two (2) separate product streams: treated produced water (permeate) and saline reject (brine). The future WTP's RO recovery rate is planned to achieve 85-95% utilising secondary RO to recover additional treated water from the saline reject produced by the primary RO units. Prior to RO desalination the filtered water will undergo pH adjustment (if required), dosing with a commercially available biocide and anti-scalent, and be de-chlorinated with sodium bisulphite to protect the RO membranes.

4.1.2.4 *Permeate water conditioning*

Prior to the supply of permeate water, the pH of the permeate water is adjusted to ensure its suitability for beneficial use and that residual disinfectant is removed. Blending in a small proportion of filtrate to increase buffering capacity and conditioning using calcium and magnesium may be undertaken to meet specific water quality limits for the end use, e.g. agricultural use.

4.1.2.5 *Waste*

Wastes generated by the water treatment plant consist of filtered solids and other chemical cleaning solutions from the process and Brine.

Wastes that are suitable for recycling will be directed to the Feed Pond for treatment. Other wastes will be directed to the brine tank.

4.1.2.6 *Permeate water use*

4.1.2.6.1. Water to Landholder – Irrigation Scheme

Utilising the application process under the End of Waste Framework, irrigation water will be provided to a landholder. A Resource Monitoring Management Plan has been developed for the End of Waste Application for the provision of irrigation water, which will be approved prior to irrigation.

Figure 8 provides an overview of the irrigation scheme. Produced water is delivered to the feed tank for treatment at the water treatment plant. The water delivered to the feed tank are from the Nipan, Mungi, Hillview, Pretty Plains, Ridgedale and Meridian fields which have higher salinity and lower volumes. Water from the Dawson River field will be delivered to the 5.5ML DR34 tank. The Dawson River Field water has higher volumes and lower salinity.

The permeate water from the water treatment plant will be delivered to the Waddington Park dam under the End of Waste Code - Associated Water for Irrigation as it will be under 950 uS/cm. The permeate water mixed with the dam water will then be blended with the produced water stored in DR34 to produce a 2000

uS/cm irrigation water quality to be used by the landholder. The irrigation will be undertaken under in compliance with an approved Resource Monitoring Management Plan under the End of Waste Framework.

4.1.2.6.1. Water to Project activities

As described in Section 3.2.2, where water quality is compatible with the requirements of the particular project activity and the End of Waste Codes, untreated produced water will be preferentially used to support Project activities. In circumstances where a better quality of water is required, treated produced water will be used in accordance with the End of Waste Codes. Project activities that could use treated produced water include:

- General construction activities such as:
  - Well drilling, workovers and completions, hydraulic fracture stimulation;
  - Hydro-testing of produced water gathering network;
  - Facility construction;
- Dust suppression; and
- Landscaping and revegetation.

4.1.1 Brine and Salt Management Scheme

The prioritisation hierarchy within the Coal Seam Gas Water Management Policy also provides guidance for managing brine waste, which comprises of:

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

The preferred brine and salt management scheme comprises storage of brine in purpose built tanks, utilising solar evaporation for the concentration of brine, followed by thermal crystallisation to produce a solid salt product suitable for containment in a Regulated Waste Facility (RWF) on or off tenure.

A conceptual overview of the scheme's key processes includes:

- Storage and solar evaporation of brine in brine tanks – brine produced by the water treatment plant is transferred into brine tanks located in close proximity to the water treatment plant for storage. Evaporation of water from the brine increases its salinity until crystallisation commences (at circa 250 g/kg of brine).
- Brine crystallisation to solid salt – The crystallisation process is anticipated to be a thermal process, with solid salts transferred to a beneficial use or to an existing regulated facility or purpose built RWF.
- Salt management options include:
  - Investigation of beneficial uses for the crystalised salt in the region include agricultural uses like salt licks.
  - Transfer to an existing RWF that accepts salts.

- Salt encapsulation within a purpose built RWF on the PL94 tenure. The RWF will be designed and operated in accordance with applicable legislation and guidelines. A RWF will utilise proven technologies that are commercially available and represent an evidence-based method of safely containing and storing waste.

Brine and salt management options will continue to be investigated the as the development progresses.

5. Groundwater

5.1 Groundwater Chemistry

The following groundwater chemistry observations have been made for the local hydrochemistry of PL94:

- The groundwater data from Alluvium bores vary between sodium-chloride and sodium-bicarbonate dominated. Salinity levels from the alluvium groundwater data indicate that the water quality is predominantly fresh.
- Moolayember Formation water quality data shows it is similar to the alluvium, the Moolayember Formation varies between sodium-chloride and sodium-bicarbonate dominated. TDS concentrations indicate that the water quality is fresh to brackish.
- The Clematis Group water quality indicate that the water is fresh. The limited groundwater data prevents the identification of the dominant ionic constituents of the water.
- The water quality results indicate that the Rewan Group groundwater is sodium-chloride dominated, and is saline.
- Water quality data of the Baralaba Coal Measures indicate that the groundwater is sodium-chloride dominated, with a quality ranging from fresh to saline (average TDS = ~10,800 mg/L). These results are comparable to the produced water quality from the current operations.

5.2 Groundwater Recharge

Recharge in the PL94 occurs as diffuse recharge with rainfall infiltration occurring at outcropping aquifers. Estimates of long-term average recharge rates have been made by OGIA as part of the 2016 UWIR (OGIA 2016b) using chloride mass balance recharge estimation method. For the units outcropping within the vicinity of the Project Area, the following recharge rates were estimated by OGIA:

- Alluvium – 6.8 mm/year
- Moolayember Formation (outcrops to southwest) – 2.5 mm/year
- Clematis Group (outcrops to southwest) – 26.9 mm/year
- Rewan Group (outcrops to south-southwest and within Project Area) – 1.2 mm/year
- Baralaba Coal Measures (outcrops to east) – 5.0 mm/year
- Older Permian Units (outcrops to east) – 6.8 mm/year

Recharge into the alluvium associated with the Dawson River is anticipated to occur during high flow periods, following significant rainfall events, although insufficient data is available to quantify the recharge. Recharge from the alluvium into the units underlying may also occur.

5.3 Groundwater-Surface Water Interactions

Groundwater-surface water interaction within the Project Area may occur as a result of two key processes:

- Recharge of aquifers as leakage from watercourses; and
- Discharge of groundwater to watercourses as baseflow.

Recharge to groundwater systems from watercourses may occur across the Project Area, however this only occurs when there are conditions of sufficient saturation in the alluvium and associated hydraulic head to allow water to infiltrate into the underlying aquifers. This is likely for the majority of the ephemeral watercourses across the Project Area where flow is only observed during and following rainfall events. The exception to this is the Dawson River where surface water flow is perennial.

Alluvial aquifers deposited by fluvial processes in river channels or floodplains are found along the Dawson River, and associated tributaries. Based on the information from the surface water flow gauges, and groundwater level data from the alluvium, there is limited potential for baseflow from the groundwater system to contribute to the Dawson River within the vicinity of the Project Area. This is supported by the comparison between groundwater levels in the alluvium monitoring bore (13030385) immediately upstream of the surface water gauging station on the Dawson River at Woodleigh (130317B). Perennial surface water flow in the Dawson River, through the Project Area, is a result of groundwater baseflow contribution up-catchment of the Project Area.

Groundwater levels recorded in monitoring bore 13030385, over the duration of the surface water gauging records that correlated with the groundwater level monitoring records (October 1985 to May 2012), indicate that groundwater levels gradually rose from 120.62 mAHD to 126.2 mAHD throughout the recorded period. In comparison, the recorded river elevation at the Dawson River at Woodleigh gauging station fluctuated from 126.254 mAHD to 144.509 mAHD, with a median of 126.808 mAHD. This indicates that the river levels were always higher than the recorded groundwater levels in the alluvium.

As a result, the elevation of the Dawson River at Woodleigh is higher than the groundwater level at 13030385, and considering that the monitoring bore is approximately 10 km upstream in the Dawson River alluvial channel this is limited connection between groundwater and surface water within the vicinity of the Project Area.

5.3.1 Spring Complexes and Groundwater Dependant Ecosystems

The majority of spring complexes are located over 50 km south of the Project Area, while other spring complexes are located over 30 km to the southwest of the Project Area. There will be no impacts to surrounding spring complexes as a result of the Project.

Potential terrestrial GDEs have been mapped in the vicinity of the Project Area. Typically, these mapped areas of TGDEs are located adjacent to watercourses (e.g. Dawson River), which are reliant on groundwater within the alluvium. Potential TGDEs are also mapped where Cenozoic sediments are present. Drawdown resulting from the proposed Project will be limited to the Rewan Group and will not propagate into the Cenozoic sediments and alluvium. Therefore, there will be no impacts to mapped potential terrestrial GDEs in the vicinity of the Project Area

6. Environmental Values

6.1.1 Environmental Values

The *Environmental Protection Act 1994* (Qld) (EP Act) defines an Environmental Value (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.

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

- identifying environmental values for waters and wetlands to be enhanced or protected;
- identifying management goals for water;
- stating water quality guidelines and water quality objectives to enhancing or protecting the environmental values of water;
- providing a framework for making consistent, equitable and informed decisions about waters; and,
- monitoring and reporting on the condition of waters.

The EP Policy provides defined EVs and water quality objectives (WQOs) for the Dawson River sub-basin under Schedule 1 of the policy. EVs for the Lower Dawson are shown in Table 3. The WQ1309 plan (State of Queensland 2013a, 13) that accompanies the policy, indicates that the Project Area is located within the Lower Dawson main channel – regulated reaches, as well as eastern tributaries. The WQ1310 plan (State of Queensland 2013b) details the groundwater zones and indicates the Project Area is located across three groundwater chemistry zones.

Table 3 - Environmental Values for the Dawson River Sub-Basin waters within the vicinity of the Project Atlas (DEHP 2011a)

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
Lower Dawson—Cracow, Theodore areas (WQ1309)												
Lower Dawson main channel – regulated reaches	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eastern tributaries – developed areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Groundwater	✓	✓	✓	✓	✓		✓			✓		✓
Undeveloped areas	✓			✓		✓	✓	✓	✓	✓		✓

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

6.1.1.1 *Relevant EVs for local groundwater*

The regional EVs identified in Table 3 have been reassessed to determine their applicability to PL94. Table 4 provides a summary of the review and presents the EVs deemed applicable to PL94 groundwaters including justification for their inclusion / omission.

Table 4 - Summary Assessment of Environmental Values related to groundwater

Environmental Value	Applicable to PL94 / Justification	
Aquatic Ecosystem	✓	Quaternary alluvium is connected to the Dawson River and Kianga Creek. During gaining stream conditions groundwater quality may affect surface water quality. Concentrations for analytes defined in the WQOs are generally similar or less than measured groundwater baseline conditions.
Water supply for Irrigation	✓	Based on GWDB review and baseline bore assessment results, groundwater from bores screened within the Quaternary alluvium are used for irrigation purposes (crops and gardens). Groundwater from bores screened within other units is not used for irrigation purposes. With the exception of iron and manganese, concentrations for analytes defined in the WQOs are generally similar to or greater than measured groundwater baseline conditions.
Stock Watering	✓	Based on GWDB review and baseline bore assessment results, groundwater from bores screened within the Quaternary alluvium is used for stock watering purposes (primarily cattle). Groundwater from bores screened within other units is not used for stock watering purposes. Concentrations for analytes defined in the WQOs are generally similar to or greater than measured groundwater baseline conditions.
Aquaculture	×	No bores were identified as being utilised for aquaculture purposes
Primary Recreation	×	No bores were identified as being utilised for primary recreation purposes
Drinking Water	×	No bores were identified as being utilised for drinking water purposes
Cultural and Spiritual Values	✓	Quaternary alluvium is connected to Dawson River and Kianga Creek which may hold cultural and spiritual significance

6.1.2 Water quality objectives

The EP Policy also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the policy are classified by groundwater depth and regional chemistry zone. Under the policy, groundwater at and surrounding the Project site will need to be compared to the WQO's relevant to Zones 28 and 34 of the Dawson Groundwaters of the Dawson River Sub-basin of the Fitzroy Basin water plan (WQ1310). WQOs for these zones are shown in Table 5 (aquatic ecosystem EVs) and Table 6 (human use EVs). In reference to the site hydrogeology it is deemed that the shallow WQOs (<30 m) are representative of the Quaternary alluvium, Tertiary sediment and Rewan Formation aquifer units with the deep WQOs (>30m) representative of the Permian coal measure aquifer units. It should be noted that where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.

Table 5 - Fitzroy Basin Water Quality Objectives (aquatic ecosystem) according to water chemistry zone

Zone	Depth (± 30m)	Percentile	EC (µS/cm)	Hardness (mg/L	pH	Alkalinity (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Fe (mg/L)	Mn (mg/L)	Zn (mg/L)	Cu (mg/L)	SAR	RAH (meq/L)	EH (mV)
28	Deep	20th	308	24	7.1	74	5	3	28	32	0	85	0	13	0.1	0.01	0.01	0.01	0.03	1.89	0.83	ID
28	Deep	50th	425	45	7.8	156	9	5	73	45	2	186	0.5	15	0.2	0.01	0.01	0.02	0.03	4.6	2.25	ID
28	Deep	80th	723	66	8.2	219	16	9	128	74	5	257	0.5	17	0.23	0.04	0.21	0.03	0.045	9.73	3.54	ID
28	Shallow	20th	300	22	7.1	73	4	3	28	42	0	85	0	15	0.114	0	0.01	0	0	2.2	0.19	ID
28	Shallow	50th	615	51	7.7	196	9	6	128	57	2	230	0.5	17	0.2	0.02	0.01	0.01	0.005	5.5	2.8	ID
28	Shallow	80th	1644	261	8.2	416	30	32	252	241	11	495	0.5	25	0.4	0.093	0.096	0.019	0.019	13.5	4.91	ID
34	Deep	20th	3419	359	7.4	156	46	35	480	753	25	188	0.01	16	0.02	0	0	0.01	0.017	10.5	0	ID
34	Deep	50th	6100	919	7.8	275	145	115	1100	1900	138	330	2.15	25	0.155	0.05	0.05	0.025	0.03	15.6	0.24	ID
34	Deep	80th	160000	3208	8.03	536	442	491	2565	5905	398	650	14.92	36	0.4	0.246	0.291	0.317	0.03	24.65	6.25	ID
34	Shallow	20th	498	163	7.1	154	18	27	135	171	12	187	0	21	0.1	0	0	0	0	4.37	0	ID
34	Shallow	50th	498	163	7.1	154	18	27	135	171	12	187	0	21	0.1	0	0	0	0	4.37	0	ID
34	Shallow	80th	2150	674	7.75	435	84	108	747	1309	140	536	0.95	36	0.28	0.03	0.01	0.015	0.015	10.85	0	ID

ID: Insufficient data to perform statistical summaries, or the parameter was not tested

Table 6 - Fitzroy Basin Groundwaters Water Quality Objectives according to human use environmental values

Environmental Value	Water Quality Objective (refer to specified codes and guidelines for full details)
Water Supply for irrigation	Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) objectives for pathogens and metals are provided in Tables 8 and 9 of Dawson River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011). For other indicators, such as salinity, sodicity and herbicides, see Australian Water Quality Guidelines (AWQG).
Farm water supply/use	Objectives as per AWQG.
Stock Watering	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 mL. WQOs for total dissolved solids and metals are provided in Tables 10 and 11, based on AWQG. For other objectives, such as cyanobacteria and pathogens, see AWQG.
Cultural and Spiritual Values	Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.

7. Risks, Potential Impacts and Management

Westside implements all produced water and brine management in accordance with the applicable legislation and Environmental Authority conditions to protect all relevant Environmental Values identified in the Project Area.

This section is an overview of the outcomes of the environmental risk assessment conducted to ensure the risks to Environmental Values from produced water are adequately controlled.

7.1 Risk assessment process

Westside is committed to the continual and effective management of risk to ensure that:

- Systems are in place to identify all risks to the extent that is reasonably practicable;
- The potential impacts of identified risks are understood and limits set to ensure their appropriate management;
- Responsibilities for risk management are delegated to appropriate persons;
- Assurance is provided as to the effectiveness of the risk management system and its associated risk controls; and
- Any material changes to risk levels are monitored and acted upon accordingly.

To achieve these aims, for all produced water management activities, Westside conducts a comprehensive risk assessment. Identified risks are evaluated considering existing controls and are assigned likelihood and consequence ratings which are then combined to derive a risk level on a five-point scale from 'Low' to 'Extreme'. 'Low' level risks and some 'Medium' level risks (of acceptably low severity), are considered to be appropriately mitigated by existing controls without the need for further treatment. For other risks, additional mitigation measures are considered and treatment plans prepared and approved. For 'Extreme' risks, a treatment plan is prepared and implemented immediately. All identified risks are registered in the Westside Risk Management System and are regularly reviewed at a frequency dependent on the risk level. 'Low' and 'Medium' risks are reviewed yearly, 'High' risks are reviewed twice a year and 'Severe' and 'Extreme' risks are reviewed once a month. A summary of risks associated with the operation of the produced water management scheme have been considered for the full lifetime of the PL94 Project and are provided in Section 7.2.

7.2 Summary of risks and controls

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
Produced water gathering network					
Uncontrolled release of produced water adversely impacts soil, surface water and/or groundwater EVs.	- Loss of pipeline integrity. - Release of produced water from low point drains.	- Gathering network designed in accordance with Australian Standards by suitably qualified engineers - Integrity of gathering network managed through implementation of the Integrity Management Plan including: - Right of way inspection prior to commencement of operation - Ongoing right of way surveillance tailored to specific gathering network. Components may include; monitoring of third-party activities within corridor, monitoring for evidence of soil erosion and conducting leakage surveys.	Serious	Unlikely	Low
Produced water storage					
Seepage of produced water through tank liner adversely impacts soil, surface water and/or groundwater EVs.	- Failure of Liner	- Operation of the produced water tanks, which includes: - Monitoring the sumps for the leak detection system of the primary and secondary liners. - Preventative maintenance of the tanks. - Tank level monitoring	Serious	Highly Unlikely	Low

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
		- External monitoring around the base of the tank for wet areas - Asset Integrity Management Plan - UWIR annual reporting			
Failure of tank or overflow with release of produced water adversely impacts soil, surface water and/or groundwater EVs.	-Poor construction and / or operation. - Extreme rainfall causes volume stored to exceed capacity	- Operation of the produced water tanks, which includes: - Monitoring the sumps for the leak detection system of the primary and secondary liners. - Preventative maintenance of the tanks. - Tank level monitoring - Operate at recommended manufactures freeboard - Ensure available freeboard is available prior to the wet season - Site water balance undertaken routinely to ensure capacity in the system. - CSG Water Storage Management Procedure (WCL-0000-HS-PRC-033) - Asset Integrity Management Plan - UWIR annual reporting	Moderate	Unlikely	Low
Drowning of Fauna	Entry of fauna into tanks	Tanks are all above ground structures with vertical walls	Minor	Highly Unlikely	Low

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
Use of untreated produced water					
Ponding and/or runoff of produced water adversely impacts soil, surface water and/or groundwater EVs.	-Poor practice during application of produced water. - produced water quality unsuitable for use.	- All requirements for use outlined in the relevant End of Waste Code will be met. - All requirements under the PL94 EA for dust suppression will be met. - Monitoring of the dust suppression applications. - Records will be kept for auditing purposes. - Application of produced water will not occur during rainfall events. - CSG Water Carting Procedure (WCL-0000-HS-PRC-035) - UWIR annual reporting	Moderate	Unlikely	Low
Vehicle incident/accident leads to spill of produced water and resultant adverse impact on soil, surface water and/or groundwater EVs.	- Driver error - Poor road condition - Poor weather - Poor vehicle condition - Collision with wildlife/stock	- All drivers to complete safe driver training. - Driver to inspect vehicle prior to use. - Toolbox meeting to discuss weather and truck movements for the day. - Driver to check with site superintendent during periods of wet weather to confirm roads are safe. - CSG Water Carting Procedure (WCL-0000-HS-PRC-035)	Minor	Unlikely	Low

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
Use of treated produced water for project activities					
Risks associated with using treated produced water for project activities are addressed by the untreated produced water use risks as the risk profile is lower.					
Use of treated produced water for water to Landholder Scheme					
Irrigation scheme of mixed treated and produced water adversely impacts soil, surface water and/or groundwater EVs.	- Off spec water supplied to the landholder - Landowner application rates are altered	- End of Waste Application – Resource Monitoring and Management Plan developed by a third party specialist and approved by the Department of Environment and Science. - Compliance with the Resource Monitoring and Management Plan. - Resource Monitoring and Management Plan obligations for the Landholder clearly defined in the agreement. - Monitoring and reporting against the Resource Monitoring and Management Plan kept for assurance purposes.	Minor	Unlikely	Low
Brine Storage					
Seepage of brine through tank liner adversely impacts soil, surface water and/or groundwater EVs	Failure tank liner	- Operation of the brine tanks, which includes: - Monitoring the sumps for the leak detection system of the primary and secondary liners. - Preventative maintenance of the tanks. - Tank level monitoring	Major	Highly Unlikely	Med

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
		- Operate at recommended manufactures freeboard - Ensure available freeboard is available prior to the wet season - Site water balance undertaken routinely to ensure capacity in the system. - CSG Water Storage Management Procedure (WCL-0000-HS-PRC-033) - Asset Integrity Management Plan - UWIR annual reporting			
Failure of tank or overflow with release of brine adversely impacts soil, surface water and/or groundwater EVs.	-Poor construction and / or operation. - Extreme rainfall causes volume stored to exceed capacity	- Operation of the brine tanks, which includes: - Monitoring the sumps for the leak detection system of the primary and secondary liners. - Preventative maintenance of the tanks. - Tank level monitoring - Operate at recommended manufactures freeboard - Ensure available freeboard is available prior to the wet season - Site water balance undertaken routinely to ensure capacity in the system. - CSG Water Storage Management Procedure (WCL-0000-HS-PRC-033); - Asset Integrity Management Plan - UWIR annual reporting	Moderate	Unlikely	Low

Risk	Potential Causes	Existing Controls	Residual Risk		
			Consequence	Likelihood	Risk Level
Secondary salinity (arising from windborne salt from brine ponds) adversely impacts terrestrial ecology, soils and/or surface water EVs	Wind-borne salt	- Tank locations considers prevailing wind-direction - Manage freeboard to minimise wind effects - Regular monitoring of surrounding vegetation will be undertaken as part of the monitoring identify any preliminary signs of salinity effects.	Minor	Unlikely	Low
Drowning of Fauna	Entry of fauna into tanks	Tanks are all above ground structures with vertical walls	Minor	Remote	Low

8. Management Criteria

In accordance with the EP Act and specific requirements of the PL94 EA, Westside has developed measurable criteria (termed management criteria) against which the effectiveness of produced water and brine management will be monitored. The management criteria have been developed in accordance with the DES factsheet *CSG water management: Measurable criteria*.

Table 7 shows the management criteria for this PWMP. Each component of the produced water and brine management strategies in implementation has been assigned a specific management criterion and together, these criteria account for the quantity and quality of all produced water used, treated, stored or disposed of in the Project Area.

Several management criteria also inherently address the management of waste (primarily retentate/brine) generated during the treatment of produced water. Each management criterion consists of:

- A management objective for protecting EVs from the potential impacts of the produced water management activity;
- A series of tasks that will ensure that the objective can be achieved;
- Specific indicators against which the performance of produced water management can be measured, assessed and audited in an objective and repeatable manner; and
- A target for produced water management.

The continued suitability of all management criteria and operational performance against each criterion will be regularly evaluated and reported once a year in the annual return for the EA. If it is found that a management criterion has not been met, the following activities will be undertaken: Investigate significance of failure to meet management criterion on EVs and identify likely cause/s; Where cause/s can be attributed to the activities of Westside, and where required in order to protect EVs, identify means to refine operating procedures in order to ensure that criterion is met in future; Where required in order to protect and maintain EVs, implement any recommended changes to operating procedures. The respective annual return will outline the results of the above activities, where required.

Table 7 – Produced water management criteria

Objective	EVs to protect	Task	Performance Indicator
Understanding produced water quality and quantity	Contaminated-free land Groundwater availability for other users. Soils for growth of native vegetation. Soils for crop and pasture growth. Treated produced water for stock watering. Treated produced water for aquatic ecosystem protection. Treated produced water for reuse in the petroleum activities.	UWIR annual reports Implement groundwater monitoring program Development and implement stimulation impact monitoring program (if activities commence)	Reports prepared annually
		Monitoring dam / tank water pre and post treatment	Monitoring carried out in accordance with EA conditions and results documented
		Use of flow meters	Flow data for volumes abstracted taken and documented.
Movement of produced water		Routine maintenance of all water gathering lines, pipelines and pump stations	No spills of produced water from water gathering lines, pipelines or pumping stations
Storage of untreated produced water		Annual inspections of dams by RPEQ Routine checks of all produced water storage dams and tanks Installation and routine maintenance of high-level alarms / telemetry for tanks	Annual report prepared in accordance with EHP's Manual (EM635) and EA conditions Recommendations from report implemented with 14 days. No overflows or leaks from tanks No evidence of contamination of surface waters High level alarms installed Any new aggregation or brine dams are designed constructed and operated in accordance with the EA and EHP's Manual (EM635).
Treatment of produced water		Maintain and operate water treatment plant Monitor capacities and treatment volumes as activities progress to prevent hydraulic overload	Treated produced water is fit for purpose / meets criteria for intended use Treated produced water meets plant manufacturer specifications Volumes treated are measured and recorded
Maximising reuse of produced water		Use of produced water for all drilling and well hole activities, construction, dust suppression and if carried out, stimulation activities. Investigate and secure third-party reuse of produced water	Apply produced water on soils using spray irrigation methods. Monitor soil where produced water has been applied Produced water for dust suppression to only occur when wind speeds are ≤ 5 km/hr to avoid wind-blown soils and surface water contamination Produced water for dust suppression to only occur as necessary Continued consultation with, and documentation of, regional stakeholders

Objective	EVs to protect	Task	Performance Indicator
Brine / solid salt residue management		Investigate treatment and/or reuse of solid brine as the first priority Dispose of brine/solid salt residues at approved facility	Documented evidence of reading studies or participating in research studies.

9. Monitoring

Monitoring is undertaken to ensure the effective performance of the produced water management in PL94.

Data from the monitoring programs is used to continually refine and improve the operation of the produced water management scheme.

The water types and locations being monitored are:

- Treated produced water:
  - Water supply to the Waddington Park Farm Dam
  - Water Supply point for irrigation at DR34
  - Water supply point for stock watering at the water treatment plant
- Untreated produced water for End of Waste Code applications (irrigation, stock watering):
  - Water treatment plant AGST
  - DR 39
  - DR59
  - MR30
  - MR54
  - MR46
  - DR34
  - DR31
  - NP24

All monitoring is to be conducted in accordance with the *Monitoring and Sampling Manual 2009* (DEHP 2013). All monitoring is to be undertaken by a suitably qualified person.

9.1 Produced and treated produced water quality monitoring program

The recording and reporting of water quality data is used to confirm that the water treatment plant is effectively treating produced water to a standard suitable (from an environmental and public health perspective) for beneficial uses. The program is based on the public health and environmental water quality monitoring requirements outlined in the PL94 EA, the End of Waste Codes, UWIR and Resource Monitoring Management Plan. The monitoring required is regularly reviewed and updated as approvals and agreements change and if new uses of produced water are authorised.

Table 8 provides the water quality parameters and frequency for the beneficial uses of the treated and untreated produced water.

Table 8 - Westside PL94 Water Quality Monitoring Parameters

Use		Agriculture Use				Project Activities
Guideline/Approval		EOWC Irrigation		EOWC Stock Watering		EOWC
Characteristic	Unit	Limit Level	Frequency	Limit Level	Frequency	Limit
Physical - Chemical						
EC	uS/cm	950	Fortnightly			No water quality requirements
pH		6.-8.5				
SAR		12 or less				
TDS	mg/L			4000 - 5000 (beef cattle)	Fortnightly	
Metals and Metalloids						
Aluminium	mg/L	20	Monthly monitoring of metals and metalloids of the same water source, then six-monthly	5	Monthly monitoring of metals and metalloids of the same water source, then six-monthly	No water quality requirements
Arsenic	mg/L	2		0.5		
Boron	mg/L	Refer to Table 9.2.18 of the ANZECC Guidelines		5		

Characteristic	Unit	Limit Level	monitoring after three consecutive laboratory results which are less than 50 per cent of the water quality parameters	Limit Level	monitoring after three consecutive laboratory results which are less than 50 per cent of the water quality parameters	Limit
Cadmium	mg/L	0.05		0.010		
Chromium	mg/L	1		1		
Cobalt	mg/L	0.1		1		
Copper	mg/L	5		1 (cattle)		
Fluoride	mg/L	2		2		
Iron	mg/L	10				
Lithium	mg/L	2.5				
Lead	mg/L	5		0.1		
Maganese	mg/L	10				
Mercury	mg/L	0.002		0.002		
Molybdenum	mg/L	0.05		0.15		
Nickel	mg/L	2		1		

Uranium	mg/L			0.2		
Zinc	mg/L	5		20		
Characteristic	Unit	Limit Level	Frequency	Limit Level	Frequency	Limit
Radiological						
Alpha Emitters	Bq/L			0.5	Parameters initially monitored monthly, and then six-monthly after three consecutive detects which are less than 50% of the listed limit. If not detected in the source water Annually.	
Betta Emitters	Bq/L			0.5 (excluding K-40)		
Radium 226	Bq/L			5		
Radium 228	Bq/L			2		
Uranium 238	Bq/L			0.2		

9.2 Tank monitoring

Westside implements a range of inspection, maintenance and monitoring procedures in order to monitor the potential for environmental impacts. A summary of these procedures is provided in Table 9.

Table 9 - Tank Storage Monitoring

Activity	Frequency	Reporting	Personnel
Monitoring			
Field Water Quality	Monthly	Kanepi	Operations Environment
Beneficial re-use water (End of waste requirements)	Monthly	Kanepi	Operations Environment
Inspections			
Tank level monitoring	Weekly	Kanepi	Operations
Seepage	Annual	Maintenance System	Operations
Sump pump test	Annual	Maintenance System	Operations
Maintenance			
Routine Maintenance schedule	Annual	Kanepi	Operations Engineer

9.3 Sample Analysis and Data Management

9.3.1 Sample Analysis and Interpretation

All laboratory analyses and tests must be carried out by a laboratory that has NATA certification for such analyses and tests, except as otherwise authorised by the administering authority.

For environmental compliance purposes (EA, Irrigation End of Waste Code, and Resource Monitoring and Management Plan), the dissolved value is reported upon. The interpretation methodology is illustrated in Figure 3.4.2 of the ANZECC Water Quality Guidelines (page 3.4.19; ANZECC and ARMCANZ 2000).

9.3.2 Data Management

The data generated by the online monitoring of water quality parameters within the water treatment plant is captured by a SCADA system. This data is automatically copied into the Kanepi database that is remote to the water treatment plant for long term storage of a minimum of five (5) years. Exceedances of water quality alarm levels associated with online monitoring at the water treatment plant are managed in accordance with Standard Operating Procedures and Critical Operating Procedures.

All laboratory results data collected in support of water management is stored in the Westside data management system. All monitoring results are kept for a minimum of five (5) years, and will be made available to the administering authority if requested, and as part of the produced water evaluation annually where required by a condition of the EA or EP Act.

9.3.3 Incident Response and Results Reporting

Westside prepares routine reports describing the results of the monitoring, preferably in spreadsheet format, on a monthly basis. Routine monitoring related to the EA will be summarised in the EA annual return. No routine reporting is required under the End of Waste Code – Associated Water for dust suppression, however monitoring will be documented in the Westside data management system.

An incident is defined as a validated exceedance of a water quality limit level. For water quality parameters, exceedances of water quality limit levels are reviewed, validated, responded to and, where required, notified and reported to the administering authority.

All incident response processes are recorded and closed out through the Westside Donesafe System.

10. Abbreviations

Abbreviation	
BUA	Beneficial Use Agreement
CSG	Coal Seam Gas
CSG WMP	Coal Seam Gas Water Management Plan
^{0}C	Degrees Celsius
dB(A)	Decibels measured on the ‘A’ frequency weighting network.

Abbreviation	
DNRME	Department of Natural Resources, Mines and Energy
DES	Department of Environment and Science
EA	Environmental Authority
EC	Electrical Conductivity
EP Act	Environmental Protection Act 1994
EP Policy	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmentally Relevant Activity
ERE	Endangered Regional Ecosystem
ESA	Environmentally Sensitive Areas
EV	Environmental Values
FA	Financial Assurance
Ha	Hectares
km	Kilometre
L	Litres
m	Metres
Mg/L	Milligrams per Litre
ML	Mining Lease
NES	National Environmental Significance

Abbreviation	
PL	Petroleum Lease
PWMP	Produced Water Management Plan
RE	Regional Ecosystem
ROW	Right of Way
HSE	Safety, Health and Environmental
µg/L	Micrograms per Litre
µS/cm	Micrograms per Centimetre
WQOs	Water Quality Objectives