

Surat Gas Project (SGP) North

Environmental Authority (EA0001399)

EA Amendment Supporting Information Report

5 December 2023

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1. Introduction

1.1 The Project Area

Arrow CSG (Australia) Pty Ltd.'s (Arrow Energy) Surat Gas Project (SGP) involves the phased development and supply of a number of gas tranches via a Gas Sales Agreement (GSA) and a Water Services Agreement with QGC Pty Ltd (QGC) under a collaboration opportunity which provides access to existing gas and water processing facilities within the Queensland Brigalow Belt Region (refer to **Figure 1-1**).

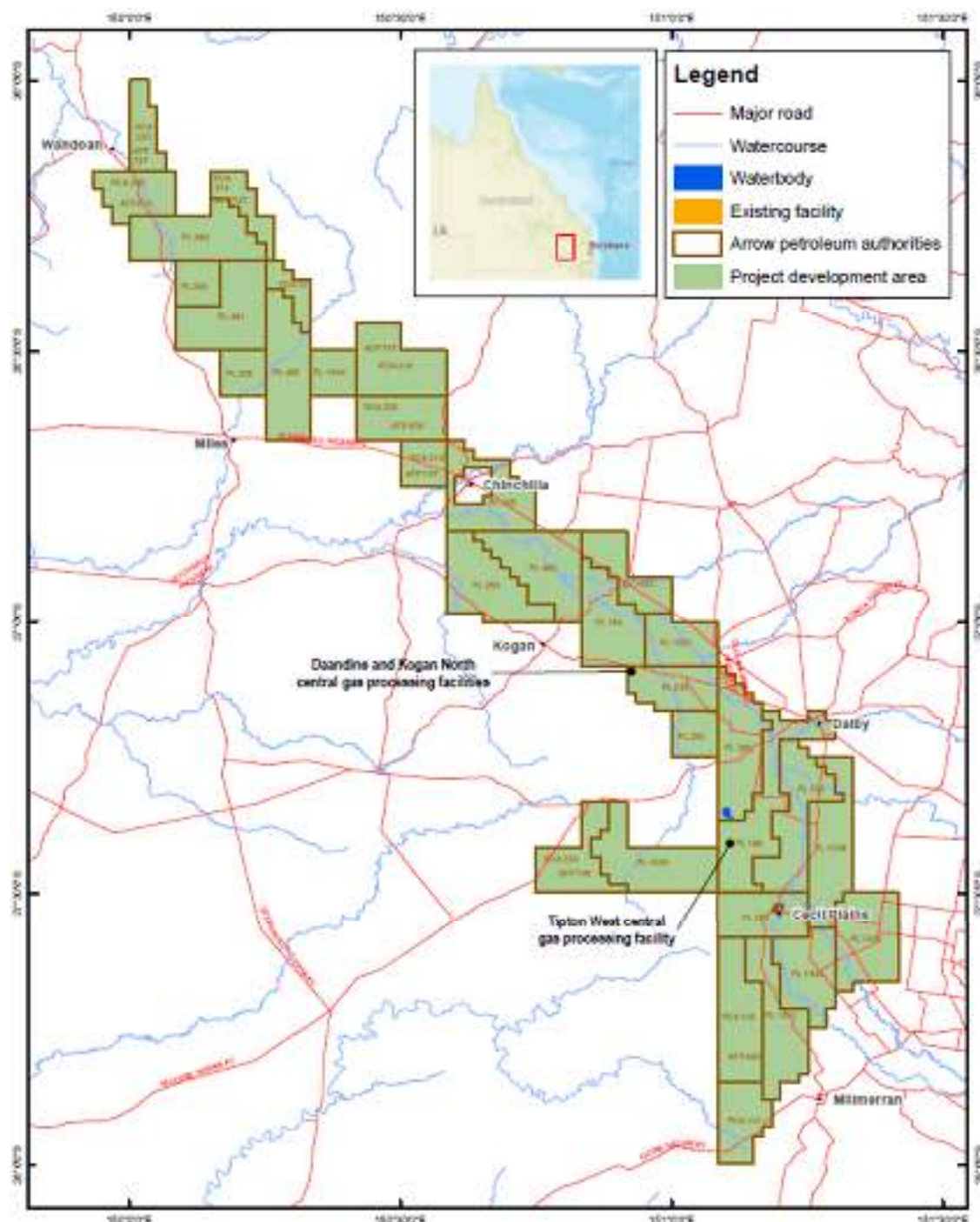


Figure 1-1 Surat Gas Project (SGP) Development Area

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The SGP covers an area of approximately 5,385 km² (538,500 ha) and is located approximately 160 km west of Brisbane in Queensland's Surat Basin. As shown in **Figure 1-1**, the SGP development area extends from the township of Wandoan in the north towards Goondiwindi in the south, in an arc shape through the township of Dalby.

The SGP phased development comprises SGP North and SGP South, authorised under environmental authorities (EAs) EA0001399 (or [SGP North EA](#)) and EA0001613, respectively. **Figure 1-2** shows the extent of the SGP gas tranches to both North and South.

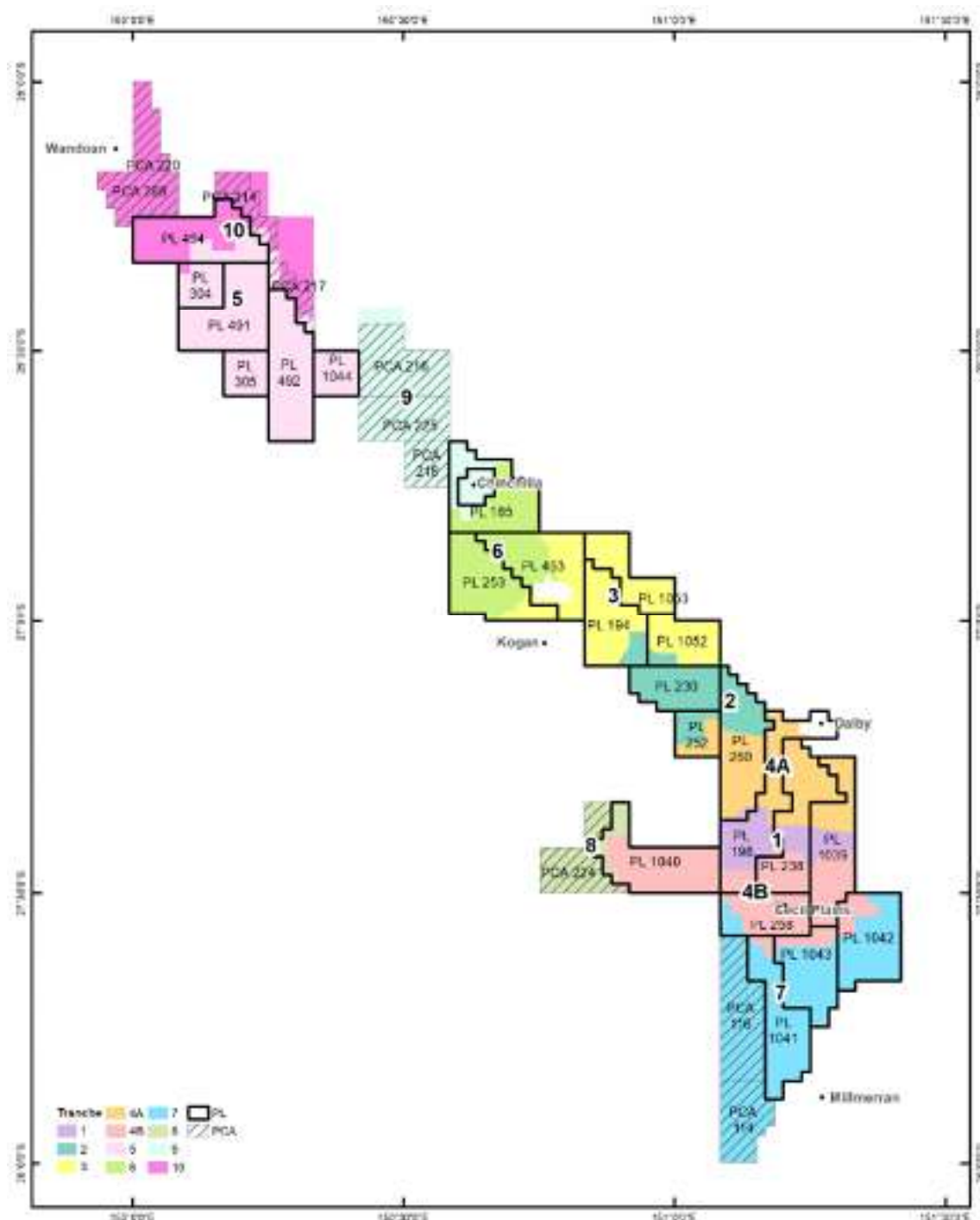


Figure 1-2 Extent of the SGP Gas Tranches – North and South

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SGP North is referred to as the Girrahween Development, which will deliver Natural Gas to the QGC Bellevue Delivery Point, and comprises Petroleum Leases (PLs) 304, 305, 491, 492, 494 and 1044 which are located north east of the township of Miles in Southern Queensland (refer to **Figure 1-3**).

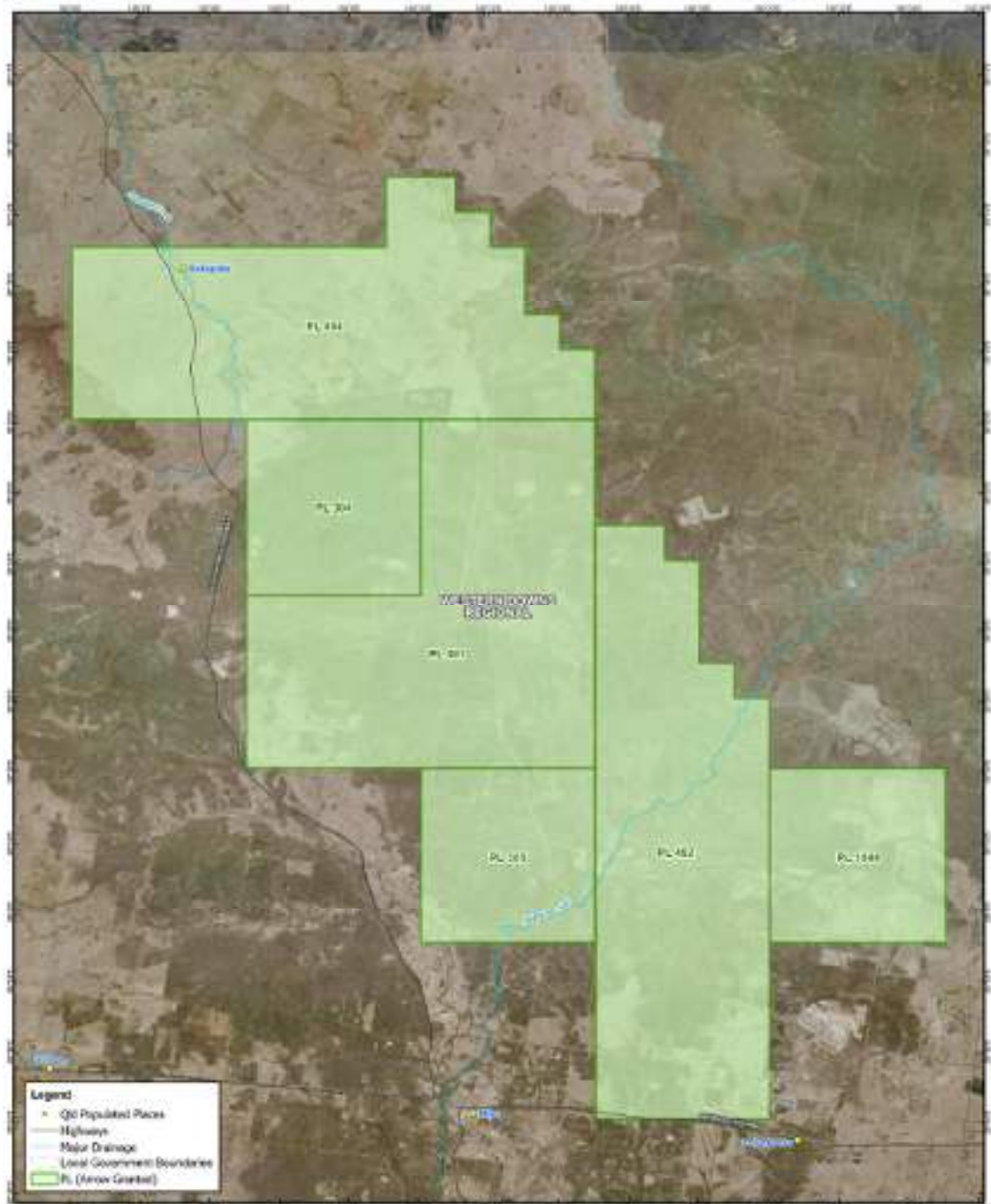


Figure 1-3 SGP North or Girrahween Development

The first phase of the SGP North or Girrahween Development is referred to as Girrahween Development Phase 1, which comprises up to 250 wells. The following Sustain phase includes an additional 200 wells. The project includes the Girrahween Phase 1 and the Sustain phase (the Project), with up to a total of 450 wells which are

authorised under the SGP North EA, including 650 km of gathering lines (refer to Section 1.2).

Subject of this EA amendment (i.e., amendment to the SGP North EA) are the authorisation of key infrastructure for the development of the 450 wells and incidental activities, which are to be developed in PL305, PL491, PL492, and PL1044. Details regarding the Project are provided in Section 1.4 and Section 2.1.

Further development of the Girrahween Development will be delivered in subsequent phases and are not part of the Project for the purposes of this report.

1.2 Currently Authorised Petroleum Activities

Arrow Energy prepared an environmental impact statement under the *Environmental Protection Act 1994* (Qld) (EP Act), the SGPEIS¹, which was submitted to the Chief Executive of the then Department of Environment and Heritage Protection in March 2012. Public consultation to the SGPEIS was conducted from March to June 2012 and a Supplementary Report to the SGPEIS (SGPSREIS)¹ was prepared which summarised and addressed the comments from the consultation process.

The SGPEIS was approved by the Queensland Government in October 2013 and by the Commonwealth Government in December 2013. The SGP obligations under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are being managed under the EPBC 2010/5344 approval².

Arrow Energy's SGPEIS considered the inclusion of the following infrastructure components:

- Coal Seam Gas (CSG) production wells;
- CSG and water gathering lines;
- Production facilities, including field compression and water transfer stations;
- Water treatment and water storage facilities;
- Power generation facilities;
- High pressure gas pipelines; and
- Supporting infrastructure and logistics.

An application for an environmental authority was submitted to the Queensland Government in June 2018, and the Environmental Authority (EA) EA0001399 (SGP North EA) was granted on 26 February 2019. This application included the abovementioned infrastructure, with the exception of the field compression station and associated infrastructure as it was planned to be constructed and operated under a Petroleum Facility Licence (PFL) and hence subject to a separate EA application.

The SGP North EA currently authorises the petroleum activities under *Schedule A, Table 1 – Authorised petroleum activities* as per **Table 1-1**. This includes 588 gas production wells, 650km of pipeline, and three (3) exploration regulated dams.

¹ Arrow Energy Surat Gas Project Environmental Impact Statement, October 2013 (SGPEIS) and Supplementary Report ([Arrow Energy SGP EIS and Supplementary Report to the SGPEIS \(SGPSREIS\)](#)).

² Arrow Energy Surat Gas Project EPBC Approval, December 2013 ([EPBC 2010/5344](#)).

Table 1-1 Currently Authorised Petroleum Activities under SGP North EA (EA0001399)

Activity(ies)	Total scale of petroleum activities / infrastructure	Intensity / maximum size
Coal seam gas production	588 gas production wells: PL304 – 95 wells PL305 – 86 wells PL491 – 192 wells PL492 – 151 wells PL494 – 27 wells PL1044 – 37 wells	1.1 ha per well
Petroleum pipeline	PL304 – 90 km PL305 – 90 km PL491 – 200 km PL492 – 190 km PL494 – 30 km PL1044 – 50 km	650 km of pipeline
Petroleum activities carried out on a site containing a regulated structure (high or significant <u>consequence category dam</u>)	PL304 – Kedron Dam PL305 – Castledean Dam PL1044 – Punchbowl Dam	Kedron Dam – 20 ha Castledean Dam – 14 ha Punchbowl Dam – 35 ha

A request to amend the SGP North EA was submitted to the Queensland Government in August 2021 to change the groundwater monitoring requirements, which was approved and granted with effective date 1 October 2021. This is the current EA, subject of this EA amendment application, and under which the activities as per **Table 1-1** are authorised.

This proposed EA amendment does not significantly increase the level of environmental harm to that addressed and approved by the SGPEIS (2013) and its Supplementary Report (SGPSREIS, 2013) (refer to Section 5 and Section 6).

1.3 Currently Authorised Environmentally Relevant Activities (ERAs)

The ERAs currently authorised under the SGP North EA, EA0001399, as per the *Environmental Protection Regulation 2019* (Qld), are:

- Schedule 2, ERA 62 (Ancillary) Resource recovery and transfer facility operation, 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing – (c) category 2 regulated waste;
- Schedule 3, ERA 3: A petroleum activity that is likely to have a significant impact on a category A or B Environmentally Sensitive Area (ESA);
- Schedule 3, ERA 6: A petroleum activity carried out on a site containing a high consequence dam or a significant consequence dam if the dam forms part of the activity; and
- Schedule 3, ERA 8: A petroleum activity or GHG storage activity, other than an activity mentioned in any of items 1 to 7, that includes one or more activities mentioned in Schedule 2 for which an AES (Aggregate Environmental Score) is stated.

1.4 Proposed Development

The Girrahween Development Phase 1 & Sustain (the Project) will export gas production to a medium pressure delivery point at the QGC owned and operated Bellevue Central Processing Plant (CPP). Low pressure gas will also be delivered to QGC's McNulty Field Compression Station (FCS). Produced water, or Coal Seam Gas (CSG) water will be transported to the water delivery point at the QGC owned and operated McNulty Pond, from where it will be transferred to be processed by the QGC water treatment plants.

As mentioned in Section 1.1, the Project will include the construction of up to around 450 wells within PLs 305, 491, 492, and PL1044, which are currently authorised (i.e., 588 wells) under the SGP North EA (refer to Section 1.2), plus key infrastructure and activities in addition to those authorised under the SGP North EA (refer to Section 2.1).

The development will consist of primarily vertical wells, with deviated wells being implemented where required to manage surface constraints. The development may include multi-well pads (MWPs) of five (5) or more wells per pad with an area of up to 2.12 ha of disturbance depending on design and field constraints.

A Right of Way (RoW) for the construction of the gathering lines, access tracks for wells, and the water transfer export pipeline (i.e., water trunkline) will also be required. For the purposes of this EA amendment, the RoW for the water trunkline of approximately 20 km length will run from the Girrahween FCS to the southern limit of PL492 (i.e., only the on-tenure section, with an average RoW width of around 22 m).

The total disturbance area for the 450 wells and its associated gathering lines, access tracks, and the water export pipeline is provided in **Table 1-2**.

Table 1-2 Girrahween Development Phase 1 & Sustain – Wells and access tracks, and pipeline corridor Disturbance

Infrastructure	Location	Quantity	Proposed/estimated and Approved Land Disturbance
Wells pads	PLs 305, 491, 492, and 1044	For up to 450 wells	394.3 ha
Pipeline corridor ³	PLs 305, 491, 492, and 1044	468.2 km	893.4 ha
Additional access tracks outside the pipeline corridor RoW	PLs 305, 491, 492, and 1044	43.3 km	64.6 ha
Total			1,352.30 ha

This proposed EA amendment seeks to include within the SGP North EA's authorised petroleum activities, a gas processing facility, and a hybrid gas/solar⁴ power station, a temporary accommodation camp, and incidental activities, such as: warehouse, offices, and laydown yards, a water transfer station, and gravel pits. The corresponding environmental impact assessments from these activities and an update to the

³ Total pipeline corridor includes: RoW for gathering lines, access tracks for wells, and the export pipeline corridor (water trunkline).

authorised activities in environmentally sensitive areas (ESAs) and to Prescribed Environmental Matters (PEMs) have been conducted (refer to Section 5).

As mentioned, the additional infrastructure includes a gas processing facility, namely the Girrahween FCS, and gas engines to power the facility⁴, a water transfer station, access tracks, and the supporting field infrastructure (i.e., offices, laydown yards, temporary camps, etc.). Detail of this additional infrastructure and the estimated land disturbance is provided in Section 2.1.

Land disturbance for water monitoring bores for Stygofauna investigation monitoring bores⁵ will also be included in this EA amendment.

Existing roads will be used, with only minor upgrades being done, including intersections.

As mentioned, Arrow Energy is seeking to amend the SGP North EA to execute the first phase of the Girrahween Development and its sustain phase, which will involve the drilling and completion of up to 450 wells. Further disturbance resulting from the development of the remaining existing approved wells under the SGP North EA and to be drilled in future development phases, are not part of this EA amendment request.

1.5 Details of the Proponent

Arrow Energy is an integrated energy company with interests in coal seam gas field developments, pipeline infrastructure and electricity generation.

Arrow Energy is a Queensland based wholly owned subsidiary of Arrow Energy Holdings Pty Ltd, a 50:50 joint venture between a subsidiary of Royal Dutch Shell plc and a subsidiary of PetroChina Company Limited (PetroChina).

Arrow Energy is a Registered Suitable Operator (RSO) in accordance with the Department of Environment and Science (DES) Suitable Operator Register, as required by the *Environmental Protection Act 1994* (Qld) (EP Act). Arrow Energy's RSO registered number is 632276.

1.6 Legislative Context

The EP Act and the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) provide the principle legislative frameworks for facilitating resource projects in Queensland, including SGP North.

Arrow Energy requires an amendment to the existing SGP North EA under the EP Act to enable the construction of key infrastructure to support development of the initial stages of SGP North. Further details regarding legislative requirements and compliance with the requirements under the EP Act are provided in Section 7.

The development will be seeking an additional separate approval under the *Queensland Planning Act 2014* for the authorisation of a solar farm to provide power to the hybrid (gas/solar) power plant located adjacent to the proposed Field Compression Station (i.e., Girrahween FCS) (refer to Section 2.1).

⁴ A hybrid (gas/solar) power plant is proposed to provide power to the gas processing facility and other infrastructure. The gas component of this power plant is part of this EA amendment, whilst the solar component is excluded.

⁵ Requirement under the 'CSG Joint Industry Framework – Managing impacts to groundwater resources in the Surat cumulative management areas under the EPBC Act approvals.

As referred to in Section 3.5.1, Arrow Energy engaged with relevant community representatives through the SGPEIS and the SREIS processes, and continues to engage with local entities and/or groups through the *Arrow Surat Community Reference Group* (ASCRG), the Area Wide Planning (AWP) (refer to Section 4.1) meetings, and local community drop-in information sessions. The ASCRG provides local representatives a consultative forum with regard to Arrow Energy's development of coal seam gas resources within its tenements in the Surat Basin, which can:

- effectively identify issues;
- provide feedback; and
- consider improvement opportunities and initiatives.

Arrow Energy's intent is that the ASCRG be used as a primary vehicle to involve, educate, and recommend initiatives and opportunities for the improvement of matters which might impact relevant communities.

The consultation activities that Arrow Energy has developed, and continues to develop, are in line with the principles as set out under the *Human Rights Act 2019* (Qld), as they enable all people the freedom of expression (*Human Rights Act 2019*, s21). All engagement with Arrow Energy is conducted under privacy rules and regulations to protect stakeholder privacy and reputation (*Human Rights Act*, s25).

Arrow Energy is committed to respecting and upholding the cultural rights of Indigenous people (*Human Rights Act 2019*, s28), and holds Indigenous Land Use Agreements across much of its operational areas. Arrow Energy also has Cultural Heritage Management Plans with relevant Indigenous Groups and undertakes Cultural Heritage surveys prior to any on-ground activity, to ensure any areas of cultural significance are identified and protected.

Where required Arrow Energy will enter into Approved Cultural Heritage Management Plans with the appropriate Native Title Parties over the Project Area.

1.7 Purpose and Scope of this Document

The purpose of this report is to support an amendment application to the Department of Environment and Science (DES) to seek an amendment to Arrow Energy's site-specific EA0001399, and to provide sufficient information to enable DES to decide on the application.

This EA amendment application seeks to authorise a number of proposed amendments to EA0001399 which are described in detail in this application.

The report has been prepared in accordance with the relevant requirements under Section 226 of the *Environmental Protection Act 1994* (Qld) (EP Act), the *Environmental Protection Regulation 2019*, and the DES guideline *Major and minor amendments* (ESR/2015/1684), version 11.00, of 26 September 2023.

1.8 Plan of Operations

Arrow Energy anticipates that the Project will likely commence in 2024. An updated PoO addressing the development activities will be submitted to the DES as required under Section 293 of the EP Act.

1.9 Estimated Rehabilitation Cost

In accordance with Section 297 of the EP Act, Arrow Energy has an estimated rehabilitation cost (ERC) decision in place.

A revised ERC calculation as necessary and applicable in accordance with the EP Act will be submitted to the administering authority for disturbance resulting from the additional activities, which will be lodged prior to commencement.

2. Proposed EA Amendments

Arrow Energy is proposing to develop around 450 wells and their associated access over six (6) petroleum leases (refer to Section 3.1), gathering lines, and incidental infrastructure of the already authorised 588 wells in the SGP North EA (refer to Section 1.2).

To help facilitate the development, Arrow Energy is seeking approval for:

- Additional infrastructure, as described in Section 2.1;
- The addition of environmentally relevant activities as described in Section 2.2;
- An update to biodiversity conditions, as described in Section 2.3 and Section 5.4; and
- Administrative changes, as described in Section 2.4.

A summary of all proposed EA amendments is provided in **Appendix A**.

This EA amendment application does not seek approval for any new produced water storage dams, additional wells, access, and pipelines which are already approved under the EA. Information pertaining to wells, access and pipelines has been included for completeness as part of the application but is not subject to assessment or authorisation.

2.1 Additional Infrastructure

The development will consider the construction of additional infrastructure within the Project area. The additional infrastructure this application is seeking to authorise will include:

- a gas field compression station (FCS), namely the Girrahween FCS, including a multi-point ground flare, and a hybrid gas-fired power plant;
- communication towers;
- multi-well pads (included in the total authorised well count);
- temporary accommodation camps, including irrigation areas;
- gravel pit (s);
- a water transfer station (WTS) in the proximity of the FCS (no water treatment);
- a warehouse and offices;
- extra work areas, access tracks and laydown areas; and
- monitoring bores for stygofauna investigation.

Detail of this additional infrastructure, and the estimated proposed land disturbance is provided in **Table 2-1**.

Table 2-1 SGP North additional infrastructure and estimated proposed land disturbance

Additional Infrastructure	Estimated proposed land Disturbance
Gas Compression/ Comms Towers/ MWPs/ Camps (STPs)/ Gravel pit(s)	
Field compression station, including a multi-point ground flare, a gas-fired power station ⁶ , access tracks, and laydown areas	13.18 ha
Communication towers	5.00 ha
Multi-well pads ⁷	41.10 ha
Temporary accommodation camps, including treated sewage irrigation areas	19.90 ha
Gravel pit(s)	19.90 ha
Incidental activities	
Water transfer station, extra work areas, warehouse and offices facilities, laydown areas, temporary waste storing area, and monitoring bores	72.20 ha
Total estimated proposed additional infrastructure disturbance	171.80 ha

The estimated disturbance based on the additional infrastructure of around 172 ha, as shown in **Table 2-1**, is approximately 13% of the circa 1,400 ha of proposed disturbance already authorised under the SGP North EA for wells, access tracks, and the pipeline corridor (i.e., gathering) (refer to **Table 1-2**).

2.2 Additional Environmentally Relevant Activities

The EA amendment being proposed considers the inclusion of new Environmentally Relevant Activities (ERAs) under the EP Act 1994 and the EP Regulation 2019 to support some additional activities being proposed as presented in **Table 2-1**, mainly electricity generation, fuel burning, and sewage treatment. Therefore, the proposed amendment to the SGP North EA seeks to add the relevant ERAs as per Schedule 2 of the EP Reg 2019, which are the following:

- ERA 14 Electricity Generation, 1: Generating electricity by using gas at a rated capacity of 10 MW electricity or more;
- ERA 15 Fuel Burning: using fuel burning equipment that is capable of burning at least 500 kg of fuel in an hour;
- ERA 16 Extractive and screening activities, 1: Extracting, other than by dredging, in a year, the following quantity of material – (b) more than 100,000 t but not more than 1,000,000 t.
- ERA 63 Sewage Treatment, 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of – (a-i) 21 to 100EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme; or
- ERA 63 – Sewage Treatment, 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of – (b-i) more than 100

⁶ There will be a solar component (i.e., solar farm) for the power station. This is not part of this EA Amendment application.

⁷ 29 multi-well pads will form part of the total well count.

but not more than 1,500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.

The proposed amendment to include the abovementioned ERAs are further discussed in section 4.10.1.

2.3 Update to Biodiversity Conditions

Impacts to biodiversity currently authorised under the SGP North EA (EA000139) are based on concept level design and layouts and are not inclusive of all disturbances necessary for the Project's development. As contemplated, the proposed amendments reflect updates to the Project as well as updates to species distribution and habitat mapping.

While avoiding disturbance to land is a priority, clearing and disturbance within environmentally sensitive areas (ESAs) and impacts to matters of State environmental significance (MSES) are unavoidable. Amendments to Condition (Biodiversity 8a) and Condition (Biodiversity 10) under the SGP North EA are required.

Further, clarification received from DES and DCCEWW requires that impacts on koala (*Phascolarctos cinereus*) be addressed as MSES and not as MNES currently contemplated in EA000139. This is due to the fact that koala was not listed as MNES⁸ at the time of the SGP EPBC 2010/5344 approval and was correctly not included in the conditions of approval, despite being assessed in the SGP EIS and impacts predicted.

Further details of the proposed amendments and inclusions to biodiversity values are specified in Section 5.4 and **Appendix A**, and the detailed biodiversity impact assessment conducted by Attexo Consulting is provided in **Appendix B**.

2.4 Administrative Changes

In addition to the amendments mentioned above, Arrow Energy also proposes to amend a number of administrative changes within the SGP North EA. These are described in detail in **Appendix A**.

⁸In accordance with Section 158A of the EPBC Act, the upgrade of the species status does not impact on the Project as the listing event occurred after the approval process decision (EPBC 2010/5344).

3. Description of the Petroleum Tenures

3.1 General Location

Arrow Energy has interests in more than 65,000 km² of petroleum tenures, mostly within Queensland's Surat and Bowen basins.

The petroleum tenures relevant to the SGP North EA (EA0001399) are PL304, PL305, PL491, PL492, PL494, and PL1044. These tenures are located within the Western Downs Regional Council (WDRC) Local Government Area and are located north east of the town of Miles in Southern Queensland (refer to **Figure 3-1**).

Table 3-1 identifies the blocks and sub-blocks of PLs within the SGP North EA which are administered under the P&G Act. This tenure overlies a land area of approximately 912 km² (91,200 ha).

Table 3-1 Blocks and Sub-blocks of the Project Area

Petroleum Tenure	Locality	Lease Commence Date	Lease Size, ha	Block	Sub-Blocks	Total Sub Blocks
PL304	North of Miles	26 February 2019	7,688	BRIS2018	A-H, J-Z	25
PL305		26 February 2019	7,676	BRIS2163	A-H, J-Z	25
PL491		26 February 2019	23,051	BRIS2019	A-H, J-Z	25
				BRIS2090	A-H, J-Z	25
				BRIS2091	A-H, J-Z	25
PL492	North-East of Miles	17 August 2019	23,026	BRIS2020	Q, R, V-X	5
				BRIS2092	A-C, F-H, L-O, Q-Z	20
				BRIS2164	A-H, J-Z	25
				BRIS2236	A-H, J-Z	25
PL494	South-East of Wandoan	26 February 2019	23,080	BRIS1874	U, Z	2
				BRIS1875	Q, V, W	3
				BRIS1945	A-H, J-Z	25
				BRIS1946	A-H, J-Z	25
				BRIS1947	A-C, F-H, L-O, Q-Z	20
PL1044	North-East of Miles	26 February 2019	7,674	BRIS2165	A-H, J-Z	25

Figure 1-3 depicts the boundaries of the PLs, and **Figure 3-1** shows the relevant blocks and sub-blocks within each petroleum lease.

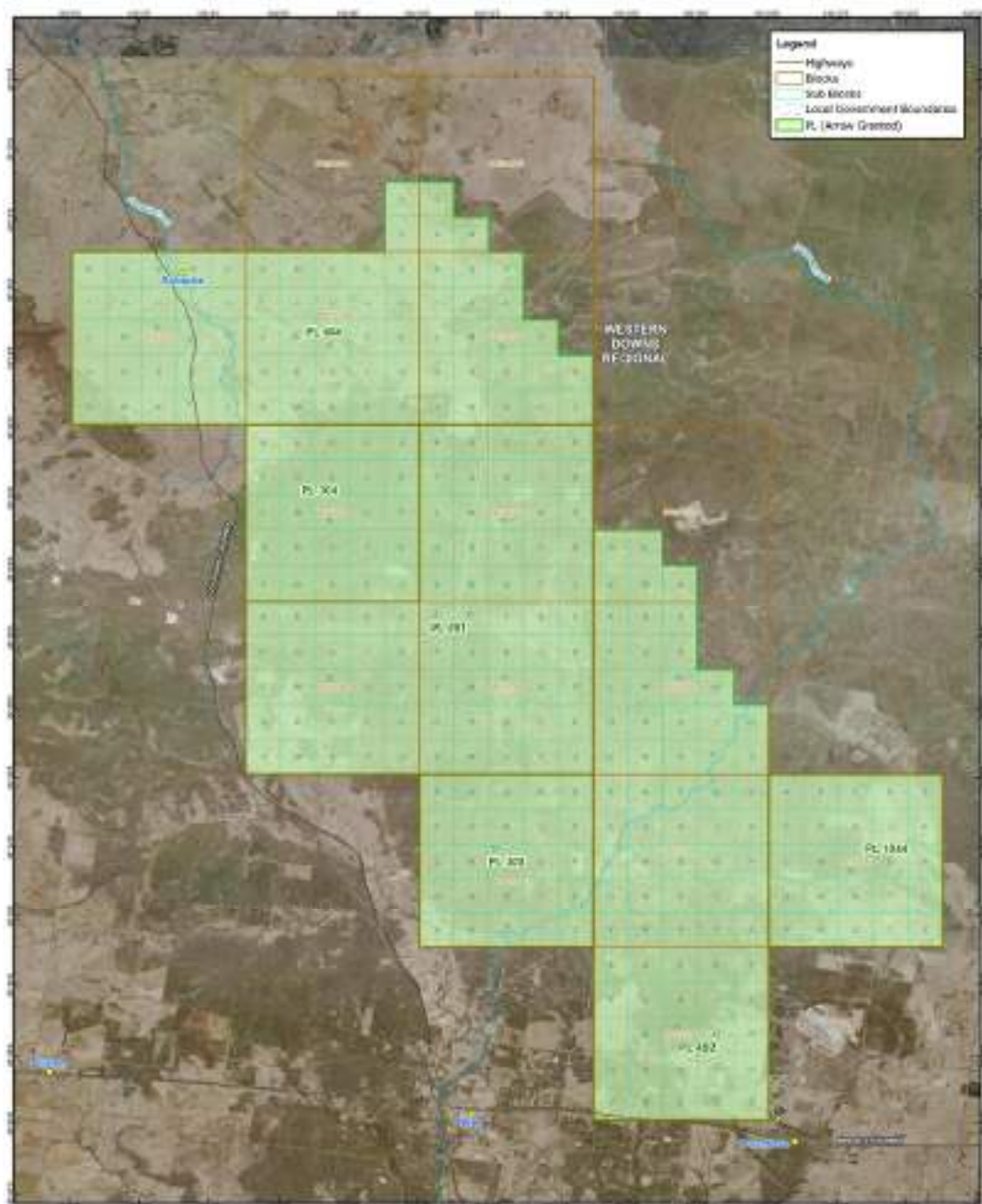


Figure 3-1 Blocks and Sub-blocks granted under the PLs for the SGP North EA

3.2 Land Use

Land use across the Project area and the broader surrounds is predominantly characterised by grazing and bushland, including the Binkey State Forest and Barakula State Forest (refer to **Table 3-2**).

Table 3-2 Queensland State Forests within the Project Area

Petroleum tenure	State Forest Name	Lot on Plan
PLs 304 and 491	Binkey State Forest	60 on FTY287
PLs 491, 492 and 1044	Barakula State Forest	302 on FTY1964

Additionally, mineral extraction encroaches on the western and southern boundaries of the Project area. Thus, depending on the location of infrastructure, post operational land use will include forestry, mining, grazing, or cropping.

Key industries in the wider region surrounding the Project area include CSG exploration and agriculture.

The *Regional Planning Interest Act 2014* (Qld) identifies and protects areas of regional interest throughout Queensland, manages the impact of resource activities, supports resource activities to cohabitate with other activities, for example highly productive agricultural activities and assists in resolving land use conflicts. There are four areas of regional interest defined: priority agricultural areas (PAAs), priority living areas (PLAs), strategic environmental areas (SEAs) and strategic cropping area (SCA).

PLAs in the vicinity of the Project area (but not within) comprise the townships of Miles and Wandoan, located to the south and north, respectively. No PAAs and SEAs are located within the Project area. SCAs are scattered within the Project area, predominantly in the north, with smaller isolated and fragmented portion in the west and south.

Where Arrow Energy's resource activities are carried out in areas of regional interest, a Regional Interest development Approval (RIDA) will be sought where required.

The Binkey State Forest is within the Project Area. Parts of the Barakula State Forest and the Cherwondah State Forest intersect the Project Area.

There are no timber reserves, resource reserves, or unallocated State land within the area of this EA amendment application.

There is area designated as Category A under the Vegetation Management Act 1999 indicating the property is a legally secured offset area. Arrow is not proposing any direct impacts to the proposed property, outside of any existing disturbance (existing access track) that is already in place. Any impacts to the proposed offset area would be done in consultation with the landholder through a CCA.

3.3 Surrounding Resource Activities

The Surat Basin is a coal and coal seam gas resource area. Therefore, there are other active mining and exploration tenures in the region with several mining related tenures located in close proximity to the Project area. The Cameby Downs Coal Mine, located in the south eastern part of PL492 and beyond, is a significant mining development that overlaps the Project area.

3.4 Relationship to Overlapping Tenure and Renewable Energy Projects

There are some overlapping coal resource authorities within the Project area, as per detail provided in **Table 3-3** and **Figure 3-2**.

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Table 3-3 Overlapping Tenures within the Project Area

Coal Resource Authority	Resource Authority Holder	Relevant PL	Overlapping Tenure Agreement
EPC1041	Surat Coal Pty Ltd	PL305, PL 491, PL492 and PL1044	Nil.
EPC1134		PL305	
EPC813		PL305 and PL492	
MDL430		PL304, PL305 and PL491	
EPC732	Syntech Resources Pty Ltd	PL492	Nil.
ML50233			Coordination arrangement in place for overlap between PL492 and ML50233.
MLA50258			JIMP in place within the overlap of PL492 and ML50258 within parties that govern safety interactions. Joint Development Plan in place in respect of PL492 and ML50258 overlap.
EPC2092	SE Qld Coal Pty Ltd	PL491 and PL494	Nil.
MDL451		PL494	
EPC787	Wandoan Holdings Pty Limited	PL494	JIMP in place within the overlap of PL494 and EPC787 and MDL224 within parties that govern safety interactions.
MDL224			Coordination Arrangement in place to the overlap between PL494 and EPC787 and MDL224 entered under the Pre-MERCP legislative regime, although valid.
EPC1015	Fairway Coal Pty Ltd	PL304, PL491 and PL492	Nil.
EPC1165	Sinocoal Resources Pty Ltd	PL491 and PL492	Nil.
EPC2199	Matilda Coal Pty Ltd	PL1044	Nil.

Arrow Energy has a number of commercial arrangements and Joint Interaction Management Plans (JIMPs) for some of these overlapping tenures (refer to **Table 3-3**).

In addition to overlapping tenure, there are also a number of existing and proposed renewable energy projects (i.e. Solar Farms) located across the Project area. The potential for these to limit the footprint of development will be considered on an ongoing basis. These renewable energy projects are not subject to the provisions of the *Mineral and Energy Resources (Common Provisions) Act 2014* but are subject to approval under the *Planning Act 2016*.

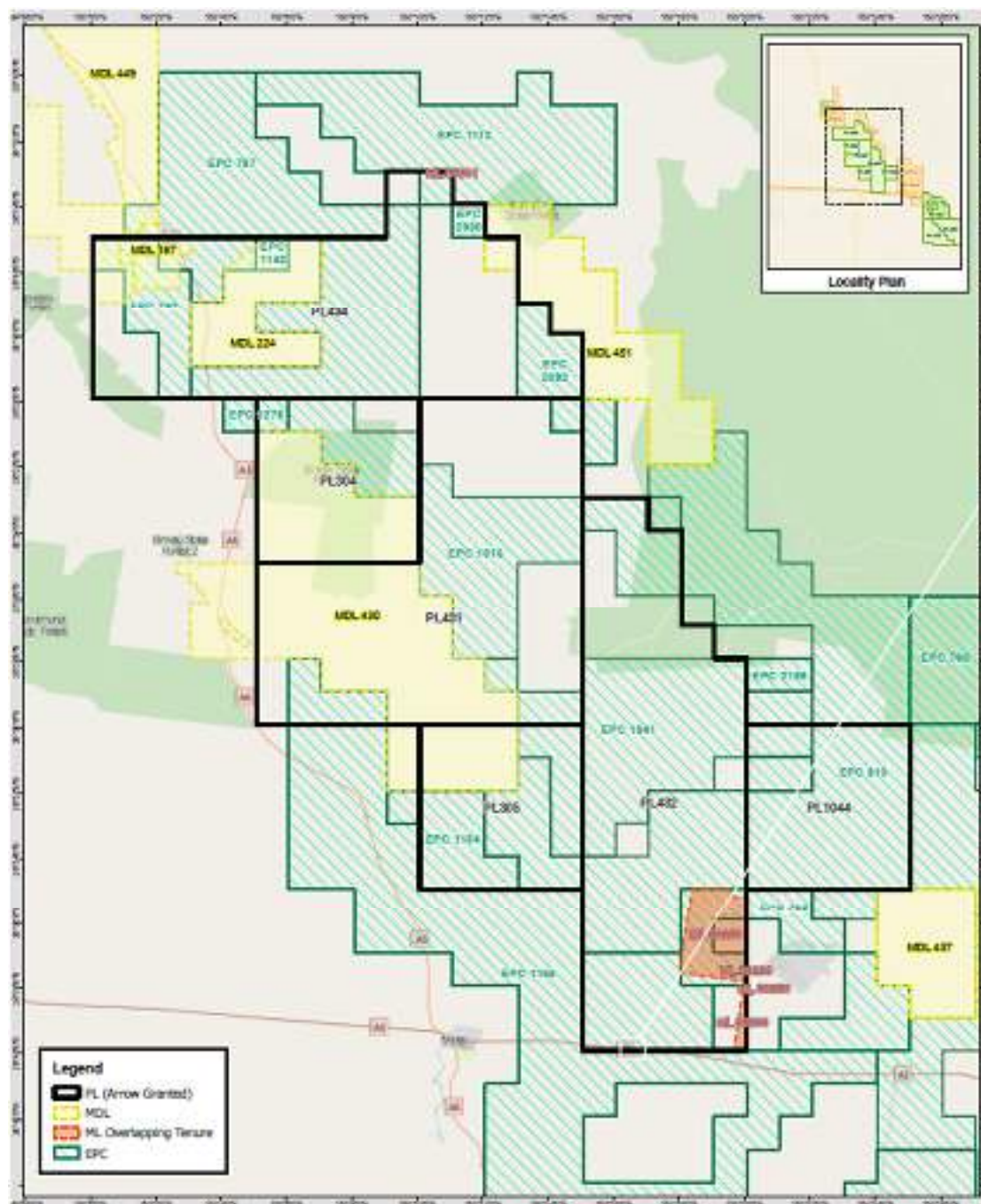


Figure 3-2 SGP North (Tranche 5) Overlapping Tenure

3.5 Community and Stakeholders

3.5.1 Local representatives

For the purpose of this EA amendment application, stakeholders are individuals or organisations who are directly or indirectly affected by the proposed development. These include landowners of properties on which, or adjacent to where Arrow Energy proposes to undertake activities. It also includes nearby communities, Traditional Owners, contractors, local business, local, state, and national government departments, policy makers, advocacy groups and NGOs who have an interest in the development.

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Public consultation on the SGP has been and continues to be extensive (refer to Section 1.6). During the development of the SGP Environmental Impact Statement (EIS), Arrow Energy consulted with representatives of the following entities and/or groups:

- Government departments;
- Government-owned corporations;
- Registered property owners across the entire SGP development area;
- Leaseholders of properties across the entire SGP development area that made themselves known through participation in consultation activities;
- The communities of Dalby, Cecil Plains, Chinchilla, Goondiwindi, Miles, and Wandoan;
- Indigenous groups;
- Local industry, business associations and agricultural associations;
- Environmental groups / associations and community / interest groups; and
- Schools.

Consultation post-EIS continued through the development and approval of the EA for SGP North, including:

- Government: Arrow Energy meets with the Queensland Department of Resources (DOR) on a monthly basis to provide project updates; and also engages with relevant local government authorities and elected officials.
- Indigenous stakeholders: The traditional owners of relevance to the SGP are the Western Downs Unclaimed Area Native Title Group, with which Arrow Energy has an existing Indigenous Land Use Agreement (ILUA) and accompanying Cultural Heritage Protocol. As per the ILUA, Arrow Energy meets with the Group's Committee on a regular basis and engages Western Downs' field crews to undertake pre-clearance surveys in areas of proposed disturbance.
- Community engagements: Project information sessions and opportunities for community groups to raise questions and discuss the SGP development included information sessions held in July 2016, December 2017, January 2018, February 2018, and November 2021. Online forums have also been held. The communities of particular relevance to the activities that are the subject of this EA amendment application are Miles, Guluguba, and Wandoan.

To enable stakeholders the opportunity to engage with Arrow at their convenience, Arrow has a Community Information Centre located in Cunningham Street, Dalby. It is open to the public from Monday – Thursday, weekly.

In addition, all potentially affected stakeholders have the opportunity to obtain information and consult with Arrow Energy via the following platforms:

- Arrow Energy Website for the public domain at Arrow Energy;
- The 1800 Community line or e-mail info@arrow.com.au; and
- Meetings with Government agencies.

Arrow Energy's free call 1800 number and information email address are available to all stakeholders who wish to ask questions, provide feedback, or raise concerns with the Company.

3.5.2 Sensitive Places

The DES guideline, Streamlined Model Conditions for Petroleum Activities (DES, 2016) defines a sensitive places which mean:

- a dwelling (including residential allotment, mobile home or caravan park, residential marina, or other residential premises;
- A motel, hotel, or hostel)
- a library, childcare centre, kindergarten, school, university, or other educational institution
- a medical centre, surgery, or hospital
- a protected area
- a public park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment
- a work place used as an office or for business or commercial purposes, which is not part of the petroleum activity(ies) and does not include employees accommodation or public roads
- for noise, a place defined as a sensitive receptor for the purposes of the Environmental Protection (Noise) Policy 2008

For noise and air impacts, a total of 18 sensitive places were identified as relevant locations for impact assessment (refer to Section 5.1 and Section 5.3) due to the construction and operation of the Girrahween FCS (refer to **Appendix C**). These sensitive places were identified as being those located within a radius of 9 km from the Girrahween FCS and are all dwellings or residential premises.

4. Description of Proposed Project Activities

The Project will involve three distinct phases covering construction, operation, and decommissioning and rehabilitation.

Project activities will include:

- Well pads, gathering lines and access roads;
- Gas compression, power, and industrial water handling;
- Warehouse offices and accommodation; and
- Ancillary activities and communication.

The anticipated activities to be undertaken at each stage of the Project are outlined in this chapter.

4.1 Construction phase

Construction activities for the Project include:

- Development of additional coal seam gas wells, including the construction of well pads and access tracks, drilling and completion of wells, installation of down-hole and surface facilities and potential flare or vent;
- Installation of gas and water gathering pipelines;
- Installation of incidental, ancillary and support infrastructure including, but not limited to, access roads, electrical and communications infrastructure, laydown areas, borrow pits, temporary and mobile camps; and
- Re-instatement and progressive rehabilitation of infrastructure not required for ongoing operations. This includes but is not limited to reinstatement and rehabilitation of wells pads and rehabilitation of gathering Right of Ways (RoW).

Final well and infrastructure locations and route selection for gathering pipelines and access tracks within the Project area will be determined in accordance with Arrow Energy's Area Wide Planning process (AWP).

The AWP process is a program that Arrow Energy has developed to incorporate landholders' knowledge and constraints into the company's wellfield development and infrastructure plans. It includes engaging with landholders to talk through any potential preferences regarding the wells development where it applies in relation to their own current infrastructure or planned infrastructure within the property. Landholders and Arrow Energy work together to identify locations for infrastructure, such as well pads, pipelines, and access tracks, across farming districts and on flood plains. Planning occurs on a 'one-on-one' basis with landholders and, where appropriate, in local area meetings. This process helps Arrow Energy to identify the best locations for gas infrastructure, potentially reduces the timeframes required to negotiate landholder agreements, and to meet Arrow Energy's commitments to coexist with agriculture. This process has commenced and will continue throughout the SGP as the project development footprint expands.

4.2 Operational phase

Operational activities for the Project include:

- Well operation and maintenance, workovers, and flaring and venting where required;
- Gathering system operation and maintenance including High Point Vents (HPVs) and Low Point Drains (LPD);
- Compression of low pressure coal seam gas using single stage screw compressors;
- Generation of power to provide power to the compression facility;
- Flaring of waste gas during outages;
- Maintenance of ancillary infrastructure, such as access roads; and
- Undertaking all necessary and incidental activities to facilitate operation, including but not limited to regulated waste storage and other activities that might be prescribed as an Environmentally Relevant Activity (ERA) under the *Environmental Protection Regulation 1994* (Qld) (EP Regulation), but for the fact that they constitute resource activities that are petroleum activities.

Natural gas and produced water (i.e., CSG water) extracted from the development will be transported to the QGC's Bellevue CPP and McNulty Pond (authorised under EPPG00611313 and EPPG00932613, respectively) for further processing and distribution. These activities are already authorised under related QCLNG approvals and are not included within the scope of this EA amendment application. No new gas or water storage/processing infrastructure is required as part of this application.

4.3 Decommissioning and rehabilitation phase

4.3.1 Land disturbance strategy

Arrow Energy's strategy regarding land disturbance is to minimise overall environmental impact to vegetation, land, native flora and fauna, farmland, and infrastructure (including crops, pastures, and stock), and to facilitate that the smallest practicable area of land is cleared. Where significant disturbance cannot be avoided, land is rehabilitated, is non-polluting and can sustain the current land use with no further mitigation or management measures required once construction or operations have ceased.

In compliance with the conditions under *Schedule H - Rehabilitation* of the SGP North EA, rehabilitation objectives are to facilitate the return of land to a stable, non-polluting state where either the former land use or another specified use as agreed with the State and landowner, and in accordance with the EA conditions, can be resumed.

Rehabilitation is managed under Land Management in Arrow Energy's HSE Compendium Standards for the management of Health, Safety and Environment (ORG-ARW-HSM-STA00001), and applies to stabilisation of operating areas, decommissioning, and final closure rehabilitation to stabilise the land following decommissioning of infrastructure (e.g., plugged and abandon wells), as follows:

4.3.2 Stabilisation

Where land disturbance is undertaken, Arrow Energy ensures that sites are progressively maintained in an appropriate stable condition following completion of construction activities.

Stabilisation, or progressive or interim rehabilitation of disturbed areas is undertaken as practicable as possible following land disturbance. The period of time between construction and rehabilitation of disturbed land that is not required for operations will be minimised to prevent degradation and loss of exposed soils.

Surface structures, equipment and waste materials not required for the operational phase will be removed prior to rehabilitation.

Ongoing monitoring and maintenance is undertaken to ensure the site remains in a stable condition and site records document the areas, volumes, methods, and locations.

4.3.3 Progressive rehabilitation activities

These activities typically include, but may not be limited to, the following rehabilitation measures:

- Backfilling of flowline trenches after pipe laying;
- Remediation of compacted areas by mechanical means;
- Remediation and backfill of drilling sumps;
- Regrading, stabilisation, and re-establishment of vegetation around completed wells (i.e., reducing the size of the well pad);
- Implementing erosion and sediment control measures, where required;
- Assessment and remediation of impacted soils, if applicable;
- Re-profiling significantly disturbed land to a stable landform similar to the original land contours;
- Re-establishing surface drainage lines on significantly disturbed land; and
- Re-establishing vegetation diversity and cover and appropriate fauna habitat.

4.3.4 Decommissioning

Following completion of activities, or when it is no longer required, infrastructure is decommissioned, and above ground infrastructure is removed. This is subject to alternative arrangements being made with landowners and authorised under the SGP North EA.

Subsurface infrastructure will generally remain in situ.

Any contaminated soils will be remediated or removed to a licensed and authorised disposal facility.

Site-specific decommissioning plans are developed as necessary for large infrastructure such as dams, pipelines and gathering networks.

4.3.5 Final land rehabilitation and use

Sites that are rehabilitated, including regular monitoring and timely maintenance of stabilisation and rehabilitation of sites to ensure rehabilitation integrity, are:

- non-polluting;
- provide a stable landform; and
- can sustain the current use of the land with no further mitigation or management measures required beyond the normal management of the land to achieve final rehabilitation acceptance criteria.

Final decommissioning and rehabilitation will occur at the end of individual infrastructure life, taking into consideration a variety of final land use options. The final land use will be determined by considering a number of factors, including but not limited to the following:

- Relevant legislative and regulatory requirements, including SGP North EA conditions;
- Surrounding land uses;
- Landowner requirements;
- Surrounding sensitive receptors and receiving environment; and
- The environmental, social, and cultural values of the area.

Site-specific rehabilitation plans will be developed as necessary.

4.4 Estimated Disturbance Area

The Project area covers an area of approximately 92,200 ha with around 48,971 ha of that area identified as remnant vegetation. The total land disturbance proposed for the Project, which includes the already approved disturbance (wells, access and gathering) of around 1,400 ha (refer to **Table 1-2**), and the additional estimated disturbance as provided in **Table 2-1**, adds to a total of around 1,600 ha of proposed disturbance across the tenure area. This area represents 1.7% of the SGP North EA tenures, and only a 0.3% of the total approved tenure for the whole SGP (refer to Section 1.1). Based on the Annual Return report and data⁹ for the period 1 January 2022 to 31 December 2022, only 71.7 ha of land has been disturbed as at the 31 December 2022, and no disturbance to MSES has been reported.

Further assessment to biodiversity impacts is provided in Section 5.4.3 and **Appendix B**, with the total proposed disturbance for the Project approximately 3.3% of the total remnant vegetation identified in the SGP North EA amendment area (i.e., 48,971.1 ha).

An assessment of impacts from the proposed disturbance has been done utilising a combination of surveyed ground-truthed data over proposed infrastructure locations and indicative proposed locations based on constraints mapping (i.e. topography, environmental, landholder etc). This is then assessed where it overlays ground-truthed ecology data or mapped ecology data to predict impacts. In instances where ground-truthed data for impacts on ecology are unable to be carried out due to land access and landholder constraints, predicted impacts have occurred utilising constraints mapping

⁹ Refer to Annual Return for EA0001399, RET-100343170.

to locate location infrastructure to avoid and minimise impacts. The final layout and location of infrastructure will only be known subject to a signed Conduct and Compensation Agreement (CCA) with the landholder, prior to that final disturbance limits cannot be determined and would only be predicted. Pre-clearance surveys will be carried out in accordance with the EA before disturbance to validate and verify disturbance limits against authorisations within the EA, which will then be used to validate against PEMs impacts and offset requirements as approved in the EA.

4.5 Well pads, drilling and well development

4.5.1 Well pads

Most surface production facilities will comprise a well pad hosting the wellhead, pump drive head, gas engine generator, metering skid including pipework, valves, fittings, and instrumentation.

In general, well construction and operation activities will be undertaken in the following order:

- identification of well location;
- construction of necessary access tracks and well pads;
- construction of accommodation camps for drilling staff (if needed and agreed with the landowner);
- drill site preparation;
- drilling and well completion (setting casing in the well bore and placing a pump down hole);
- installation and operation of well pad infrastructure;
- progressive rehabilitation; and
- monitoring and maintenance.

Arrow Energy's standard for the development wells use steel casing. However, in certain locations, glass-reinforced epoxy (GRE) casings may be used. Each stage of well construction is detailed in the following sections.

The majority of natural gas wells are drilled as a single well per well pad, with each well pad having a disturbance area of approximately 1 ha. Wells are spaced approximately 750 m to 1000 m apart with the final number, spacing and phasing depending on field development optimisation, production performance, landholder consultation and management of other surface constraints, particularly including, environmental constraints.

Arrow Energy are investigating the potential for deviated wells or multi-well pads which would result in well spacing being approximately 1,000 m apart and reduce the overall total number of wells pads to be developed across the Project area. The final decision on the introduction of deviated or multi-well spacing will be subject to sub-surface and surface constraints.

After drilling of the well is completed, a portion of the well pad will be partially rehabilitated to ensure stability of the area following installation of well pad infrastructure.

4.5.2 Well site selection

Development areas are selected based on a combination of geological analysis, reservoir modelling and engineering, each of which will be determined by on-going appraisal activities.

In particular, the factors considered include:

- Landform and topography – a relatively firm and level pad is required;
- Environmental, social, cultural heritage and tenure constraints – avoiding environmentally and culturally sensitive areas, using previously disturbed areas to minimise potential environmental impacts and considering tenure in accordance with the AWP process;
- Landholder disturbance – the location of houses and existing land use will be considered to reduce impacts to landholders and ongoing land use or overlapping tenure requirements;
- Existing site access – upgrading existing landholders' tracks, locating sites close to existing tracks and adjacent to fence lines, where practicable, to minimise impacts associated with access and disturbance to primary production; and
- Constructability for gas and water gathering systems to the well location.

4.5.3 Drill site preparation

Depending upon the type of drill rig used, pre-drill work may include installation of and provision for:

- A hardstand area for the well pad of approximately 100 m x 100 m (1 ha) to facilitate drilling and maintenance activities and infrastructure placement on site. Where wells are constructed on slopes, some cutting may be required to establish a level base which may increase the workspace required for the well pad. This is to allow the correct batters and sediment and erosion control measures to be put in place. In addition areas that are either heavily timbered may have vegetation windrowed on the edge of the lease pad for use in rehabilitation at completion and also to form habitat for species. Or pads could be located in intensely farmed land;
- A drill cutting pit (also referred to as drill sump) is required for storage of drilling cuttings and cement for drilling.
- Recirculation of water into the drilling rig mud system and collection of drill cuttings. Where possible, sump-less drilling techniques may be adopted;
- Fuel storage in accordance with Australian Standard AS1940 *Storage and Handling of Flammable and Combustible Liquids*;
- Transportable buildings for drill equipment, storage, lighting towers, site offices and amenities;
- Drill rig and sub base, generators, mud tank casing racks and pipe trailer loading bays and entry and exit points for vehicles; and
- New access tracks, where required.

When drilling is complete, semi-permanent fencing will be erected around the well site. Appropriate signage relating to restricted entry, fire hazards and protective clothing requirements will be displayed prominently to warn of hazards and required controls. A typical drill site layout during drilling is provided in **Figure 4-1**.

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Vegetation and topsoil will be graded and stockpiled separately for use during partial hardstand rehabilitation.

Well sites will be located principally on flat ground clear of vegetation (i.e. trees and shrubs). Some vegetation may be cleared but tall trees (including hollow-bearing trees) will be avoided as far as possible.

Any clearing will be in accordance with existing relevant conditions.



Figure 4-1 Typical well site layout during drilling

4.5.4 Drilling and well development

Once site preparation is complete, drilling and well completion will be undertaken. Each section of the drill hole will use progressively smaller drill bits, such that deeper sections have a smaller diameter than the section immediately above it. Refer to **Figure 4-2** for a photo showing a typical drilling rig. A different drilling rig may be used for each stage of the hole.



Figure 4-2 Typical Drilling Rig

Drilling will be carried out in stages. To construct a vertical well, a conductor pipe is typically installed to about 6 m with an auger rig. This will be followed by a smaller diameter hole to between 60 m to 500 m in depth by a drilling as shown in **Figure 4-2**. Steel or glass-reinforced epoxy casing will then be run into the open hole and cement pumped in to fill the gap around the casing. Well control equipment will be installed at the surface and tested to verify integrity. A blow-out preventer (BOP) will prevent gas or water leakage while drilling operations are conducted.

The final section is then drilled to the required depth to intersect the target coal seams. Drilling muds, or drilling fluids, being a suspension of solids and additives (e.g. potassium chloride (KCl) solution to aid hole condition through inhibiting the swelling of clay) in a base of water, will be used to aid drilling. Arrow Energy sometimes may use lost circulation materials to cure high fluid losses situation to prevent pipe getting stuck as part of drilling process. Arrow Energy but does not use oil-based or synthetic drilling muds.

In some instance, deviated well drilling practise is employed. The overall well process is similar to that of a vertical well with the exception of directional drilling equipment. More information can be found in the next sections.

Cuttings are removed from the drilling fluids at the rig location using shale shakers. Other dewatering technology may be implemented. The fluids are re-used in the drilling process or disposed of at an appropriately authorised facility once the fluid is beyond standard solids control equipment conditioning capability. Where appropriate, Arrow Energy will reuse drilling mud material in our site rehabilitation or construction activities in accordance with our regulatory requirements.

With regards to preservation of aquifer isolation, Arrow Energy complies with the Code of Practice for the construction and abandonment of coal seam gas wells and associated bores in Queensland. This includes measures to preserve aquifer isolation.

On completion of initial drilling, the formation will be logged with electric logging tools to determine the formation composition. Well-drilling operations are conducted 24 hours a day and generally take up to 3 to 4 days.

Each drill rig will be powered by diesel generators. Depending on the type of drill rig and engine, about 2,000 L of fuel is required per day. Approximately 25,000 L of fuel is anticipated to be stored on each site, with typical individual stored volumes ranging between 10,000 and 20,000 L. All fuel will be stored in accordance with Australian Standard AS1940 *Storage of Flammable and Combustible Liquids*.

A final casing will be installed to cover the reservoir section and to provide additional zonal isolation from aquifers. The well will then be suspended and a cap at the surface to prevent fluid leakage prior to preparation for production.

After the drilling rig leaves the location, the completion rig will arrive on location to finalise the well for production. The completion rig will clean the well and then run the pump, tubing, permanent downhole gauge, and rod string into the well.

The completion rig will finalise the wellhead installation, pressure test it to confirm integrity and then move off site to enable the production surface equipment to be installed. In some cases, the production surface equipment may be installed prior to the arrival of the completion rig.

When the well is ready to begin producing, surface equipment will be connected to the well. Gas and water pipelines will be run from the surface equipment and the separator to a flare stack and/or the Girrahween FCS, and the pond or tanks. The produced water will either flow or be pumped to the surface, thereby lowering hydrostatic pressure in the coals, and allowing gas to desorb from the coal seam and flow into the well. The gas then flows to the surface.

A gas, diesel or electric powered hydraulic unit connected to the top of the wellhead will rotate the pump rods in the wellbore. When pumping is required to remove water, a dewatering pump will be set in the well bore with water transferred up an inner tubing string with gas produced through a surrounding annulus.

The proposed dewatering method will use either Progressive Cavity Pump (PCP) or Electric Submersible Pump (ESP), driven by gas or electric powered surface units. Once at the wellhead, the natural gas and produced water are piped to a separator.

Once separated from the water, the natural gas is piped to the FCS and then on to a CPP.

4.5.5 Drill water management

Water, or drilling fluids and muds (including water, solids, and additives with about 2 to 4% potassium chloride) will be used for primary well control, transportation of cuttings and conditioning of the well hole. Water sourced from untreated or treated produced water or from groundwater bores will be used for drilling purposes and will be delivered in tanker trucks or via the pipeline network. It is anticipated that the volume required will be up to 150,000 L per well.

The water is stored on site either in water trucks, tanks or in constructed drill pits or sumps. Where drill pits are used, they are constructed with upslope drainage to divert stormwater run-off around the pit. The drill cuttings are collected and stored on site in drill pits. Most often, fluid sumpleless drilling techniques are used where all fluids are stored in tanks.

4.5.6 Workovers

Wells may be 'worked over' to improve production. Generally, a workover is required to clean out the well bore or to maintain or change out down-hole pumps used to provide artificial lift to remove water from the coal seams. Some pumping wells may be converted to free-flowing wells for a period of time. Free-flowing wells require workovers far less frequently.

Workovers generally require a workover rig, which are similar to, but smaller than a drilling rig, to enable well flushes, pump installation or changes and other necessary work. The procedure allows field operators to enhance well productivity or maintain downhole equipment. Once the hole is completed by a workover rig, the production wellhead will be re-installed.

A workover rig consists of a derrick, a workover platform with hydraulic powered tongs, a pump, and a BOP. In addition to the initial workover following drilling to complete the well for production, workovers are also carried out on individual wells roughly every two years and each workover takes about three days per well. The actual frequency of workovers on any well depends on well design and well performance.

4.5.7 Deviated or Multi-well pad drilling

Arrow Energy may use deviated or high-angle drilling for field development of multiple wells from a single drill pad (refer to **Figure 4-3**). Use of a single pad for multiple wells is likely to decrease the number of well pads required for project development and increase spacing between pads. Some change in drilling pad layout would be required, but the overall project disturbance footprint would likely be reduced.

The target coal measures consist of multiple coal seams separated by non-coal intervals. To tap into all coals, a well needs to be vertical or deviated (i.e., drilled at an angle) so that they intersect multiple seams. In certain circumstances, multiple wells may be drilled from the same pad. Multi-well pad drilling requires wells to be deviated so that each well drains a separate area of the coals. However, because the target coal measures are shallow, well interception points with the top coals may be too close together for optimum drainage and too far apart in relation to the lowermost coals.

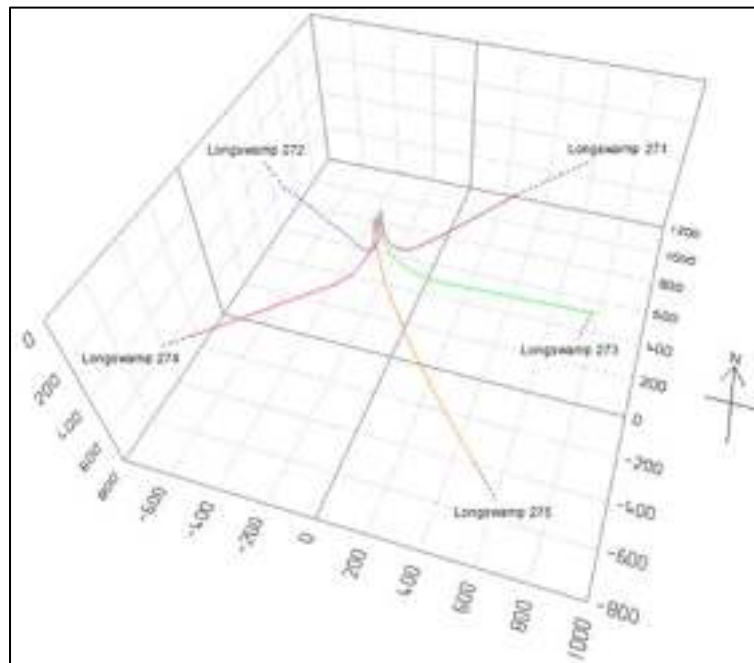


Figure 4-3 Deviated or MWP General Layout

4.5.8 Wellhead production infrastructure

As mentioned in Section 4.5.1, surface production facilities will typically consist of a well pad fitted out with the wellhead, gas-fired generator(s), pumps, pipe work, valves and fittings, instrumentation, and telemetry package (refer to **Figure 4-4**). Some wells will also require a small well-site pump to transfer water to water storage. Arrow Energy may use gas or electric drives as appropriate, depending on final design and layout.

A wellhead seals casing strings and isolates the underground fluids (gas and water) from the surface. The separator is provided with safety devices as protection against overpressure, with vessel design pressure specified to provide a safe margin for the downstream gathering network rating.

The pump is powered by a gas-fired generator to pump water from the wells. Where a diesel engine is present, approximately 2,000 L of diesel may be stored in tanks on

site. One or more two-phase (i.e., water and gas) separators may be fitted to channel water and gas into separate gathering lines.

Wells are equipped with instrumentation and telemetry to transmit information including production and gas flow data to Arrow Energy's control rooms. The control rooms' primary function is to manage and balance gas production against demand, as well as provide a central point for managing and responding to field based process issues. Shutdown triggers are typically due to downstream production constraints but could also include potential well leaks or incidents.



Figure 4-4 Typical well configuration

4.6 Gathering Network

Gas gathering connects wells to the Girrahween FCS. Water gathering lines connect wells to water transfer facilities (tanks or ponds).

4.6.1 Gas and water gathering lines

Typical gathering systems will utilise High-density polyethylene (HDPE) pipes as per Australian Standard AS4130 *Polyethylene Pipes for Pressure Applications and installed in accordance with APGA Code of Practice (CoP) for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*.

APGA CoP will provide requirements for the safe design, construction and operation of a Gathering Network that carries CSG and water.

Low point drains (LPD) skids are installed on gas gathering lines to remove any free water condensed from the gas. High-point vents (HPV) are installed on water gathering lines to release free gas from the water. HDPE pipe sizes used by Arrow Energy range from 110 mm up to 900 mm.

4.6.2 Gathering route selection

Route selection for gas and water gathering is undertaken in consultation with affected landholders and uses previously cleared or disturbed areas where practicable. AWP and constraints mapping will inform route selection of areas of environmental, cultural, or social significance so they can be avoided where practicable. Pre-construction

surveys will be undertaken to verify known constraints and provide additional information where necessary.

4.6.3 Gathering line installation

Arrow Energy's preferred method of laying gas and water gathering lines is by direct installation using standard pipeline trenching methodologies. This involves the following:

- Right of way (RoW) clearance, including vegetation clearing and topsoil stripping;
- Pipe stringing: small diameter pipe (up to 160 mm) via coils, large diameter pipe via 21 m lengths;
- Pipe welding to join supplied lengths into networks;
- Trenching, pipe lowering and trench backfilling/compaction;
- Pneumatic pressure and leak testing;
- RoW rehabilitation including top soil re-instatement;
- Regular communication with affected landholders and patrols to monitor any subsidence for repair.

Construction will be executed progressively by multiple work crews. Depth of pipe burial will comply with the requirements in the APGA Code of Practice for Upstream Polyethylene Gathering Networks – Coal Seam Gas Industry. Gas and water pipelines are collocated as much as possible.

Generally, an average typical RoW width of 22 m is required to allow vegetation clearing, mulching, and stockpiling, stockpiling of subsoils and topsoils, and safe access and movement of personnel and heavy machinery (including trenching machines) and access tracks to the wells. The RoW width is dependent upon the number of gathering lines in the RoW (trenching required), stock piling of additional vegetation clearing, permanent access tracks to wells and work space during construction and/or operational phases.

The current practice is an average ROW width of 24 m with a separate permanent access track. Arrow is planning to implement gathering before drilling strategy that will consider converting vehicle work area into access tracks thereby reducing ROW width (10%) with an average typical 22 m.

4.6.4 Gathering line maintenance

Surface structures including manifolds, low point drains, high point vents, end-of-line risers and isolation valves will be inspected as per Arrow Energy's Network Integrity Management Plan Surat Basin (S00-ARW-PPL-PLA-0003).

Gas transfer export pipeline

A gas transfer export pipeline is proposed to be constructed from the Girraheven FCS to QGC's Bellevue CPP. This pipeline will be subject to a separate pipeline licence and a new EA application. It is noted that the gas pipeline will be co-located in the same RoW as the gathering lines authorised under the SGP North EA to help reduce impacts due to land disturbance. There will be an overlap of 12 to 15 m of RoW width to minimise environmental disturbance.

4.7 Gas Compression, Power, and Water Handling

4.7.1 Field Compression Station

Location and components

The Girrahween FCS, and power station, will be located approximately 18 km north of Miles in the Darling Downs region of Queensland, on PL305 and Lot 16AU38 owned by Arrow Energy. A total footprint of 11 ha will be used for the Girrahween FCS and the power station (refer to **Table 2-1**).

The Girrahween FCS will facilitate compression of low-pressure coal seam gas (CSG) and deliver medium-pressurised gas downstream to a gas sales points. The Girrahween FCS will consist of:

- Four (4) screw compressors which compress the low-pressure CSG with normal throughput of 116 MMscfd and up to 140 MMscfd;
- A power plant to provide electricity for the compressors and Girrahween FCS facilities, which will operate through seven (7) CSG fired internal combustion engines¹⁰ of 3.36 MW with one generator as sparing capacity, which is further discussed in section 4.7.2. A Battery Energy Storage System (BESS) of around 10 MW will be built within the compound and footprint of the Girrahween FCS power plant (refer to Figure 4-5). The BESS will provide immediate power reserves to cover for energy requirements whilst the back-up generator comes online. In addition, a 20 MW solar farm may be built as an incidental activity to help reduce GHG impacts, and offset power usage required at the power plant;
- A multi-point ground flare (MPGF)¹¹ to manage distressed gas and upset conditions, which will normally operate during unplanned outages, maintenance, and commissioning ramp up;
- A slug catcher to remove water in the gas line; and
- Filter coalescers to remove solids, liquids fines and carryover compressor oil in gas line.

Figure 4-5 shows the Girrahween FCS proposed footprint and layout, including the power plant. Total footprint of the FCS and the power plant is provided in **Table 2-1**.

The MPGF is designed to feature a surrounding fence and wall to minimise noise impacts, prevent access by fauna, reduce radiation and to reduce visibility of the flare flame.

Construction

During construction of the Girrahween FCS, it is expected that there will be heavy vehicle movements, buses, and light vehicles to and from site. A Traffic Management Plan will be developed to manage and reduce impacts on local roads and ensuring haulage routes and approved roads are utilised once final logistics and contracts have been confirmed. It is expected that work would occur seven days a week for the

¹⁰Arrow Energy are investigating the potential for a solar farm to provide auxiliary power to the Girrahween FCS. Arrow are investigating the ability to authorise the Solar farm under a development application. The solar farm may be located on PL491 on Arrow Energy owned property.

¹¹A Civil Aviation Safety Authority (CASA) approval is not required for the ground flare as the height is less than 100 m.

duration of the FCS construction but limited to day time hours of 7 am to 6 pm and subject to compliance with the noise conditions in the SGP North EA.

Construction materials including the compressors and gas fired generators, etc. will be brought in from the suppliers and staged at a laydown on site.

A temporary construction office including crib rooms, toilets and ablution facilities will be provided on site at the Girrahween FCS for the duration of the construction and commissioning of the FCS and power station. Upon completion, the office, crib rooms and toilets would be decommissioned and taken off site with the area either utilised as laydown in the future or rehabilitated in agreement with the landholder or back to its previous land use.

Construction of the Girrahween FCS would take approximately 16 months and involve the following activities and typical equipment during the period of peak activity:

- Clear and grade of the site: Grader, D8 Dozer, tipper, bobcat, mulcher, and a couple of light vehicles.
- Constructing concrete foundations: Concrete truck, concrete vibrator, and a couple of light vehicles.
- Installing new components and sheds: a 250 tonne crane for lifting equipment, welding rigs (diesel), angle grinders, pile rig, three (3) Franna 20 tonne cranes, two (2) scissor/boom lifts, two (2) semi-trailers for delivery of equipment, and hand tools.

Commissioning

Commissioning of the Girrahween FCS and the power station will occur at the same time and will require CSG from the surrounding gas fields. As noted above, commissioning will utilise the existing construction offices and facilities, and may require workers to be present for 24/7 operating in two 12 hour shifts, although commissioning usually occurs during daytime, only with occasional night time works when doing compressor test runs. It is estimated that commissioning will last four (4) months.

In the event of upset conditions during commissioning, flaring of gas at the ground flare may occur resulting in visible smoke from the burning of gas for a period of time. Given the design of the ground flare and that methane burns with a non-smoky flame, this is unlikely to occur. The design of the ground flare includes a 16.7m high fence around the perimeter of the ground flare to minimise visual and noise impacts.

Operation & Maintenance

During operations of the Girrahween FCS and the power station, operators (of two (2) to five (5) people) may be located at the offices located at the warehouse and utilise the facilities there. There will not be an oily water pond at the FCS.

During turn arounds and maintenance of the Girrahween FCS, which could occur once or twice a year depending on maintenance scheduling or in the event of an issue, there would be an influx of workers to the site requiring the use of the additional office capacity at the warehouse during these events. It's likely that a turnaround will require 24/7 support operating in two 12 hour shifts to minimise downtime and impacts on gas production.

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In the event of upset conditions during a turnaround or maintenance, flaring of gas at the ground flare may occur.

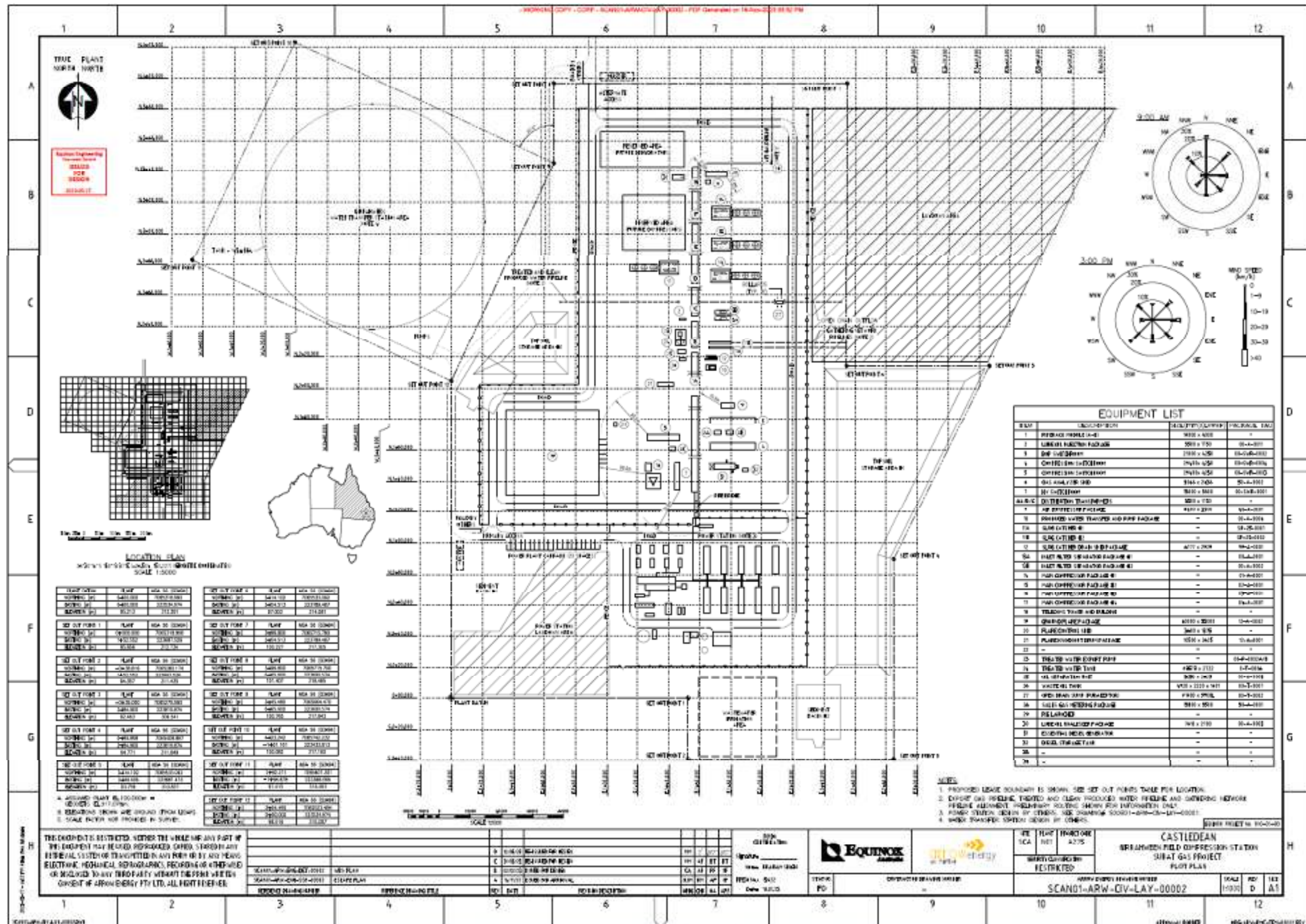


Figure 4-5 Proposed FCS footprint and layout (including power generation)

4.7.2 Power Supply

Location, components, and power supply

As stated in Section 4.7.1, the Girrahween FCS power station will be located within the footprint of the Girrahween FCS.

Power for the Girrahween FCS will be provided via six (6) gas engine generators, with one (1) spare, providing up to 25 MW of power through the use of CSG. These generators will operate 24 hours a day seven days a week to power the FCS. In addition, a BESS will be built within the compound footprint of the power plant and will be used to provide immediate power reserves whilst the back-up generator come online. The BESS will be used to replace spinning reserves, but will also allow for increased renewable penetration by avoiding unnecessary engine running. Power will be provided via a High Voltage Cable from the gas generators, with Supervisory Control and Data Acquisition (SCADA) and or Fibre Optic Cable (FOC) between the two facilities for operations.

Power to the FCS may come from the grid as part of future phasing. This would require an overhead power line (i.e. 132 kV) from a substation located nearby with the powerline corridor to be co-located with existing linear infrastructure (i.e., gathering, access or trunklines) with the appropriate offset (i.e., to avoid low frequency induction with steel pipelines). The overhead power lines may use wooden, steel lattice or concrete towers, with pads every 350m which are approximately 60m x 60m. These pads would require access tracks for maintenance.

The operation of the power station will require the inclusion of ERAs 14 and 15 (refer to Section 0), and as further described in Section 4.10.1.

Power to the Girrahween Temporary Accommodation Camp and the warehouse and offices may be supplied in the future from this power station via a high voltage power line.

Power to the wells will be provided by alternative methods depending on the power requirements and proximity to existing electricity infrastructure. Power to individual vertical wells will typically be provided by a gas fired generator installed on the well pad but may include grid powered well sites in the future.

Wherever possible, power infrastructure (i.e., 11 kV buried or single line power) will be co-located with gas and water gathering lines and adjacent existing roads or access tracks. Additionally, where practicable, power lines will be installed with other infrastructure in a common RoW. This may include above ground High Voltage (HV) power lines to power infrastructure in the future.

Construction

During construction of the FCS power station, it is expected that there will be heavy vehicle movements, buses, and light vehicles to and from site. A Traffic Management Plan will be developed to manage and reduce impacts on local roads and ensuring haulage routes and approved roads are utilised once final logistics and contracts have been confirmed. It is expected that work would occur seven days a week for the duration of the power station construction but limited to day time hours of 7 am to 6 pm and subject to compliance with the noise conditions in the EA. Construction materials including the gas fired generators, etc. will be brought in from the suppliers and staged at a laydown on site.

Temporary construction offices including crib rooms, toilets and ablution facilities will be shared on site at the Girrahween FCS location for the power station construction for the duration of the construction and commissioning. Upon completion, the office, crib rooms and toilets would be decommissioned and taken off site with the area either utilised as laydown in the future or rehabilitated in agreement with the landholder or back to its previous land use.

As discussed in Section 4.7.1 commissioning and operation of the power station will occur concurrently with the Girrahween FCS.

4.7.3 Water Supply and Management

Water supply and volumes required

Water will be required for short term construction activities and ongoing use for drilling, minor use for dust suppression (minor), for hydrostatic testing of pipelines, and for human consumption.

Potable water will be required for camps during construction and operational activities, which will be sourced and trucked from existing town water supplies, or treated from groundwater from bores or Arrow Energy owned dams on site.

Water for construction and dust suppression for the proposed activities may come from a number of potential water sources. These water sources may be from:

- Off-site commercial suppliers (i.e., water service providers) and trucked from Miles, Chinchilla, or other nearby locations;
- Reused treated effluent;
- Produced water, or CSG water, from production wells and installed water gathering lines; or
- Existing Arrow Energy owned water dams.

The use of CSG water will be compliant with the relevant conditions under the SGP North EA or the End of Waste Codes. Water sourced from dams or groundwater wells will be authorised for water supply, i.e., from service providers with the relevant water licences where applicable.

The expected volume of water consumed during construction and operations will be approximately 7 ML per annum and 18 ML per annum, respectively.

Approximate volumes of water required for construction activities are detailed below **Table 4-1**.

Table 4-1 Indicative construction water requirements

Water Requirement	Water Quantity Requirement	Water Source (s)
Wells	1,000 kL per well	Treated water / untreated CSG water of appropriate quality / groundwater / overland flow water
Gathering	1,000 kL/km	Treated water / untreated CSG water of appropriate quality / groundwater / overland flow water
Access tracks	50 kL/km	Treated water / untreated CSG water of appropriate quality / groundwater / overland flow water
Facilities (construction)	35 ML	Treated water / untreated CSG water of appropriate quality / groundwater / overland flow water

Water Requirement	Water Quantity Requirement	Water Source (s)
Dust suppression	As required to meet environment obligations	Treated water / untreated CSG water of appropriate quality / groundwater / overland flow water

Operational activities will require about 1 ML of water per day over the operational life of the development for the following facilities:

- Potable water supplies at camp, offices, warehouse, crib rooms;
- Dust suppression;
- Washdown facilities; and
- Emergency services.

It is generally expected that operational water requirements will be met through the use of treated and untreated produced water. However, should produced water be unavailable due to geographical or timing issues, alternative sources such as groundwater and overland flow/runoff may be sourced for operational requirements.

Water Transfer Station (WTS)

A water transfer station is proposed to be constructed adjacent the Girrahween FCS as depicted in Figure 4-5. The water transfer station consists of:

- An above ground storage panel tank, with nominal size 43 ML;
- Three pumps (two in duty and one on standby);
- Power will be supplied from the adjacent power station; and
- Standpipe and truck loading facilities to allow beneficial use of produced water for dust suppression and construction water etc.

Construction of the water transfer station would require an area of approximately 6.25 ha (refer to **Table 2-1**) to which erect the panel tank and locate the pumps, stand pipe, and provide access to the site.

Commissioning of the water transfer station will require produced water from the surround wells to commission the tank and pumps. Once connected to the water gathering system, water will flow into the tank to and then into the pumps to test where it will be pumped through the system to the McNulty pond on QGCs PL.

The water transfer station has the ability to operate 24/7 seven days a week, however the operational philosophy of the water pumps is to maintain the tank water level between high and low during normal operation and manage inflows before the water is pumped to QGC for treatment and beneficial use.

Water gathering system

The water gathering system will convey water from the wells to a centralised facility (i.e, the Girrahween FCS and the WTS), and will follow the path of the gas gathering system. HDPE water gathering lines will be installed, ranging from 110 mm to 1000 mm nominal diameter and will include Low Point Drains (LPD) and High Point Vents (HPV).

Where practicable, water lines, gas lines, fibre optic cables and power cables will be installed in a common Right of Way (RoW). The RoW width for the co-located facilities

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will be up to 40 m. This exclude the Girrahween to Bellevue pipeline RoW, i.e., the combined pipeline and petroleum lease clearing will be up to 47 m (refer to **Figure 4-6**).

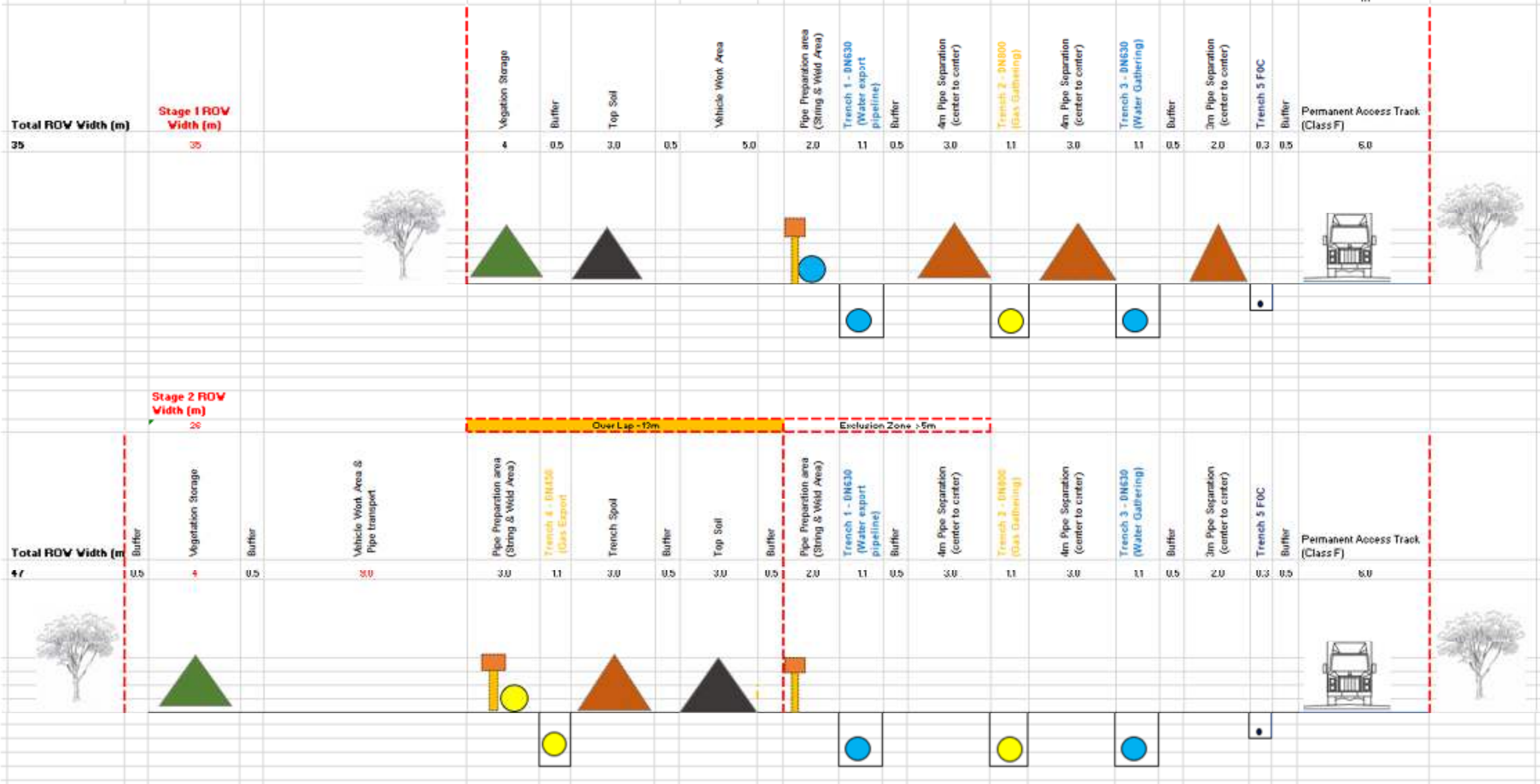


Figure 4-6 RoW collocation with the Girraheen to Bellevue (G2B) pipeline

Generally, the gathering network will be installed by conventional trenching with a trenching machine. Where the gathering network is required to be installed below existing roads or infrastructure, other trenchless technologies such as horizontal directional drilling (HDD), thrust boring or micro tunnelling may be used.

Conventional trenching involves an open trench as deep and as long as needed to install, inspect, or maintain piping, conduits, or cables. After the pipeline installation is completed, the trench is backfilled with soil, compacted equivalent to surrounding soils, reinstated in the same order it was removed and the topsoil spread across the surface.

High point vents

High Point Vents (HPVs) will be constructed along the water gathering network to catch and remove gas accumulating in the gathering system and to maintain the hydraulic performance of the lines as shown in **Figure 4-7**.



Figure 4-7 High point vent (HPV)

HPVs are typically vented to the atmosphere however some areas may have sufficient waterline pressure to be able to inject the gas to the gas gathering system. The required location of HPVs is dependent on the topography of each trunkline and will be determined as the gathering network is refined. The number of HPVs is subject to preliminary studies and optimally most of the accumulated gas will be released in the first one or two HPVs from each well site.

The design criterion for HPVs are:

- Minimise physical footprints aboveground;
- Atmospheric vents on water lines are to be used in rural locations only, preferably away from landholder properties;
- Not Normally Manned; and
- Automated operation.

Low point drains

Low Point Drains (LPDs) will be constructed to manage liquid accumulation in the gas gathering system. A LPD consists of an oversized tee piece on the pipeline to catch

liquid and transfer it to the water line. There is also a surface pump for injection of the removed water into the adjacent water pipeline.

The design criteria for LPDs are:

- Environmental – eliminate discharge of CSG water to grade;
- Health, Safety, Regulatory Compliance;
- Stakeholder and land access – minimising surface impacts and footprints;
- The location of LPD pad and associated infrastructure will be carefully selected with consideration to factors such as terrain slope, ground disturbance, proximity to water courses, flood levels during wet seasons, and the presence of rock;
- Not Normally Manned; and
- Automated operation.

Water transfer export pipeline

A water transfer export pipeline is proposed to be constructed from the Girrahween field to QGC's McNulty pond (refer to Section 2.1). The section of this pipeline that goes off-tenure from PL492 to the south will be constructed under a separate pipeline tenure and is subject to a separate new EA application.

4.8 Warehouse, Offices and Accommodation

4.8.1 Warehouse and offices

A warehouse and offices area are planned to be constructed to support with the construction and commissioning of the Girrahween FCS and power station, and the associated infrastructure. These facilities will have a dedicated access and will remain during the operation phase, and up to decommissioning, and will include:

- Warehouse and offices, including a first aid clinic facility;
- Laydown areas;
- Vehicle fuelling areas;
- Vehicle washdown facility with an oily water interceptor pit that would be cleaned out by a regulated waste authorised contractor;
- An 'all weather' two lane access road;
- A carpark for light and heavy vehicles, and buses; and
- A regulated waste collection and temporary storage area, until regulated waste is taken out by a regulated waste authorised contractor, and including general waste and recyclables.

It is estimated a total land disturbance of 10 ha for these facilities (refer to Section 2.1 and **Table 2-1**).

The offices will be used during turnaround and maintenance shut downs of the Girrahween FCS on a 24/7 basis. There will be small office operations up to 30 people for construction, irrigation area, and ablution facilities and showers. It is estimated that during operations there will be 4 to 5 people located at the warehouse and offices.

The warehouse and offices will require the inclusion of ERA 63 for the treatment of sewage (refer to Section 4.10.1), with a sewage treatment plant (STP) and a spray irrigation field required to manage the treated effluent from toilets and ablution facilities.

Power to the warehouse and offices facilities may be supplied through a reticulated line from the FCS power station once it is running. Two diesel generators of 143 kVA size requiring 10-15 m³ of diesel storage capacity will provide power whilst future connections to the power station, or alternative power sources are finalised.

Potable water for human consumption will be sourced locally and trucked in and treated via a small water treatment facility if required.

Traffic impacts during construction and commissioning will be managed through a traffic management plan, which will be prepared once the accommodation and logistics strategy is finalised. Impacts due to traffic will be minimal during operations.

4.8.2 Accommodation and Vehicle movement

There may be the need to establish small, short term temporary accommodation to support the early establishment of works of the development (e.g. construction of the FCS, power station, warehouse).

Options for the accommodation requirements are:

- Using hotels, motels, and third party accommodation around the respective areas, i.e., in the nearest townships of Miles (17 km) and Wandoan (23 km); and
- Using a temporary accommodation camp in proximity to the warehouse, offices, and the Girrahween FCS.

Girrahween Temporary Accommodation Camp

The nature of the work for the construction and commissioning of the FCS, power station, and the development of the initial phase of wells, gathering and access would require construction workers to be located close to the workfronts for approximately three (3) years from commencement of construction, or until construction and commissioning is completed for the FCS and the power station.

In the event that there is insufficient existing local accommodation to house the influx of workers due to the development, the temporary construction workforce may be required to be housed in a proposed temporary accommodation camp of around 350 Equivalent Persons (EP) (i.e., the Girrahween Accommodation Camp), which would be built within the Project area. The estimated disturbance for the Girrahween Temporary Accommodation Camp is 12 ha.

Potable water supply for the camp could come from groundwater wells or existing surface water supplies where it would be treated for consumption by a small water treatment plant located at the camp, or it could be trucked in from an existing municipal supply subject to availability and health and safety constraints.

Power for the camp will come from diesel generators, with power to potentially come from the on plot power station in the future via a high voltage power line subject to availability.

The Girrahween Temporary Accommodation Camp will require the inclusion of ERA 63 for the treatment of sewage (refer to Section 4.10.1). A sewage treatment plant (STP) and a spray irrigation field will be required to support the camp to manage the treated

effluent from ablution facilities at the camp. The area required for irrigation with treated effluent will be subject to a Model for Effluent Disposal Using Land Irrigation (MEDLI) and will be submitted to the department for assessment prior to use as per the SGP North EA conditions.

Upon completion of construction and commissioning of the FCS and power station, the Girrahween Accommodation Camp would be decommissioned, and the site rehabilitated back to pre-existing condition, or as agreed with the landholders.

Should any additional overflow accommodation be required during construction and for any ongoing operations, accommodation will be provided in the local townships of Miles or Wandoan, as the closest towns to the Project area, or at other existing camp providers or hotel accommodation. Arrow Energy seeks to support local content by using existing accommodation where appropriate.

Vehicle movements

There will be a number of vehicle movements during construction of the FCS and the power plant. Depending on the final location for the accommodation of the workforce, workers could be transported daily by bus to the FCS location along existing highways and roads to site, or from the Girrahween Accommodation Camp, which is planned to be on the same property as the FCS, with construction taking place 7 days a week.

Table 4-2 provides the estimated volumes of heavy vehicle and light vehicle traffic to the Girrahween FCS during construction, considering two possible scenarios, this is, from the local townships of Wandoan and Chinchilla, and from the proposed Girrahween Temporary Accommodation Camp.

Table 4-2 Estimated Light Vehicle and Heavy Vehicle traffic scenarios to the Girrahween FCS during construction

FCS Traffic without Arrow Camp from Town		FCS Traffic with Arrow Camp	
Traffic Infrastructure	FCS; Power Station; WTS	Traffic Infrastructure	FCS; Power Station; WTS
Timing	2024 - 2025	Timing	2024 - 2025
Heavy Vehicle count	7409	Heavy Vehicles count	7409
Light Vehicles count	8800	Light Vehicles count	2200

Temporary Mobile Drilling Camps

Mobile drilling camps will be required within the Project area, which will be located in close proximity to the wells and in existing disturbed areas where possible, or on the well pads.

The temporary drilling camps consist of demountable buildings which are packed up and moved to the next site to support the drilling campaign but also to support well work overs and ultimately plug and abandonment and decommissioning. These self-contained camps will be sized appropriately for the workforce and will generally provide accommodation, kitchen facilities, communications, mobile sewage treatment facilities, bunded fuel storage areas, and waste collection and segregation facilities.

Power supply to the mobile drilling camps will be provided via two (2) x 168.7 kVA diesel generators and potable water will be supplied by tankers.

Sewage from these temporary drilling camps will be managed in accordance with the EA conditions.

The additional area required for the temporary camps would only be in place for a short duration during the construction of the wells. These mobile drilling camps would then move to the next area to service the next lot of well construction.

Operational accommodation camp

A small operational camp of up to 100 EP may be required to be located at the same camp location for a longer period of time to support the operation of the Girrahween FCS, but also during turnarounds of the FCS which would require staff to be located in close proximity due to their 24/7 nature which can occur once or twice per year depending on maintenance scheduling.

Power for the operational camp could be provided from a diesel generator or via high voltage power from the nearby power station at the Girrahween FCS.

4.9 Communications

Telecommunications for the development will include the following systems:

- Well site telemetry systems;
- Telecommunications towers and connections via a combination of Microwave and fibre optic cables (FOC);
- Mobile (wireless) communication (e.g., mobile phones and two-way voice communications such as hand-held radios and vehicle mounted radios);
- Vehicle tracking systems (e.g., vehicle location, speed, braking force, etc.);
- CCTV for security and site monitoring (e.g., dam water levels);
- Intruder detection systems for either perimeter (i.e., fence line) mounted or subsurface 'listening' devices; and
- Access to Arrow Energy's corporate voice and data network from manned locations and remote offices.

These systems will be supported by a combination of a high-speed networks and secure wireless solutions. The high-speed network would interconnect the production wells and production facilities.

A fibre optic system backbone will be installed to transmit data for monitoring and remotely controlling all wellheads and CSG facilities (e.g., a Supervisory Control And Data Acquisition (SCADA) system)). It is planned this will be installed at the same time as the gathering lines and in the same right of way (RoW), and placed in the same trenches as the low and medium pressure gas gathering pipelines.

The secure wireless system will provide coverage across the gas field and provide telecommunications to the wells for telemetry and CCTV.

Five (5) communication towers are proposed to be installed within the Project area (refer to Section 2.1).

4.10 Ancillary Activities

4.10.1 Environmentally Relevant Activities

As mentioned in Section 0, the amendment to the SGP North EA considers the inclusion of new ERAs under the EP Act 1994 and the EP Regulation 2019, to support the additional activities being proposed for the development. In addition to the activities described in Section 4.5 and Section 4.6, the development is required to be supported by, but not limited to the ERAs as indicated in **Table 4-3**.

Table 4-3 Additional ERAs to be included in SGP North EA (EA0001399)

Ancillary ERA ¹²	Threshold	Facility (ies)
Schedule 2 Part 3 Energy related services – 14 Electricity Generation	1: Generating electricity by using gas at a rated capacity of 10MW electricity or more.	Girrahween FCS Power Station
Schedule 2 Part 3 Energy related services – 15 Fuel Burning	Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	Girrahween FCS Power Station
Schedule 2 Part 4 Extractive activities – 16 Extractive and screening activities	Extracting, other than by dredging, in a year, the following quantity of material – (b) more than 100,000t but not more than 1,000,000t.	Gravel Pit ¹³
Schedule 2 Part 13 Water treatment services – 63 Sewage treatment 1, (a-i)	Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of 21 to 100EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	Girrahween Warehouse/Offices facilities and Temporary Mobile Drilling Camps (MDCs)
Schedule 2 Part 13 Water treatment services – 63 Sewage treatment 1, (b-i)	Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of more than 100 but not more than 1,500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	Girrahween Temporary Accommodation Camp

4.10.2 Notifiable activities

The EP Act enables listing of land on the environmental management register (EMR) if either a notifiable activity has been or is being conducted, or the land is contaminated land. The DES will consider the need to list land on the EMR where a notifiable activity is being carried out on the land.

As described in Section 2.1, the following notifiable activities have been identified within the Project area:

- Notifiable Activity 29 Petroleum product or oil storage – storing petroleum products or oil, 2: in above ground tanks with – 3. Petroleum products that are combustible

¹² Environmentally Relevant Activities as per Schedule 2, *Environmental Protection Regulation 2019* (Qld).

¹³ One of two proposed options (refer to Section 2.1).

liquids class C1 or C2 in Australian Standard AS 1940, *'The storage and handling of flammable and combustible liquids'* – more than 25,000 litres capacity.

Arrow will review whether there are properties on the EMR/CLR within the SGP North EA area which may be required to be notified and included on the environmental management register (EMR).

4.10.3 Roads and access tracks

Roads

Minor upgrades to unsealed roads and intersections will be conducted within the Project area. The standard for roads will follow the 'typical road' design as per the WDRC standard for rural access roads¹⁴ where applicable. There will be some widening of existing roads to support the facilities and well delivery access which will be determined during the design phase.

The total estimated land disturbance for roads and intersections within the Project Area is 25.4 ha, with 16 ha on new roads and 9 ha for upgrades to intersections.

Wells and gathering access tracks

Access tracks will be required for all proposed activities, including well sites, and gathering line ROWs. Wherever possible, existing (gazetted) roads and tracks (farm and landholder tracks) will be used. Actual access routes will not be determined until the final well sites and pipeline routes have been chosen. The location of access tracks and upgrading of existing tracks will be completed in consultation with the relevant landholders with a view to minimising environmental impacts. As a result, access tracks may potentially provide a beneficial use for the landholder by allowing additional access to and on the property or providing an upgraded all weather access track.

Access tracks will be constructed within an average typical RoW width of 22 m. Additional working space may also be required to facilitate creek crossings and safe vehicle movement (e.g. for additional sediment and erosion control at creeks and for turning and passing bays for vehicles).

In some locations, all weather access tracks will be constructed, or existing roads upgraded to ensure access to facilities such as the FCS, warehouse etc are accessible during wet weather conditions. In these instances, this may be in the form of sealed dual carriageway roads.

Additional working space may also be required within ESAs or their associated protection zones to facilitate creek crossings and safe vehicle movement (e.g. for additional sediment and erosion control at creeks, vegetation, and soil stockpiles and for turning and passing bays for heavy vehicles).

4.10.4 Laydown areas and workspaces

Additional laydowns are required to support construction and operational activities proposed. Should temporary project office structures be required, these will be collocated within associated development footprints, such as laydown areas.

Laydowns will be required to the temporary storage of equipment such as piping, building materials as well as for machinery. Additional workspaces may be required for the temporary stockpiling of vegetation, topsoil, subsoil, bell holes for Horizontal

¹⁴ Typical road design is 7 m formation with 5 m gravel traffic width, and 1 m shoulders either side of the formation

Directional Drilling (HDD), Thurst Boring or Micro tunnelling under roads, rail lines and watercourses.

4.10.5 Gravel pit

Quarry materials are required throughout the life of the Project, with its initial use being for short term construction of roadworks, hardstands and concrete works during the construction and commissioning phase.

Quarries and/or gravel pits are also the source of material such as foundation aggregate for the construction of well pads and access tracks as is reasonably required.

For the purposes of this EA amendment, the material will be sourced from either authorised quarries or an on-site gravel pit.

The location of gravel pits depends on a variety of factors including:

- Whether a source of suitable quarry material can be identified from within Arrow Energy's tenements, or failing this, within the local area or region;
- The significance of impacts to the local environment; and
- The significance of impacts on roads and traffic from transporting quarry material if this is to be sourced from local or regional sources.

When determining the location of gravel pits, potential sites will be assessed on a case by case basis using Arrow Energy's AWP process and utilising the findings of the geotechnical investigation, to determine the appropriate size and depth of the gravel pit. The aim of this undertaking is to minimise the environmental disturbance and impacts resulting from gravel pit development by identifying the maximum amount of available material at that location.

The number of gravel pits required for the Project area will depend on the area and depth of each gravel pit and the quarry material it may supply, and in securing the relevant landholder agreements that may be required to develop pits in the identified locations. Disturbance of land will be required for the establishment of gravel pits, and two options are being proposed for the Project (refer to Section 2.1.).

4.10.6 Waste generation and management

Waste generation

The construction, operation, and decommissioning and rehabilitation of the Project is expected to produce solid, liquid, and gaseous waste streams. Depending on the waste characteristics, these can be classified as general waste, inert or organic waste, recyclable waste, or regulated waste.

The anticipated typical wastes expected to be generated from the Project during construction, operation, and decommissioning and rehabilitation are presented in **Table 4-4**.

Table 4-4 Expected Waste streams and examples of waste types from the Project during construction, operation, and decommissioning and rehabilitation

Project Activity	Waste Stream / Characteristic	Examples of waste Type (s)
Construction of wells, gathering systems, and facilities	Solid / Regulated	<ul style="list-style-type: none"> Contaminated soils Drill cuttings and residual muds Used lubricating oil and filters Debris from pipe blow-outs (i.e., cleaning)
	Liquid / Regulated	<ul style="list-style-type: none"> Chemicals (spent/unused solvents, paints, oils, etc.) Drilling fluids Wastewater (greywater and sewage) Contaminated hydrostatic test water
	Solid / Organic	<ul style="list-style-type: none"> Cleared vegetation
	Solid / Inert	<ul style="list-style-type: none"> Soil
	Solid / Recyclable	<ul style="list-style-type: none"> Empty drums and containers Wood pallets Scrap metal Paper and cardboard Scrap swarf (high definition PE fillings) Unused composite pipe
	Gaseous / Air contaminants	<ul style="list-style-type: none"> Nitrogen oxide Sulfur dioxide Carbon monoxide Particulate matter
Operation of pipelines and facilities	Solid / Regulated	<ul style="list-style-type: none"> Crystallised salt / brine Activated carbon filters Filter cartridges Batteries Oily rags and sorbents Contaminates empty drums and containers Grease Sewage sludge
	Solid / Inert	<ul style="list-style-type: none"> Concrete Cut and fill materials
	Solid / General waste	<ul style="list-style-type: none"> Office consumables Kitchen refuse
	Solid / Recyclable	<ul style="list-style-type: none"> Paper, plastics, glass Packaging materials Non-contaminated empty containers Plastic pipe cutoffs/scrap Electric cable waste Steel cutoffs and scrap metal Rubber and tyres
	Solid / Organic	<ul style="list-style-type: none"> Wooden pallets and timber

Project Activity	Waste Stream / Characteristic	Examples of waste Type (s)
	Liquid / Regulated	<ul style="list-style-type: none"> • Produced water (or CSG water) • Wastewater (greywater and sewage) • Domestic cleaners • Fuels • Oils • Chemicals, paints, and cleaning acids • Contaminated stormwater runoff • Piggings waste (water and sludge) • Pesticides and herbicides • Wash out liquids
Decommissioning and rehabilitation	Solid / Regulated	<ul style="list-style-type: none"> • Debris • Chemical or oil contaminated soil • Sludge
	Solid / Inert	<ul style="list-style-type: none"> • Concrete
	Solid / Recyclable	<ul style="list-style-type: none"> • Electrical cables • Fencing • Gas compressors • Gas pipelines • Production wellheads • Power generators • Pumps • Sewage treatment plants and tanks • Storage tanks

Details for the proposed management practices for the waste streams as per **Table 4-4** are described in Section 5.10.

Regulated waste management

The storage of produced water (or CSG water) as regulated waste is currently authorised under the SGP North EA via the ERA 62 *Resource recovery and transfer facility operation*¹⁵ under the EP Reg 2019. This includes CSG water stored in dams authorised under the SGP North EA (refer to **Table 1-1**).

CSG water is gathered via a network of buried HDPE low pressure pipelines to a series of aggregation dams (refer to **Figure 4-8**). Arrow Energy defines its dams as follows:

Aggregation Dams

These dams are used to contain CSG water from the gathering network and provide a buffer to address variations in CSG water production and water treatment capacity. Three (3) dams, Kedron Dam, Castledean Dam and Punchbowl Dam are currently located within the SGP North area on PL304, PL305, and PL1044, respectively. No new dams to store CSG water are planned as part of the Project.

Treated Water Dams

¹⁵As per EP Reg 2019 Schedule 2, Prescribed ERAs, and aggregate environmental scores, Ancillary 62 – Resource recovery and transfer facility operation – 1 (c) – Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 2 regulated waste.

These dams contain treated CSG water. Treated water dams provide a buffer between treatment plant output and beneficial use demand. There will be no treated CSG water dams located within the Project area.

Brine Dams

These dams contain brine produced from the reverse osmosis water treatment process. There will be no brine dams located within the Project area.

As there will not be a gas processing facility within the Project area, there will be no dams to contain waste lubricants and chemicals used in treatment and compression systems.

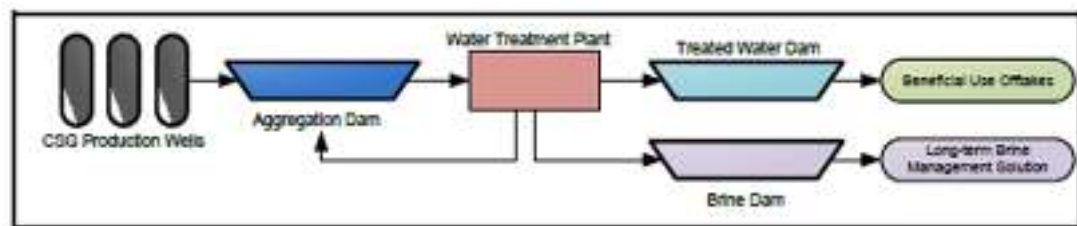


Figure 4-8 Conceptual diagram of CSG water management

CSG water produced from the CSG production wells and associated water gathering system from the Project will be transported through the water transfer export pipeline to QGC's McNulty Pond and then to QGC's water treatment facilities. These facilities are located outside the Project area.

Further details regarding the management of CSG water is described in Section 5.10.5 and in Coal Seam Gas Water Management Plan (refer to **Appendix F**).

Other regulated waste are potentially anticipated to be produced, which includes spent hydrotest water, used batteries, waste water from vehicle wash downs, plant and equipment oils, and lubricants aggregated in Intermediate Bulk Containers (IBCs) with bunding. These wastes will be collected and transferred offsite via an authorised regulated waste contractor.

Temporary storage of other regulated waste may be required to be undertaken as an incidental activity for this development, should regulated waste be produced.

As previously described in Section 4.8, workers could be accommodated at existing accommodation facilities within the local townships or within the proposed temporary construction camp pending final logistics plans and requirements. As such, sewage generated from these facilities will be managed in accordance with the relevant SGP North EA conditions.

Sewage from temporary camps and offices facilities will be treated through Sewage Treatment Plants (STPs), and the treated sewage effluent will be managed in accordance with proposed SGP North EA conditions.

The Model for Effluent Disposal Using Land Irrigation (MEDLI)¹⁶, which will be submitted to the administering authority as per proposed conditions in the EA, has been used for designing and analysing the effluent disposal for the proposed STPs, using land irrigation as a reuse option. The suitability of the proposed sites to receive irrigated

¹⁶ This tool is recommended by the Queensland DES for assessing the viability of long term treated effluent irrigation.

treated effluent from onsite packaged-style STPs associated with the camps and the warehouse and offices facilities, which are predominantly temporary in nature.

Other waste management

Waste is managed by Arrow Energy in accordance with the requirements of the *Environmental Protection (Waste Management) Regulation 2000* (Qld) and the *Waste Reduction and Recycling Act 2011* (Qld) and waste management measures detailed in Section 5.10.5, which applies to both construction and operational activities.

The warehouse facility may contain a number of small waste aggregation yards where bins for various solid and liquid waste materials are stored. Site personnel empty waste into these bins and waste is collected by licensed waste management contractors.

Waste management practice throughout Arrow Energy's operations is routine collection of solid waste, solid recyclables, and liquid waste, contracted to established mainstream waste management contractors. Post collection, the waste contractors manage each material via their procedures.

5. Assessment of Environmental Impacts

5.1 Air Quality

5.1.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on air quality for the Project.

- *Environmental Protection Act 1994 (Qld)* (EP Act): The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development. The Environmental Protection Regulation 2019 provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to ESAs.
- *Environmental Protection Policy (Air) 2019* (EPP (Air)): This policy sits under the EP Act and aims to protect and enhance environmental values relating to Queensland's air environment. The EPP (Air) provides air quality objectives for the protection and enhancement of the environmental values.
- *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air Quality NEPM, or AAQ NEPM). The AAQ NEPM provides a nationally consistent framework for jurisdictions to monitor and report ambient air quality through setting reporting standards for key air pollutants. The AAQ NEPM contains standards and goals for six common air pollutants, commonly referred to as criteria pollutants (i.e., sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, particles, and lead).

5.1.2 Description of environmental values

In accordance with the EPP (Air), the environmental values that are to be enhanced or protected include:

- The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems;
- The qualities of the air environment that are conducive to human health and wellbeing;
- The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures, and other property; and
- The qualities of the air environment that is conducive to protecting agricultural use of the environment.

For the Girrahween FCS location, as all nearby sensitive receptors are dwellings or residential premises, the air quality environmental value for protection human health and wellbeing is relevant for this EA amendment (refer to Section 3.5.2). However, the air quality assessment shows that the air quality criteria for protection of all air quality values is also achieved in the immediate area.

Regulatory air quality parameters, objectives, and environmental values relevant to the project are provided in Section 5.1.4.

5.1.3 Existing air environment

This section provides a description of the relevant air pollutants, the climate and meteorology of the region, and the air quality of the regional airshed including concentrations of key pollutants.

Climate and Meteorology

The Project area has a climate typical of subtropical regions and is summarised as follows:

- Mean monthly minimum temperatures range from 4.4°C in winter (June to August) to 21°C in summer (December to February).
- Mean monthly maximum temperatures range from 20°C in winter to 34°C in summer.
- Monthly rainfall displays a consistent pattern across the area and ranges from an average of 22 to 40 mm in winter to 87 mm summer.
- Wind patterns across the area are characterised by northerly flow predominant in the mornings and winds fairly evenly distributed in the afternoon, with a relatively low frequency of westerly winds in the afternoon. Summer is characterised by a high frequency of north to north east winds, shifting to a higher frequency of easterly winds in autumn, followed by relatively stronger southerly winds prevalent in winter which ease during the Spring months.
- Mean daily solar exposure changes throughout the year in line with the seasons, with values ranging from 12.5 MJ/m² in winter (June) to 25.8 MJ/m² in summer (January).
- Relative humidity varies with time of day and season, increasing through summer and autumn before reaching a maximum in winter (June) and falling in spring. Morning humidity levels range from an average of around 73% in early winter to around 59% in mid-spring. Afternoon humidity levels are lower, at around 49% in summer and dropping to a low of 48% in mid of spring.

More detail on climate and meteorology is provided in **Appendix C**.

Existing Air Quality

In collaboration with industry partners, DES operates an air quality monitoring network across southwest Queensland to monitor for any air quality impacts associated with the intensive CSG production activities in the Western Downs region. These monitoring stations are located on properties near CSG infrastructure, including processing facilities and active gas wells. The AQMS located at Miles Airport is the nearest AQMS to the Girraheen FCS site. Given this, ambient air quality data recorded by the Miles Airport AQMS is used to estimate background air quality levels for assessing cumulative impacts.

Background levels of key air pollutants for the Project area are shown in **Table 5-1**. Ambient monitoring data shows that all criteria air pollutants are well below state and national objectives.

Table 5-1 Background Levels of Key Air Pollutants

Air Pollutant	EPP (Air) Objective	Air NEPM Objective	Averaging Period	Background Concentration
	(µg/m ³)			(µg/m ³)
Nitrogen dioxide (NO ₂)	250	162	1 hour	6.2 ^a
	62	30	Annual	6.1 ^a
Carbon monoxide (CO)	11,000	11,250	8 hours	232 ^a

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Environmental Authority (EA0001399)
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Air Pollutant	EPP (Air) Objective	Air NEPM Objective	Averaging Period	Background Concentration
	(µg/m ³)			(µg/m ³)
Ground level ozone (O ₃)	210		1 hour	72.8 ^a
	171		4 hours	71.8 ^a
		139	8 hours	70.7 ^a
Sulfur dioxide (SO ₂)	570	286	1 hour	2.9 ^b
	229	57	1 day	2.0 ^b
	57		Annual	1.4 ^b
Total suspended particulate (TSP)	90		Annual	26 ^a
Particulate matter (PM ₁₀)	50		1 day	13 ^a
	25		Annual	12 ^a
Particulate matter (PM _{2.5})	25		1 day	16.8 ^a
	8		Annual	5.5 ^a

^a Monitoring data derived from Miles Airport air quality monitoring station for 2020 and 2021. The seventieth percentile of the data was taken for sub-annual averaging periods

^b Monitoring data for SO₂ derived from Flinders air quality monitoring station for 2020 and 2021.

Relevant Air Pollutants

EA0001399 authorises the establishment of wells, gas and water gathering lines and associated access tracks. This EA amendment is submitted to allow for the construction and operation of the Girrahween Field Compression Station (FCS) and associated power station. It is noted that small diesel gensets will be used to provide power to camps and minor pumps. These are assessed through screening appropriate for the source size and potential for impact.

Air pollutant sources relevant to the SGP North EA, including sources relevant for this amendment, are summarised in **Table 5-2**.

Table 5-2 Overview of assessment approaches for each Activity/Source

Emission Source	Relevant Air Pollutants	Air Impact Assessment Approach
Construction		
Construction of new wells through drilling and completion rigs	Combustion products, mainly NO _x and CO	Generic assessment of rig emissions (NO ₂ and CO) to identify off-set distances based on rig emission rates
Construction of access tracks and gathering lines	Construction dust (TSP, PM ₁₀ and PM _{2.5})	Site specific qualitative construction dust assessment
Construction of Girrahween FCS	Construction dust (TSP, PM ₁₀ and PM _{2.5})	Site specific qualitative construction dust assessment
Operation		
Operation of new wells	Combustion products, mainly NO _x and CO	Generic modelling assessments of NO _x and CO of emissions from

Emission Source	Relevant Air Pollutants	Air Impact Assessment Approach
		CSG fired gensets located on well pads
Operation of small diesel generators (camp power, pumps stations)	Combustion products, mainly NO _x and CO	Screened as negligible based on larger rig diesel combustion assessment
Operation of Girrahween Field Compression Station (FCS) a	Combustion products from the CSG fired generators at the Girrahween power station (mainly NO _x and CO). Combustion products from flaring at Girrahween FCS	Site specific modelling assessment (NO _x , CO) of: Normal operations Maximum flaring scenario

^a New sources relevant to this EA Amendment.

Emissions of sulfur dioxide and volatile organic compounds from the sources in this EA application are negligible.

Ozone is a regional air pollutant that is formed from photochemical reactions between NO_x and VOCs. Ozone is mainly relevant for condensed urban areas and in constrained airsheds (e.g., Sydney, South East Queensland). Regional assessment of ozone has been conducted for the Surat Basin and is well within recommended air quality guidelines for the entire region even when considering planned project expansions within the region (SGPEIS and SREIS, Arrow Energy 2012, 2013). The project is expected to have negligible impact on regional ozone levels.

Also, as CSG contains negligible odorous compounds (e.g. sulfur compounds) and combustion is one of the most effective methods for controlling odour, impacts from odour are not expected from the project emissions.

The main air pollutant of concern from combustion is nitrogen dioxide (NO₂). Nitrogen dioxide is predominantly formed in gas combustion through 'thermal NO_x'. Thermal NO_x is the process of thermal dissociation and subsequent reaction of nitrogen (N₂) and oxygen (O₂) molecules in the combustion air to form NO_x.

Combustion also results in carbon monoxide (CO) emissions through incomplete combustion of fuel. However, as the combustion efficiency of flares, gas engines and diesel engines is so high, and background levels of CO are so low, potential impacts from CO emissions are negligible (and as demonstrated through the air quality assessments).

Particulate matter emissions are likely to be caused by construction activities and due to the disturbance and handling of material. Construction emissions will be infrequent and transient and will be managed through best practice measures to avoid dust emissions through a Construction Environmental Management Plan (see 'Management practices' below for further details).

5.1.4 Air quality objectives and indicators

Regulatory air quality parameters, objectives, and environmental values relevant to the Project area are provided in **Table 5-3**.

Table 5-3 Air Quality Objectives relevant to the Project Area

Substance		Queensland Objective	Air NEPM Objective	Environmental Value	Time Period
		(µg/m³)			
Carbon monoxide (CO)		11,000 ^a	11,250 ^d	Health	8 hours
Nitrogen dioxide (NO ₂)		250 ^a	162 ^d	Health	1 hour
		62 ^a	30 ^d	Health	Annual
		33 ^a		Health and biodiversity of ecosystems	Annual
Ozone (O ₃)		210 ^a		Health	1 hours
		171 ^a		Health	4 hours
			139 ^d	Health	8 hours
Total suspended particulate matter		90 ^a		Health	Annual
Particulate matter < 10 µm (PM ₁₀)		50 ^{a, d}		Health	1 day
		25 ^{a, d}		Health	1 year
Particulate matter < 2.5 µm (PM _{2.5})		25 ^{a, d}		Health	1 day
		8 ^{a, d}		Health	Annual
Sulfur dioxide		570 ^a	286 ^d	Health	1 hour
		229 ^a	57 ^d	Health	1 day
		57 ^a		Health	Annual
		31 ^a		Agriculture	Annual
		21 ^a		Ecosystems	Annual
Dust deposition		120 ^b (mg/m²/day)		Nuisance	Monthly
Odour	Tall stacks	0.5 (OU) ^c		Nuisance	1 hour
	Ground level/short stacks	2.5 (OU) ^c		Nuisance	1 hour

^a Queensland objective listed in the Queensland *Environmental Protection (Air) Policy 2019*

^b Queensland Department of Environment and Science (2017) *Guideline - Application requirements for activities with impacts to air*.

^c Queensland Department of Environment and Heritage (2014) *Guideline – Odour impact assessment for developments*

^d National Environment Protection (Ambient Air Quality) Measure, Compilation No. 3 - 2021

It is noted that the Air NEPM standards apply at performance monitoring locations.

Performance monitoring stations are to be located so that they provide a representative measure of the air quality likely to be experienced by the general population in the region or sub-region. The Air NEPM standards are therefore not intended for use in assessing air quality impacts from individual sources, specific industries, or roadside locations. Nonetheless, many State regulatory agencies, including DES, have adopted them as air quality impact assessment criteria for use in AQIAs.

5.1.5 Assessment of environmental impacts

The key emission sources for the activities addressed in this amendment application are related to the Girrahween FCS.

There will be no change to the emissions generated from other sources as a result of this amendment application, such as :

- Construction: of access tracks and gathering lines; new wells through drilling and completion rigs; Girrahween FCS.
- Operation: of new wells; and the FCS.

It should be noted that the subject of this application does not include the authorisation or operation of the wells and impacts on environmental values as they are already authorised under the EA. This has been included for completeness.

An air quality impact assessment was conducted by SLR Consulting specifically for the Girrahween FCS and is provided in **Appendix C**. Air quality impact assessments for other associated activities e.g. drill rigs, construction dust, operation of well head engines has also been completed by SLR Consulting (SLR, 2018).

The main potential air quality impacts associated with the construction activities are nuisance and health related impacts due to fugitive dust emissions from earthworks. These potential impacts have been assessed qualitatively using the IAQM methodology (refer to **Appendix C**).

Expected emissions to air during the construction activities will be primarily due to dust (i.e., particulate matter) associated with earthworks and the movement of vehicles, with some minor sources of combustion products such as nitrogen oxides (NO_x) and carbon monoxide (CO) generated by diesel vehicles and small diesel generators. Emissions from larger diesel rig engines have negligible impact of air quality values. Likewise, emissions from small diesel generators, used for camps and pump stations, which are much lower than rig engines, will also have negligible impact on air quality values.

Modelling of dust from construction activities is generally not considered appropriate, as emission rates can vary significantly depending on a combination of the activity and prevailing meteorological conditions (i.e., rainfall and wind speed), which cannot be reliably predicted.

A qualitative assessment has therefore been performed of the potential risks to air quality associated with dust from construction activities associated with the EA, based on the IAQM Guidance on the Assessment of Dust from Demolition and Construction developed in the United Kingdom by the Institute of Air Quality Management (IAQM 2014), which uses a four step process for assessing dust impacts.

Based upon the assumptions from Section 4.5 and the IAQM definitions, the dust emission magnitudes for individual well pad sites and for road and pipeline active construction areas have been categorised as presented in **Table 5-4**.

Table 5-4 Categorisation of dust emission magnitude for well pads, gathering lines and access tracks

Activity	Dust Emission Magnitude	Basis
Earthworks	Small	Total site area less than 2,500 m ² , less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t.
Track out	Small	Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length,

5.1.6 Proposed management practices

Arrow Energy is committed to applying a hierarchy of controls in order to minimise environmental impact. Arrow Energy has standard operating procedures determining how selection of equipment will be completed in regard to protecting environmental values.

Equipment that results in environmental impact will be:

- Avoided;
- Substituted out; and
- Have mitigations imposed to reduce the impact.

In order to determine what equipment should be installed for the project (and therefore what equipment should be avoided), equipment selection will consider as part of the assessment process:

- Low source of noise emissions;
- Low emissions to air;
- High energy efficiency and fuel efficiency;
- Low generation of waste;
- Low greenhouse gas emissions;
- Avoidance of ozone depleting substances;
- Avoidance of particularly hazardous chemicals;
- Low emissions of pollutants to water; and
- Low water use.

Across all of Arrow Energy's SGP activities, Arrow Energy has committed to the mitigation measures listed in **Table 5-5** to minimise air quality impacts. These measures are recorded in standard operating procedures included in the Surat Gas Project operating model.

In addition to these measures, Arrow Energy is committed to selecting sites for project infrastructure that will protect the environmental values of the project development area wherever practicable. The objectives of site selection are to:

- Ensure the selection of optimal, environmentally acceptable sites for infrastructure placement;
- Avoid or eliminate potential impacts to environmental values;

- Minimise, to the greatest extent practicable, potential impacts to environmental values unable to be avoided or eliminated during design; and
- Identify environmental measures for low, moderate, and highly constrained areas and 'No Go' such areas.

Modelling of emissions from CSG-fired generators that would be installed at well pads as part of the SGP, as presented in this report, indicates that to ensure that ground-level NO₂ concentrations meet guideline criteria, well pads should be located no closer than 200 m from sensitive receptors.

Table 5-5 Air Quality Impact Mitigation measures

Project Phase	Mitigation Measures
Operational Phase	<ul style="list-style-type: none"> • Implement a preventative maintenance program to ensure engines are operating efficiently to minimise NO_x, CO, methane, and VOC emissions. • Implement a quantifiable monitoring and measuring program. • Roads, access tracks and other areas may be watered to suppress dust. Vehicle travelling speeds will be restricted, and movements will be limited to approved access tracks. • Selection of gaskets, seals and vehicle exhaust systems that are suitable for the task, and maintained according to manufacturer's recommendations. • Manufacturer's recommendations and guidelines with respect to air emissions control systems are followed at all times. • Air pollution control technologies are to be maintained in good working order and kept in place at all times the equipment is operating. • Air emissions will be monitored at the source in accordance with the corresponding Environmental Authority conditions. • Equipment that produces abnormal monitoring results will trigger maintenance /review procedures to return emissions to acceptable levels. Where practical, the equipment should not be brought back into service until normal operational emissions are achieved.
Vehicles and machinery	<ul style="list-style-type: none"> • Ensure all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturer's specifications. • Smoke from internal combustion engines should not be visible for more than ten seconds.

Arrow Energy implements a range of dust mitigation measures to ensure that adverse air quality impacts do not occur during well, pipeline and road construction activities. This includes the use of water carts and minimising the extent of disturbed areas to minimise wind erosion.

Given that the uncontrolled emissions are concluded to have negligible risk for adverse impacts on sensitive receptors due to the distance to the nearest sensitive receptors, the risks of residual impacts after mitigation measures are considered, would also remain negligible.

A water truck would also be used to suppress dust emissions and a mulcher/shredder may be required to process any cleared vegetation.

5.2 Greenhouse Gas

5.2.1 Applicable legislation

A summary of key applicable legislation related to greenhouse gas management is summarised as follows:

- *National Greenhouse and Energy Reporting Act 2007 (NGER Act)*: The NGER Act established the NGER Scheme, which is a national system for reporting greenhouse gas emissions, energy consumption and energy production by Australian corporations. Arrow is subject to compliance requirements under the NGER Act which mainly relate to:
 - Annual reporting of emissions, energy consumption and energy production; and
 - External auditing requirements to reasonably assure reported emissions and energy statistics.

Existing systems are in place for reporting under the NGER Act for Arrow. These will be maintained for the Project and reporting of greenhouse gas emissions, energy consumption and energy production under the NGER Act will be required.

- *National Greenhouse and Energy (Measurement) Determination 2008*: The NGER Measurement Determination was made under subsection 10(3) of the NGER Act, which provides for the Minister to determine methods, or criteria for methods, for the measurement of:
 - greenhouse gas emissions;
 - the production of energy; and
 - the consumption of energy.

Arrow is required to measure greenhouse gas emissions, energy production and energy consumption in accordance with the NGER (Measurement) Determination 2008.

- *NGER (Safeguard) Mechanism 2015*: The Safeguard Mechanism was designed to protect taxpayers' funds by ensuring that emissions reductions paid for through the crediting and purchasing elements of the Emissions Reduction Fund were not displaced by significant increases in emissions above business-as-usual levels elsewhere in the economy.

The Safeguard Mechanism started on 1 July 2016. It requires Australia's largest emitters to keep emissions within baseline levels. The Safeguard Mechanism applies to facilities that emit more than 100,000 t CO₂-e of covered emissions in an Australian financial year.

The Safeguard Mechanism was reformed on 1 July 2023 such that emission baselines decline to zero by 2050 to help achieve Australia's emissions reduction goals of:

- 43% reduction on 2005 emission levels by 2030, and
- reach "net-zero" emissions by 2050.

All designated large facilities (DLFs) with scope 1 emissions above 100,000 tonnes CO₂-e are required to apply for an emissions baseline. Applications for an emissions baseline:

- Identify "prescribed production variables";
- Allocate emission sources to each production variable, and
- Assign initial emission intensity values.

The emission intensity values decline year after year resulting in lower emissions baseline relative to production rates year on year. GHG emissions over the annual emissions baseline are required to be offset through the purchase and surrender of Australian Carbon Credit Units (ACCUs). This process "nets" off or "offsets" "excess emissions" and is designed to achieve 'net zero' emissions by 2050. As per Arrow Energy's hierarchy of controls, GHG emission that can be avoided or reduced on site (direct emissions reduction) have higher priority than offsetting excess emissions via the Safeguard Mechanism.

Due to the gas interconnections between existing and future SGP assets, Arrow plans to form a single NGER facility called the "Arrow Surat Gas Project" which would encompass all Arrow Surat assets. This would ensure that the Safeguard Mechanism applies to the Girraheeween Project as greenhouse gas emissions would always be above the Safeguard DLF threshold.

- *Petroleum and Gas (Production and Safety) Act 2004 (P&G Act)*: The operation of CSG facilities in Queensland is covered by the P&G Act. This state legislation covers the management, measurement, and reporting of coal seam gas throughout all production operations associated with the development of the field.

With specific reference to released gas disposal, the P&G Act Part 1, Section 72, division 4, subdivision 3, states that:

"Flaring the gas is authorised if it is not commercially or technically feasible to use it -

- *Commercially under the authority; or*
- *For an authorised activity for the authority.*
- *Venting is authorised if –*

It is not safe to use the gas for a purpose as outlined above; or
Flaring is not technically practicable."

In addition, venting is permitted in the situation under which safety is of concern, or if it is a part of a greenhouse abatement scheme. In summary, all disposed waste gas should be flared wherever it is deemed to be safe or technically practicable.

Section 801 of the P&G Act also states that:

"A petroleum producer must ensure that each product (e.g., gas and water) is measured by a meter in accordance with the relevant measurement scheme for the meter. These products include:

- *Petroleum the producer produces;*
- *Any of the petroleum produced that is used to produce petroleum (e.g. fuel gas);*
- *Any petroleum produced that is flared or vented by or for the producer; and*
- *Any petroleum produced that the producer, or someone else for the producer, injects into a natural underground reservoir."*

Excluded from these requirements is any gas that is:

- *Unavoidably lost before it can be measured; or*
- *Lost or used as a part of normal operations for instrumentation, purging, blowdown or similar activities.*

The P&G Act also authorises the Code of Practice – for leak detection, management, and reporting at petroleum operating plant. This code requires that operators must conduct regular leak detection and repair programs over all infrastructure and report results to the P&G Inspectorate using prescribed methods. This ensures that all risks from gas leaks at CSG facilities are reduced to as low as reasonably practical and enables continuous management and minimisation of leaks from operating plant in Queensland.

5.2.2 Description of environmental values

The description of environmental values for air quality are provided in Section 5.1.2.

Greenhouse gases are an essential component of the earth's climate, which sustains life and maintains the diversity of ecosystems.

As per the DES's Guideline *Application requirements for petroleum activities*, greenhouse gases are a subsection of Air. In accordance with the EPP (Air), the environmental values that are to be enhanced or protected include:

- The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems;
- The qualities of the air environment that are conducive to human health and wellbeing;
- The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures, and other property; and
- The qualities of the air environment that is conducive to protecting agricultural use of the environment.

5.2.3 Existing environment

Greenhouse gases in the earth's atmosphere include carbon dioxide, methane, nitrous oxide, and ozone. The existing air quality environment for the Project area is described in Section 5.1.3.

In relation to greenhouse gas emissions, Arrow Energy supports the international, Australian and Queensland objective of achieving net zero emissions by 2050, which is designed to limit the global temperature increase.

The latest *Queensland State of the Environment Report 2020* covers an analysis of GHG emission trends for the period 1990 – 2018 for the following sectors:

- energy;
- industrial processes;
- agriculture;
- land use change, forestry; and
- waste.

The latest Queensland GHG emission data available on Australia's National Greenhouse Accounts covers the 2021 calendar year. The Qld State of the Environment report updated with 2021 GHG emissions data is summarised in **Table 5-6**.

Table 5-6 Summary of existing GHG emissions in Queensland environment

State Aspect	Summary
Total annual GHG emissions	Queensland's total greenhouse gas (GHG) emissions in 2021 were 140 million tonnes of carbon dioxide equivalent (Mt CO ₂ -e) (including the land use, land use change and forestry (LULUCF) sector) making up 30% of Australia's total. Queensland's greenhouse gas emissions decreased by 29% between 2005 and 2021.
Energy sector GHG emissions	In 2021, emissions from the energy sector remained Queensland's largest source of emissions, contributing 115 Mt CO ₂ -e, or 82% of total emissions. Emissions increased by 20% between 2005 and 2021, owing to strong growth in mining and exports and long term growth in population and economic activity.
Industrial processes GHG emissions	In 2021, emissions from the industrial processes sector contributed 5.8 Mt CO ₂ -e, or 4% of Queensland's total emissions. Emissions increased by 14% between 2005 and 2021 owing mostly to the use of air-conditioning and refrigeration.
Agriculture GHG emissions	In 2021, emissions from the agriculture sector contributed 20.6 Mt CO ₂ -e, or 15% of Queensland's total emissions. Emissions decreased by 9% between 2005 and 2021. The change is mainly related to the change in beef cattle production between periods.
Land use, land use change and forestry sector GHG emissions	In 2021, net emissions from the land use, land use change and forestry (LULUCF) sector contributed -4.5 Mt CO ₂ e (i.e. a sink). This is compared to 2005 levels when Queensland contributed 70.5 Mt CO ₂ -e. Historically Queensland has been the largest source of this type of emission in Australia since 1990. In 2021, Queensland achieved a carbon sink level reflecting improved land use change in relation to carbon management.
Waste GHG emissions	In 2021, emissions from the waste sector contributed 3.1 Mt CO ₂ -e), or 2% of Queensland's total emissions. Emissions increased by 10% between 2005 and 2021, however waste emissions have fallen since 2013 due to increased capture and combustion of landfill gas.

When considering the existing environment and greenhouse gas, it is also important to consider global and local trends to achieve the global goal of net zero GHG emissions by 2050.

Australian natural gas is pivotal to reaching net zero in Australia and the region, supporting the transition away from coal, providing the firm dispatchable energy required to unlock renewable energy potential, and powering Australian industries including those processing the critical minerals necessary for net zero.

With structural changes underway in the power generation sector and growth in renewable energy technologies, natural gas is the perfect partner to intermittent renewable energy that requires 'on-call' electricity generation to manage falls in renewable output or peaks in demand. As more renewable energy is integrated into the grid, this balancing role becomes more critical. For instance, the Australian Energy Market Operator (AEMO) forecasts in its Integrated System Plan (ISP) that gas fired peaking plants in Australia will be required to increase from current energy production

of 7 GW to 10 GW by 2050 to achieve net zero GHG emissions by 2050. This trend will be required globally to meet the global emission reduction target of net zero by 2050.

Globally, fuel switching from coal to gas has provided significant global GHG emission reductions since 2010. The International Energy Agency's, World Energy Outlook special report into the *Role of Gas in Today's Energy Transitions* (IEA, 2019¹⁷) reports that fuel switching from coal-to -gas has saved around 500 Mt CO₂-e since 2010 (IEA, 2019). Further GHG emission benefits are achievable in the world through fuel switching.

It is also important to acknowledge the role of natural gas plays in providing energy security to a growing global population and also improvements to air quality when replacing other fossil fuel heating/cooking/power applications when considering the existing global environment.

5.2.4 Greenhouse gas emissions objectives and indicators

The environmental objective for greenhouse gas emissions is to mitigate greenhouse gas emissions by achieving net zero GHG emissions by 2050. This GHG emission target is designed to limit global temperature increase.

This is aligned with the Australian and Queensland GHG emission target of:

- 43% reduction on 2005 emission levels by 2030; and
- "net-zero" emissions by 2050.

Arrow supports the international, Australian and Queensland objective of achieving net zero emissions by 2050.

5.2.5 Assessment of environmental impacts

Forecast GHG Emissions

GHG emissions are estimated using standard methods for the accounting and reporting of six (6) greenhouse gases covered by the Kyoto Protocol: carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF₆).

The standard methods are consistent with international guidance on greenhouse gas reporting provided by the World Business Council for Sustainable Development and the World Resources Institute Greenhouse Gas Reporting Protocol (The GHG Protocol). These methods are also incorporated into Australian legislation through the NGER (Measurement) Determination. The GHG Protocol, defines three scopes of emission categories:

- **Scope 1:** Covers direct emissions from sources within the boundary of an organisation such as fuel combustion (e.g. FCS fuel combustion, field gas combustion) and fugitive GHG emissions (e.g. flaring, venting and equipment leaks).
- **Scope 2:** Covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation. Scope 2 emissions result from

¹⁷ [The Role of Gas in Today's Energy Transitions \(International Energy Agency \(IEA\), 2019\)](#)

the combustion of fuel to generate the electricity, steam or heat and do not include emissions associated with the production of fuel.

- **Scope 3:** Includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation.

Forecast GHG emissions from the Project are made using the latest estimation techniques published in the NGER Measurement Determination. Forecast Scope 1 and 2 GHG emissions are displayed in **Figure 5-1**.

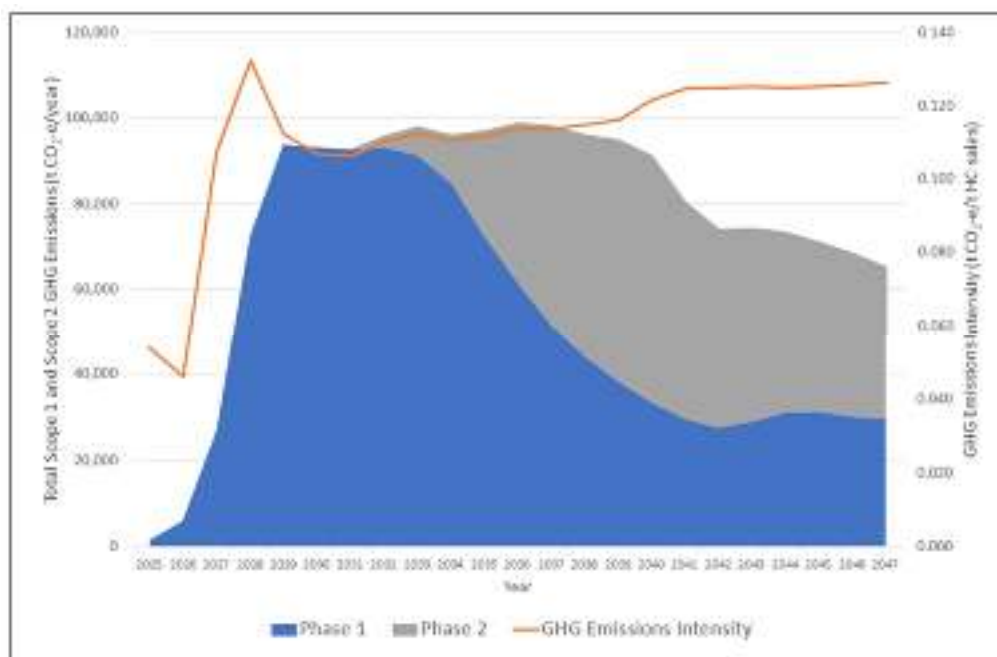


Figure 5-1 Forecast for Scope 1 and Scope 2 emissions

The distribution of GHG sources over the life of the project is presented in **Figure 5-2**.



Figure 5-2 Priority Scope 1 GHG emission sources for the Project¹⁸

¹⁸GHG emissions from the FCS (power generation, flaring, and leaks) are additional sources which are applicable to this EA amendment. Other Project sources of emissions are included for completeness.

Assessment of Emissions

Annual average Scope 1 and Scope 2 GHG emissions over the life of the Project (2026 – 2047) are forecast at 80,080 tonnes CO₂-e per annum. Fugitive GHG emissions (flaring, venting and leaks) account for 20% of total Scope 1 & 2 emissions.

The estimated gas loss rate for all fugitive sources (venting, leaks, and flares) is approximately <0.3% (i.e. tonnes gas lost per tonne gas sold). The estimated gas loss rate due to venting and leak sources is ~0.06%. This is in line with current best practice loss rates.

In relation to requirements under the Safeguard Mechanism, there are zero Scope 1 reservoir CO₂ emissions from the Project.

The contribution of the Project to the state and national total greenhouse gas emissions are presented in **Table 5-7**.

While contributions to total state and national GHG emissions appear minor, GHG emissions are managed to ensure emissions are controlled to levels that are ‘as low as reasonably practical’ (ALARP).

Table 5-7 Contribution of the Project to State and National total GHG

Boundary	Total Annual GHG Emissions (Scope 1 & 2)	Units
Girraheen Development Phase 1 & Sustain (the Project)	80,080 ^a	t CO ₂ -e/annum
Queensland	139,665,100 ^b	t CO ₂ -e/annum
Australia	464,770,700 ^b	t CO ₂ -e/annum
Contribution to State Annual Total	0.046%	
Contribution to National Annual Total	0.014%	

^a: Forecast annual GHG emissions are for the complete SGP North development (i.e. FCS operation, wells and gathering systems, construction, and operation). GHG sources relevant to this EA amendment account for 66% of the forecast emissions.

^b: Department of Climate Change, Energy, the Environment and Water (DCCEEW), 2021 inventory year - latest available year ([Australia's National Greenhouse Accounts, DCCEEW, Australian Government](#))

Lifecycle GHG emissions, Scope 1, 2 and 3 emissions are forecast to result in a well to wire GHG emissions intensity of 461 g CO₂-e/kWh (if gas is used in a combined cycle gas turbine to produce power). Power produced from gas produced from the Project has a relatively low lifecycle carbon intensity when compared to other fossil fuels. It is important to note the main role of gas in developing and transitioning energy markets, is to firm intermittent renewable electricity supply.

5.2.6 Proposed management practices and continual improvement

Greenhouse Gas Management

Arrow Energy's carbon management principles are based on well-established hierarchy of GHG emission controls. The hierarchy is applied through evaluation of carbon opportunities through the process as described in **Figure 5-4**.



Source: Royal Melbourne Institute of Technology (RMIT) (2019), Environmental Protection Authority Victoria (EPAV) (2020)

Figure 5-3 Hierarchy of Carbon Management

The carbon management hierarchy is applied through an iterative process favouring actions at the top of the pyramid (refer to **Figure 5-3**) and are described in **Table 5-8**.

Table 5-8 Carbon Management Hierarchy and application to the Project

Carbon Management Options	Description	Examples Relevant for Girraheen Development Phase 1 & Sustain Case
Avoid	The best way to reduce the carbon impact is by avoiding direct greenhouse gas emissions and energy related indirect emissions. Some avoidance opportunities may not require a capital outlay and may just be a change in behaviour for a business.	<ul style="list-style-type: none"> Avoiding gas driven pneumatic devices Connecting wells directly to grid electricity supply where feasible.
Reduce	Reducing GHG emissions typically involves changing equipment so that it uses lower energy. It can encompass the recovery of energy from existing processes.	<ul style="list-style-type: none"> Gas field genset swap at low loads to improve pumping efficiency Installation of permanent magnet motors on deviated wells Capturing vents at the FCS facility and directing to flare system Further implementation of leak detection and repair (LDAR) on FCS and gas field leak sources and using this data for reporting Targeted workover flaring Minimising pilot/purge gas requirements on the flare system
Substitute	Changing the energy primary energy source to be less emission-intensive source may offer carbon reductions	<ul style="list-style-type: none"> FCS hybrid power incorporating solar and battery energy storage systems (BESS) to minimise combustion emissions.

Carbon Management Options	Description	Examples Relevant for Girraheen Development Phase 1 & Sustain Case
		<ul style="list-style-type: none"> Consideration of local reticulation of electricity to wells from the FCS power plant Solar hybrid well pads
Sequester	Following the reduction of greenhouse gas emission sources in an organisation, the organisation may then look to the reductions that can occur that sequester carbon within the organisation	<ul style="list-style-type: none"> Natural carbon sequestration through forests, vegetation, soils on Arrow Energy properties or within organisation
Offset	Carbon offsetting is the purchase of a reduction certificate that allows a reduction project outside the scope of an organisation to be claimed against the emissions profile. Carbon offsets provide a legitimate means of reducing the net impact of greenhouse gas emissions. Offsets sit as the least favoured option in the hierarchy	<ul style="list-style-type: none"> Purchase and surrender of Australian Carbon Credit Units on the Australian National Register of Emission Units (ANREU)

Key levers in line with the Oil and Gas Climate Initiative (OGCI), for Arrow Energy to reduce GHG emissions from the Surat Gas Project are as follows:

- Improve energy efficiency (reduce);
- Near zero flaring (reduce);
- Electrify operations with renewables where possible (substitute); and
- Near zero methane emissions (reduce).

Management and design strategies incorporated into the Project to minimise direct GHG emissions are presented in **Table 5-9**.

Table 5-9 Management strategies to minimise GHG emissions

GHG Source	Management and design strategies used to minimise GHG emissions
FCS Power – Fuel Gas	<p>The Girraheen FCS is being designed as a hybrid gas power station that utilises solar, battery energy storage system (BESS) and gas fired internal combustion engines. This is designed to minimise GHG emissions due to the FCS power requirements.</p> <p>The Girraheen FCS is isolated from the electricity grid, such that grid connection is not currently feasible, although it might be an option in the future.</p> <p>The hybrid power option provides the lowest GHG emissions intensity available to the Girraheen Development with a forecast greenhouse gas intensity of 0.34 t CO₂-e per MWh which is 53% less than the emissions intensity from the current Qld electricity grid at 0.73 t CO₂-e per MWh and 37% less than the prescribed emissions intensity for electricity in the NGER (Safeguard Mechanism) Rule 2015 of 0.539 t CO₂-e/MWh.</p>
FCS Flaring	<p>The flare at Girraheen FCS will be used when a downstream compression train requires maintenance or there are downstream system upsets. During planned outages, the well field will be managed in advance to minimise flaring. During unplanned outages, the well field will be managed in reaction to the unplanned outage to minimise the flaring. Distressed gas management will be achieved by flaring. FCS vents and losses will also be directed to the FCS flare.</p>

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GHG Source	Management and design strategies used to minimise GHG emissions
	<p>In relation to venting and flaring, the overall philosophy is to eliminate venting and minimise flaring (Venting and Flaring Standard). This is in alignment with the requirements under the P&G Act.</p> <p>It is forecast that less than 0.26% of produced gas will be flared through the Girrahween flare.</p> <p>The management strategies to reduce the rate of flaring include:</p> <ul style="list-style-type: none"> • All production assets will be monitored and controlled via a single integrated Process Control and Production Information System referred to as the Process Automation System (PAS). The control system will be designed for 24/7 operation and have an availability of between 99.9% and 99.99% (value trade off to be completed). • Assigning all wells to a turn down class (1-5) based on their risk of failure after a shutdown (1 being best to 5 being worst). The recovery performance will be determined in the first 12-24 months post start-up of the well. • A control solution which will turn down well field production to match downstream demand by automatically turning down those wells that recover best (Class 1) first and progressively turning down subsequent well classes. Each field will include a block controller which allows the Control Room Operators (CRO) to turn down the field production from a single faceplate. The block controller will consider each well classification and adjust the wellhead metering skid pressure control valves to turn down the field flow. • FCS equipment train shutdowns will take place for major equipment inspection and maintenance. • Use of available line pack to enable production holds for short periods. • Interconnection enabling distressed gas flows to be diverted to alternative delivery points. • Once operational, further optimisation will be developed to minimise flaring rates. <p>It is also noted that multi-point ground flares have higher methane destruction efficiencies when compared to elevated flares. Higher destruction efficiencies of methane result in lower GHG emissions due to flaring.</p>
Gas Field Power – Fuel Gas	<p>Management strategies to reduce GHG emissions from fuel gas used in the gas field include:</p> <ul style="list-style-type: none"> • Consideration of local reticulation from FCS power or grid power to power well skids (where feasible) <p>If feasible powering well skids with excess power from the FCS or from grid power connections has the potential to reduce direct emissions from the Girrahween Development and will be considered as the gas field is developed.</p> <ul style="list-style-type: none"> • Genset swap on low load single well pads. <p>The current configuration and basis for the Project is for well pads to be powered by 60 kVA gensets.</p> <p>After the initial dewatering phase, typical well pads will operate at lower loads and well outside the PSI 5.7L engine best point of efficiency used in the 60 kVA gensets. Where SWP loads permit, swapping out the 60 kVA gensets for a smaller variant such as a 25 kVA (PSI 3.0L engine) unit will result in greater operating efficiency, less GHG emissions and reduce the risk of reliability and performance issues (associated with low-load operation).</p>

Surat Gas Project (SGP) North
Environmental Authority (EA0001399)
EA Amendment Supporting Information Report

GHG Source	Management and design strategies used to minimise GHG emissions
	<p>Multi Well Pads (MWP) have the ability to cycle gensets on and off to reduce the number of gensets operating at any given time. As a result, the MWPs can be configured to operate the PSI 5.7L engines at more efficient operating points. On this basis it is assumed that the majority of SGP MWPs would not need conversion to 25 kVA gensets.</p> <ul style="list-style-type: none"> Installation of Permanent Magnet Motor (PMM) to improve well efficiencies <p>Installation of a permanent magnet motor (PMM) in deviated wells has the potential to improve pumping efficiency from wells with electrical submersible pumps (ESPs) by an estimated 14%. This opportunity is currently being investigated to reduce GHG emissions from the Girrahween Development.</p> <ul style="list-style-type: none"> Solar Hybrid Well Pad Power <p>Arrow Energy has investigated the use of hybrid power options consisting of solar, battery energy storage systems (BESS) and gas generators to provide power to wells in the gas field. This may be a viable power pad power source especially as well pads reduce in load requirements as the seam is dewatered.</p>
Venting and flaring	<p>In relation to venting and flaring, the overall philosophy is to eliminate venting and minimise flaring (Venting and Flaring Standard). This is in alignment with the requirements under the P&G Act.</p> <p>All major vents at the Girrahween FCS are rerouted to the flare system to minimise GHG emissions.</p> <p>Other design features to minimise venting include:</p> <p>Dehydrator A significant source of venting traditionally is from stripping gas used in glycol dehydrators. A dehydrator is not required at Girrahween FCS, eliminating this potential source of GHG emission.</p> <p>Cold process vents Significant cold process vents are eliminated from the current design concept. Emissions from vessel blowdowns at Girrahween FCS are controlled by capturing gas and routing to the FCS flare system.</p> <p>Note that high point vents on the water gathering lines are considered under leak category for 'produced water'</p> <p>Gas driven pneumatic devices Natural gas-driven pneumatic devices are not used in the Girrahween Development avoiding this potential fugitive emission source.</p> <p>Gas driven chemical injection pumps Gas-driven chemical injection pumps (CIPs) are not used in the Girrahween Development avoiding this potential fugitive emission source.</p> <p>Vessel blowdowns/Compressor starts and blowdowns Blow down of gas from vessels/compressors will be directed to the flare header in the Girrahween Development reducing this fugitive emission source (when compared to venting).</p> <p>Gas well workovers A coal seam gas well workover is a routine maintenance activity. During the life of a well, various workovers may be required to reconfigure the well so that it will continue to produce gas. As water and gas are extracted, reservoir pressures decline, and it may be necessary to change production equipment later in the life of a well to ensure it is capable of producing fluids to surface.</p>

GHG Source	Management and design strategies used to minimise GHG emissions
	<p>Gas generated during well workover activities due to underbalance activities, live well workovers and air cleanouts are generally vented and included in the current design concept. Venting from workovers can be minimised through:</p> <ul style="list-style-type: none"> • increasing the time periods between workovers; and • minimising the time wells are underbalance during a workover event. <p>Where mobile flare systems are available on workover rigs, flaring of emissions will occur.</p> <p>Gas well completions Fugitive emissions from well completions are controlled by circulating water into the wells, preventing release of CSG until the gas and water gathering pipelines are connected and the wells are dewatered, thereby capturing any emissions.</p> <p>Minor emissions can occur during airlifts or well-clean outs using compressed air. Emissions associated with air lifts are included in the current design concept. Where mobile flare systems are available on rigs, flaring of emissions occurs.</p> <p>Gathering gas pipeline blowdowns and mishaps Pipeline blowdowns refers to the venting of gas within a segment of the gas gathering line (normally as part of scheduled routine maintenance activities), while dig-ins are ruptures of gathering pipelines caused by unintentional (often third-party) damage.</p> <p>Fugitive emissions from gathering gas pipeline blowdowns and mishaps are included in the current design concept.</p> <p>Where planned gathering gas blowdowns are scheduled to occur, evaluation of flaring requirements is mandatory in order to minimise venting and flaring rates.</p>
Leaks (emissions other than venting and flaring)	<p>There is potential for leaks to occur from connectors, flanges, valves etc at gas fields and compression facilities if such items fail or are improperly sealed.</p> <p>A leak detection and repair (LDAR) program is integral to the maintenance of all gas field and compression facilities, where on a regular cycle, gas detection equipment is used to identify any leak points within the piping networks and process plant. The implementation of a LDAR program is mandatory under Schedule 1 of the Petroleum and Gas (Production and Safety) Act (2004) and there are specific requirements for the reporting of all identified leaks over certain thresholds to the Petroleum and Gas Inspectorate.</p> <p>Produced water GHG emissions While downhole separation is performed on all wells, the water extracted from production wells can be expected to contain small quantities of gas (both as free gas and dissolved gas). This water is piped to dams/holding tanks for storage and treatment, and vents are installed at high points along the water gathering pipelines to vent gas/air entrained and liberated as free gas within the water flow. These vents are a potential source of methane emissions. When the water reaches the dam/holding tanks there is also potential for any remaining methane entrained within the water flow to degas at the holding tank and from the pond surface.</p> <p>Recent studies indicate that the current produced water methane emission estimation approach in the NGER (Measurement) Determination potentially overstates emissions from produced water. Arrow Energy is committed to improving understanding and minimisation of potential methane emissions from the produced water system.</p>

The Project also includes a commitment/requirement to minimise land disturbance and clearing and a commitment to rehabilitate land to its original condition.

The Girrahween Development is part of Arrow's upstream Surat Gas Project (SGP) (refer to Section 1.1). Reporting of greenhouse gas emissions, energy consumption and energy production is required under the NGER Scheme. Arrow's SGP is forecast to trigger the designated large facility threshold under the *NGER (Safeguard) Mechanism 2015*. As such, declining emission baselines are likely to apply to the SGP in line with the government's emission reduction targets net zero emissions by 2050.

Where direct emission reductions are not technically feasible, obligations to meet the emissions baselines will be achieved through the acquisition, purchase and surrender of carbon credit units prescribed by the NGER Safeguard Mechanism.

Commitment to continual improvement

The SGP is subject to international, national, state, and corporate greenhouse gas policies with abatement objectives and performance standards. Arrow Energy will comply with all mandatory international, national, and state objectives. Arrow Energy is committed to the ongoing measurement and monitoring of the project's emissions, energy consumption and production.

Arrow Energy strives for continual improvement in greenhouse gas emissions performance. To achieve this, Arrow Energy sets GHG emission intensity targets for operating assets both on a total GHG emissions level and on a venting and flaring loss rate basis. Annual emissions intensity targets incorporate continuous improvement elements.

To achieve the reduction in GHG emissions from Arrow Energy's operating assets, Arrow Energy has implemented a GHG abatement opportunity maturation process (refer to **Figure 5-4**). To further drive adoption of GHG emission abatement opportunities, Arrow Energy incorporates an internal carbon price in the economic assessment of potential opportunities.

The Project may include a hybrid power plant as part of incidental activities which involves the development of a solar farm and inclusion of a BESS with the intent of being able to increase the use of electricity in the operation of the Girrahween FCS from a renewable energy source.

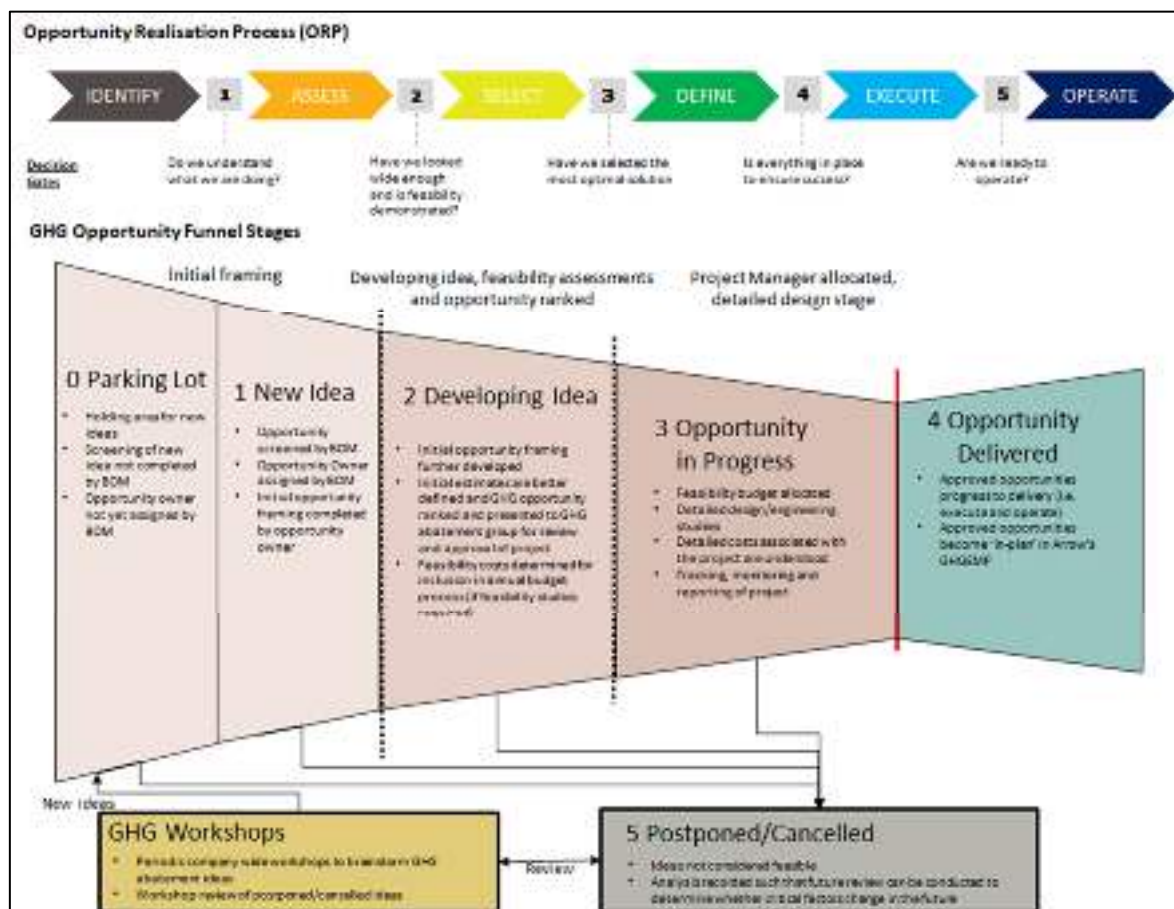


Figure 5-4 Arrow Energy's GHG abatement opportunity maturation process

5.3 Noise

5.3.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on noise quality for the Project.

- *Environmental Protection Act 1994* (EP Act): The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development. The *Environmental Protection Regulation 2019* provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to ESAs.
- *Environmental Protection (Noise) Policy 2019* (EPP (Noise)): This policy sits under the EP Act and aims to protect and enhance environmental values relating to Queensland's noise environment. The EPP (Noise) provides noise quality objectives for the protection and enhancement of the environmental values.

5.3.2 Description of environmental values

The areas surrounding the Project area are predominantly rural in nature, with land uses such as grazing, pre-existing gas field development, and overlapping mining tenures dominating. Existing road infrastructure typically includes a number of rural secondary roads linking the major regional road network, as well as numerous CSG field access roads and mining activities.

The environmental values to be enhanced or protected under the EPP (Noise) are:

- The qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems.
- The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following: sleep, study or learn or be involved in recreation, including relaxation and conversation.
- The qualities of the acoustic environment which are conducive to protecting the amenity of the community.

5.3.3 Sensitive Receptors

As described in section 3.5.2, the DES guideline, *Application requirements for petroleum activities* (DES 2016) defines for noise, sensitive receptors are defined in Schedule 2 of the of the *Environmental Protection (Noise) Policy 2019*.

Noise sensitive receptors listed in the EPP (Noise) that are most relevant to Arrow's operations are:

- Residences (at all times);
- Commercial and retail activity (when the activity is open for business);
- Protected areas or critical areas (at all times); and
- Parks or gardens that are open to the public (at all times).

All identified noise sensitive receptors surrounding the Girrahween FCS are dwellings/residential premises.

Sensitive receptors for the Project area were identified as being located within 9 km from the Girrahween FCS and are presented in **Table 5-10**.

Table 5-10 Sensitive Receptors within 9 km of the Girrahween FCS

Receptor ID	Coordinates (GDA94 zone 56)	
	Easting	Northing
G1	222,680	7,068,507
G2	220,766	7,064,862
G3	220,144	7,067,178
G4	220,272	7,064,803
G5	220,584	7,063,619
G6	220,381	7,063,139
G7	219,152	7,064,353
G8	220,013	7,062,935
G10	218,243	7,067,196
G11	218,247	7,064,078
G12	228,263	7,064,589
G13	228,626	7,065,108
G14	226,966	7,061,991
G15	227,791	7,062,623
G16	220,018	7,061,057
G17	227,278	7,061,081
G18	217,814	7,072,105

5.3.4 Existing noise environment

The Girraheen FCS site and surroundings is predominantly rural with land uses such as grazing and pre-existing gas field development. Existing infrastructure typically includes a number of rural secondary roads linking the major regional road network as well as numerous CSG field access roads. Existing noise sources are generally typical of rural roads and include fauna (birds and insects), traffic and local sources associated with mining activity and rural based human occupation.

The deemed minimum background noise levels as stated in the *2016 Streamlined Model Condition* have been applied for the basis of this assessment (refer to **Table 5-11**). The deemed minimum background noise levels are considered applicable given the rural nature that the Girraheen FCS area is located within and the expected low background noise levels within this area.

Table 5-11 Deemed background noise levels as per Streamlined Model Condition (DES, 2016)

Time Period	Deemed Background Noise Level (dBA)
6:00 am – 7:00 am (morning)	30
7:00 am – 6:00 pm (day)	35
6:00 pm to 10:00 pm (evening)	30
10:00 pm – 6:00 am (night)	25

Noise sources relevant to the SGP North EA, including sources relevant for this amendment are summarised in **Table 5-12**.

Table 5-12 Overview of Noise Sources and Assessment Approaches

Noise Source	Description of noise source	Noise Impact Assessment Approach
Construction		
Construction of new wells through drilling and completion rigs	<p>Drilling and other rig activities, which typically involves drilling, workovers, completions, and flaring activities.</p> <p>Rig activities can operate on a 24 hour basis and can last from anywhere between two days up to a month depending on the depth of the well, type of well and the geology of the area. Rig activities can produce impulsive noise (e.g., impacts of drill tools) as well as constant noise. Noise from diesel engines vary according to load and speed, but the main component of the sound is the fundamental rotation speed.</p> <p>Flaring or venting can occur during rig activities to dispose of gas that cannot be processed in a safe manner. Typically, flaring or venting is a minor</p>	<p>Noise assessments are conducted on each rig contractor, and these are used to determine required separation distances to achieve Arrow Energy's noise limits. Each well and rig activity is assessed to determine whether activity restrictions are required (e.g., noisy rig activities restricted to daytime only)</p>

Noise Source	Description of noise source	Noise Impact Assessment Approach
	source of noise relative to the total noise of drilling activities and is only discernible in the context of other well pad construction noise within relatively short distances from the flare.	
Construction of access tracks and gathering lines	<p>General construction activities undertaken on Arrow Energy tenure can potentially result in noise impacts.</p> <p>Construction noise levels inevitably depend upon the number of plant and equipment operating at any one time and on their precise location relative to the sensitive receptor(s). Therefore, a sensitive receptor may experience a range of values representing “minimum” and “maximum” construction noise emissions.</p>	<p>Noise assessments have been conducted using conservative operating assumptions to derive a maximum distances where daytime noise may cause an issue.</p> <p>Where construction is planned to be within the maximum separation distance, additional controls are required to minimise risk of daytime construction noise impact (e.g., reduced equipment operating at a time, site specific assessment and monitoring).</p>
Construction of Girrahween FCS ^a	<p>Construction activities of the FCS facility and associated infrastructure.</p> <p>Construction limited to daytime only.</p>	Site specific noise assessment of construction equipment (SLR Consulting, 2018).
Operation		
Operation of wells/well pad noise	<p>The operation of wells is a long term noise event that occurs on a 24-hour basis. The main noise impacts from the operation of wells relate to:</p> <ul style="list-style-type: none"> Gas fired generators – contained within an enclosure on the well pad Well drive heads Well head motors Gas flows especially through pressure control valves (PCV) and across orifice plates where there is significant differential pressure and turbulent flow <p>Noise levels generated by operating well pads are dependent on a number of factors including:</p> <ul style="list-style-type: none"> number of generators, generator loads, well pump type, drive head type, and well pad gas flow rate. 	<p>Arrow Energy has conducted detailed noise assessments of well pad noise levels and associated separation distances to achieve required noise levels.</p> <p>Well pads are located and/or configured with noise attenuation features to achieve Arrow Energy’s nighttime noise limit under maximum load and worst case weather conditions.</p>
Operation of gathering lines	Noise from high point vents is intermittent and highly variable due to varying water pressures and volumes of gas in the water lines over time.	Noise measurements have been made from a sample of high emitting high point vents in Arrow Energy’s operating gas fields.

Noise Source	Description of noise source	Noise Impact Assessment Approach
		Separation distances have been derived to achieve < 25 dBA under worst case HPV operation and worst case weather conditions Where these separation distances cannot be achieved noise attenuated HPVs can be used.
Operation of camps and other incidental activities, such as: warehouse, offices	Noise from small diesel generators	Noise impact is screened using methodologies in Arrow Energy's Environmental Noise and Vibration Management Plan. Noise is minimised and sources are located to ensure compliance with relevant Environmental Authority noise criteria.
Operation of Girraheewen Field Compression Station (FCS) ^a	The Girraheewen FCS has been assessed for the following operating scenarios: <ul style="list-style-type: none"> Scenario 1 – Normal Operation <ul style="list-style-type: none"> Up to six (6) Howden 510 screw compressors running at 2,000 RPM with coolers, and Seven (7) operating CSG fired power station (internal combustion engines) and one (1) spare 3.36 MW Jenbacher units with BESS. Scenario 2 – Flaring <ul style="list-style-type: none"> MPGF to occur under four (4) separate flare flow rates being 130 MMscfd, 97.5 MMscfd, 65 MMscfd and 32.5 MMscfd. 	Site specific noise modelling assessment (SLR Consulting 2023).

5.3.5 Noise quality objectives and indicators

The EPP (Noise) contains Acoustic Quality Objectives (AQO) for receptors potentially sensitive to noise. Where the overall level of noise at the receptors, from all sources but excluding road and rail transport noise, are within the AQO, the environmental values are considered to be achieved.

The AQO for the noise sensitive receptors and land use surrounding the Project area are presented in **Table 5-13**. Project operations require continuous operation of plant as such this Assessment has referenced the 1-hour L_{Aeq} and L_{A1} AQO to assess the noise emissions from Project noise sources.

Table 5-13 EPP (Noise) Acoustic quality objectives

Receptor Type	Time of Day	Acoustic Quality Objective (dBA)		
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$
Residential dwelling (outdoors)	Day time and evening	50	55	65

Receptor Type	Time of Day	Acoustic Quality Objective (dBA)		
		L _{Aeq,adj,1hr}	L _{A10,adj,1hr}	L _{A1,adj,1hr}
Residential dwelling (indoors)	Day time and evening	35	40	45
	Nighttime	30	35	40

The Queensland Department of Environment and Science (DES) has published a noise assessment guideline entitled *Prescribing noise conditions for environmental authorities for petroleum activities* (DES, 2016), which is intended to assist in the assessment of noise impacts and the development of noise conditions for petroleum activities within the general framework provided by the EP Act.

This guideline addresses noise management and includes best practice noise emission limits for CSG activities.

The guideline noise limits are designed to protect the acoustic values of a sensitive receptor in rural or isolated areas and to satisfy the acoustic quality objectives of the EPP (Noise) whilst considering cumulative impacts and background creep.

Best practice measured noise emission limits for long term noise exposure applicable to the Surat Basin from the guideline (DES, 2016, DES, 2022) for each of the specified daily time periods are provided in **Table 5-14**. These noise limits closely align with the 'Streamlined Conditions' contained within the DES *Streamlined Model Conditions for Petroleum Activities* (DES, 2016), effective 5 May 2016 (hereafter referred to as SMC).

Table 5-14 Best Practice Measured Outdoor Noise Emission Limits (DES, 2016)

Time Period	Time of Day	Metric	Long Term Noise Limit (dBA) ^a
6:00 am – 7:00 am	Morning	L _{Aeq, adj, 15 minutes}	35 (L _{ABG} + 5)
7:00 am – 6:00 pm	Day	L _{Aeq, adj, 15 minutes}	40 (L _{ABG} + 5)
10:00 pm – 6:00 am	Evening	L _{Aeq, adj, 15 minutes}	35 (L _{ABG} + 5)
6:00 pm – 10:00 pm	Night	L _{Aeq, adj, 15 minutes}	28 (L _{ABG} + 3)
		Max L _{pA, 15 minutes}	55

^a LABG is the deemed background noise levels which are:

6:00 am – 7:00 am: 30 dBA
7:00 am – 6:00 pm: 35 dBA
6:00 pm – 10:00 pm: 30 dBA
10:00 pm – 6:00 am: 25 dBA

The night period is considered the most critical daily period in respect to noise compliance. Compliance with the long-term night noise limit for operating plant and equipment will ensure compliance with the noise limit for all other daily periods. Furthermore, for continuous operating plant, compliance with the night time limit of 28 dBA demonstrates under worst case operating conditions and worst case weather conditions sufficiently protects against the risk of "background creep". The risk of background noise creep for temporary noise sources is very low due to their temporary nature and background noise creep being a long term measure.

5.3.6 Assessment of environmental impacts

A noise impact assessment was conducted by SLR Consulting for the Girraheen FCS and is provided in **Appendix D**.

Environmental noise impacts are informed by various studies conducted by Arrow Energy and management is achieved through implementation of Arrow Energy's environmental noise and vibration management plan.

Noise assessments have been conducted on common CSG activities to inform planning and constraints analysis to avoid noise impacts from CSG activities. These activities are not all part of this EA amendment but are included for completeness and are summarised as follows:

Well pad noise

Arrow Energy has developed a well pad noise assessment tool based on noise measurements and modelling on Arrow Energy's operating well pads. The well pad noise assessment tool is used to inform:

- Required separation distances from sensitive receptors to operating well pads; and
- Site specific well pad configuration(s) to achieve noise limits

High point vent noise

Noise measurements have been made from a sample of high emitting high point vents in Arrow Energy's operating gas fields.

Separation distances have been derived to achieve < 25 dBA under worst case HPV operation and worst case weather conditions.

Almost all HPVs can be located to achieve this noise criteria. Where the separation distance cannot be achieved, noise attenuated HPVs can be used.

Well pad rig noise

Arrow Energy has an activity specific noise management plan for rig operations and has also introduced minimum noise performance standards for rig operators. This is driving continual improvement in noise performance from rig operations from Arrow Energy tenure through the design and implementation of attenuated sources within the rig carriers and associated equipment.

Modifications to rigs to reduce the noise impact have included (*but are not limited to):

- Design and implementation of acoustic enclosures for noisy equipment
- Installation of rubber matting along pipe racks
- Replacing tonal reversing alarms with broad spectrum squawker alarms
- Heavy duty silencers on exhausts
- Acoustic cladding on mud pumps; and
- Ventilation chutes directing noise upwards and not horizontally

Construction noise

Arrow Energy limits construction activities to daytime only to avoid noise impact. Furthermore, conservative noise assessments have been made to derive maximum distances where daytime noise may cause an issue.

Where construction is planned to be within the maximum separation distance, additional controls are required to minimise risk of daytime construction noise impact.

Operation of camps and other incidental activities, such as: warehouse, offices

Camps and other incidental activities may have minor noise sources associated with their operations such as diesel generators. These sources of noise are selected in order to avoid noise through selection of less noisy equipment and inclusion of appropriate noise abatement technology (e.g. exhaust silencers). Sources of noise from incidental activities are also located with sufficient separation distances to sensitive receptors to avoid amenity noise impact.

Operation of Girrahween FCS and power station

The location of the Girrahween FCS was selected to optimise the distance between the facility and nearby sensitive receptors to avoid the potential for noise impact. The impacts from noise from the Girrahween FCS was done considering the nearby sensitive receptors.

Furthermore, the Girrahween FCS incorporates several noise abatement technologies to reduce the potential for noise impact including:

- FCS Compressors:
 - Compressor enclosures with acoustic lining to minimise noise emissions.
- Power Station Engines:
 - Engine enclosures to minimise noise emissions;
 - Acoustically treated louvres on air intakes; and
 - Exhaust silencers.

Girrahween FCS flare noise

The main sources of noise from flaring are from:

- Jet noise at the flare exit; and
- Combustion noise along the length of the flame.

Potential flare types include:

- Multi-point ground flares; and
- Enclosed flares.

Ground flares and enclosed flares provide improvements to visual pollution and reduce the noise impact when compared to elevated flares. The dominant source of noise from flaring is combustion roar (which occurs no matter which flare type is selected). As such, the best noise mitigation for flaring is avoidance/reduced flare rates.

The noise impact from MPGFs is slightly reduced when compared to elevated flares due to the ground flare structure which impacts the noise transmission from the flare to the receptor, thereby slightly reducing the noise received at the receptor.

Arrow Energy has selected a MPGF for the Girrahween FCS to reduce both the potential for noise and light impact on the surrounding area.

Noise assessment of the Girrahween FCS and power station and the FCS flaring has been conducted by acoustic specialists SLR Consulting (refer to **Appendix D**).

The noise assessment found that the:

- Girrahween FCS development is expected to meet all nominated noise criteria when operating under all weather conditions.
- During flaring events:
 - Noise objectives are expected to be met for more than 95% of flaring events.
 - Under neutral weather conditions, noise objectives are met for all possible flare flow rates.
 - Under adverse weather conditions and at flare flow rates of 97.5 MMscfd and above, marginal exceedance of the night-time noise limit of 28 dBA could occur during adverse weather at up to four (4) sensitive receptors. This is likely to be extremely rare events and for short periods only.

Noise assessments for the CSG activities show that the best practice night time noise limit of 28 dBA is achieved at sensitive receptors. As such, the assessments demonstrate that background creep due to the activity is unlikely and noise impacts are managed to best practice levels.

5.3.7 Proposed management practices

Noise is managed at Arrow Energy through its Environmental Noise and Vibration Management Plan, which has been developed based on the noise management principles and hierarchy of the EPP (Noise):

- Avoid – plan the activity and engage with affected stakeholders to avoid noise impacts.
- Minimise – implement noise mitigation measures; and
- Manage – conduct monitoring and ensure compliance.

The current SGP North EA conditions are suitable for controlling noise impact from the operation of the Girrahween FCS.

5.4 Biodiversity

5.4.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on biodiversity for the Project.

- *Environmental Protection Act 1994* (Qld) (EP Act): The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development.
- *Environmental Protection Regulation 2019* (Qld) (EP Reg): This regulation provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to ESAs.
- *Environmental Offsets Act 2014* (Qld) (EO Act): The main purpose of this act is to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets, by: (a) establishing a framework for environmental offsets; (b) recognising the level of protection given to prescribed environmental matters under other legislation; (c) providing for national, State, and local matters of environmental significance to be prescribed environmental matters for the purpose of this act; (d) coordinating the implementation of the framework in conjunction with other legislation.

- *Environmental Offsets Regulation 2014* (EO Reg) (Qld): This regulation provides details of the prescribed activities regulated under the existing legislation and prescribed environmental matters to which the EO Act applies.
- *Queensland Environmental Offsets Policy, Version 1.14*: This policy provides a single, consistent, whole-of-government policy for the assessment of offset proposals to satisfy offset conditions.
- *Environment Protection and Biodiversity Act 1999* (Cwlth) (EPBC Act): This Commonwealth act provides for the protection of matters of national environmental significance, including groundwater resources that relate to coal seam gas development. Any action with the potential for a significant impact on these matters must be referred to the Minister for the Department of Climate Change, Energy, the Environment and Water and may require approval under this act.
- *Vegetation Management Act 1999* (Qld) (VM Act): This act regulates the clearing of vegetation in a way that: (a) conserves remnant vegetation that is an 'endangered' or an 'of concern' or a 'least concern' regional ecosystem; and (b) conserves vegetation in declared areas; and (c) ensures the clearing does not cause land degradation; and (d) prevents the loss of biodiversity; and (e) maintains ecological processes; and (f) manages the environmental effects of the clearing; and (g) reduces greenhouse gas emissions; and (h) allows for sustainable land use.
- *Planning Act 2016* (Qld): This act establishes an efficient, effective, transparent, integrated, coordinated, and accountable system of land use planning, development, assessment, and related matters that facilitates the achievement of ecological sustainability.
- *Nature Conservation Act 1992* (Qld) (NC Act): This act regulated the clearing of native plants in Queensland to protect 'critically endangered', 'endangered', 'vulnerable', and 'near threatened' plants. Provides for the gazettal of protected areas, including nature refuges; prescribes classes of wildlife; and sets out restrictions on the taking or harm to native wildlife without a valid permit.
- *Nature Conservation (Plants) Regulation 2020* (Qld) (NC Reg Plants): This regulation contains the clearing regulatory requirements and the list of 'critically endangered', 'endangered', 'vulnerable', or 'near threatened' plants.
- *Nature Conservation (Animals) Regulation 2020* (Qld) (NC Reg Animals): This regulation provides for the conservation and management of protected animals in Queensland by: listing animal species under the conservation classifications under the NC Act; providing a management approach for each classification based on the threat of extinction to the species; providing general authorisations for interactions with animals in the wild; providing a permitting and authorisation framework for taking, keeping, and using native animals outside of protected areas; streamlining the licencing framework for keeping and using animals; including administrative arrangements for permitting and licencing frameworks; specifying offences and associated penalties; and including transitional provisions to allow continuity and preserve existing rights.
- *Queensland Government Protected Plants Framework and Species Management Program*: establishes the requirement for proponents to complete flora surveys prior to clearing, to locate any extinct, extinct in the wild, critically endangered, endangered, vulnerable, or near threatened plants within a clearing impact area. Pre-clearing surveys are typically conducted twelve months prior to construction to support for a clearing permit under the NC Act.

5.4.2 Description of environmental values

Description of general ecological values

As discussed in Section 2 of **Appendix B**, Arrow Energy has undertaken a range of desktop and field ground-truthing surveys over the Project area dating from 2013 up until 2023. These surveys were carried out to support the original Environmental Impact Statement (SGPEIS) and the Supplementary EIS (SGPREIS) and have been used as baseline data for Arrow Energy's ecological assessments.

This baseline data has been supplemented with further ground-truthing surveys that have occurred since 2021 up until 2023 of the proposed infrastructure locations and habitat assessments outside of the proposed infrastructure to support the validation. Where there has been a difference between baseline surveys and targeted surveys, Arrow Energy's ecological data and corporate database has been updated to reflect the most current ecological survey. The ground-truthing surveys have helped to support the baseline data and has significantly increased the local knowledge of ecological values.

In a few cases, the process as outlined above, has identified ways in which the mapping rules and baseline data could be modified and improved for greater accuracy for determining impacts to ecological values and impact assessment. Furthermore, additional MSES species have been listed under legislation since the original work from the SGPEIS was completed.

These new additional species had not been previously assessed (given their latest change in status), but are included in this assessment as an abundance of caution based on the likelihood of occurrence assessment and the suitability of habitat within the Project Area utilising the aforementioned baseline data, ground-truthed ecology surveys, survey data, and updated mapping rules. This ensures that the most valid data is being used for assessment and planning of infrastructure by applying the precautionary principle when assessing the impacts. Arrow Energy will continue to carry out ground-truthing surveys to confirm disturbance against proposed limits which would be defined in the SGP North EA.

Project area vegetation types and Environmentally Sensitive Areas (ESAs)

The Project area is located to the north-east of Miles in the Barakula subregion of the Brigalow Belt bioregion. It can generally be described as grazing lands dominated by dry eucalypt woodlands to open woodlands interspersed with small areas of open forest to woodland dominated by Poplar Box (*E. populnea*) or Silver-leaved Ironbark (*E. melanophloia*) and Spotted Gum (*Corymbia citriodora*). These dominant vegetation types are dissected by riparian open forests to woodlands associated with Dogwood Creek and Bottle Tree Creek. There are also small areas of off-channel palustrine wetlands associated with these creek systems.

The Barakula to St George Terrestrial Biodiversity Corridor runs through the northern part of the SGP North EA amendment area, linking Barakula State Forest in the east with Binkey State Forest in the west (refer to **Figure 5-5**), both of which contain intact areas of remnant vegetation and habitat.

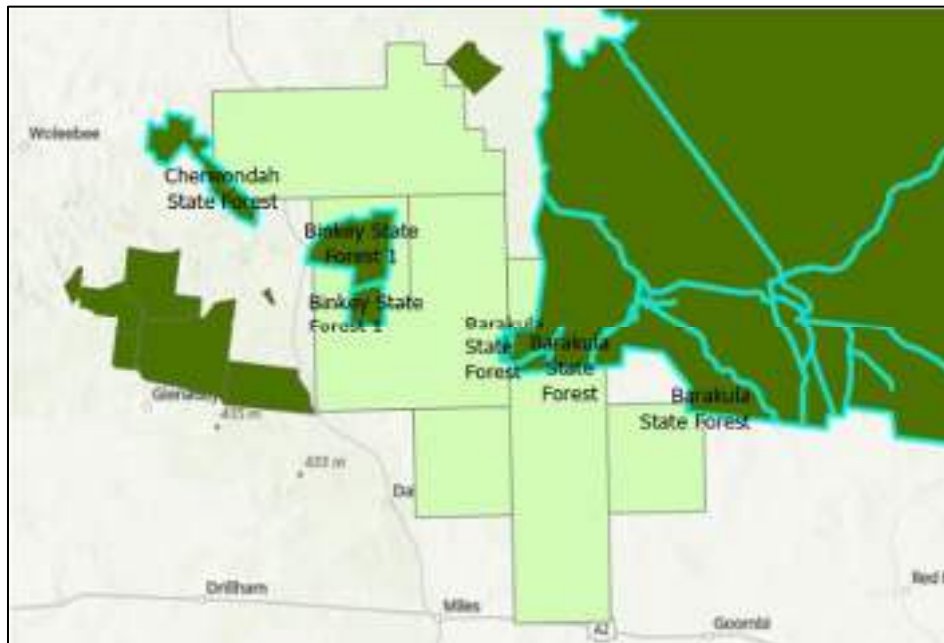


Figure 5-5 Barakula State Forest and Binkey State Forest intersection with the Project Area

Straddling the Great Dividing Range, Barakula State Forest is the largest state forest in Queensland and contains a rich mosaic of vegetation communities, including eucalypt forests, cypress pine woodlands, heathlands, and spinifex.

Environmentally Sensitive Areas (ESAs) in the Project area, as defined by the EP Reg and the SGP North EA (for Category C ESAs) are summarised in **Table 5-15** (refer to **Appendix B**).

Table 5-15 ESAs within the Project Area

ESA Category	ESA Type	Occurrence in SGP North EA amendment area
Category A	All	None
Category B	Endangered Regional Ecosystems (RE) by biodiversity status	Occurs in the Project area as Brigalow RE 11.9.5 and RE 11.9.10
	Other than endangered RE	None
Category C	Nature refuge	None
	Koala habitat	None
	Essential habitat	Mapped essential habitat for Koala and Corben's Long Eared Bat Essential habitat noted but not assessed for Near threatened species (Golden-tailed Gecko – <i>Cryptandra ciliata</i>).
	Of Concern RE by Biodiversity Status	Occurs in the Project Area as watercourse associated Res 11.3.2., 11.3.4, and 11.3.25
	Regional Parks (previously known as Resources Reserves)	None
	State Forest or Timber Reserve	Binkey State Forest Barakula State Forest
	Areas of vegetation that are 'critically limited'	None

For further details and mapping please refer to **Appendix B** for the detailed description of environmental values (i.e., terrestrial; flora and fauna) used for the assessment of impacts to biodiversity from the Project activities.

Terrestrial Flora

Certified Regional Ecosystem (RE) mapping prepared by the Queensland Herbarium identified 19 REs within the SGP North EA amendment area (refer to **Appendix B**).

The descriptions for mapped REs are provided in Table 3.2 of **Appendix B**, and include:

- Three (3) classified as 'endangered' by Biodiversity status;
- Four (4) classified as 'of concern'; and
- Twelve (12) classified as 'least concern'.

The SGP North EA amendment area retains significant native vegetation cover compared with other parts of the Brigalow Belt bioregion, with approximately 76% of the total land area (64,092 ha) supporting remnant native vegetation and a further 9% supporting regrowth and non-remnant vegetation. Ground-truthed RE mapping prepared for the SGP North EA amendment area was based on Project-specific vegetation community surveys. All 19 REs originally mapped by the DOR for the Project area were recorded during the field survey, with the exception of RE 11.3.27b, and a further five (5) REs recorded that were not mapped by DOR (RE 11.3.1, 11.3.25g, 11.3.27f, 11.4.3 and 11.5.20). Ground-truthed Res by biodiversity status are provided in Table 3.3 of **Appendix B**.

Of the 22 REs recorded for the SGP North EA amendment area, four (4) 'endangered' REs (RE 11.3.1, 11.4.3, 11.4.10 and 11.9.5) correspond with the Brigalow threatened ecological community (TEC) which is listed under the EPBC Act. Impacts on Brigalow TEC are managed under the EPBC approval and do not require further consideration as PEMs for the EA amendment application. Activities in these 'endangered' REs are restricted by the SGP North EA *Schedule F, Table 1 – Authorised Activities in Environmentally Sensitive Areas* and their Protection Zones.

Searches of DES's Wildnet database returned records for 13 threatened or near threatened flora species within 10 km of the SGP North EA amendment area. Of these:

- Five (5) are also listed as MNES, have approved maximum disturbance limits under the EPBC approval 2010/5344 (refer **Appendix B**) and have been excluded from further assessment; and
- A further three (3) species are considered unlikely to occur based on known habitat preferences and the availability of that habitat within the SGP North EA amendment area.

Those species considered known or likely to occur in the SGP North EA amendment area are addressed in **Appendix B**.

There are records for four (4) flora species listed as near threatened under the NC Act within 10 km of the SGP North EA amendment area, with those considered known or likely to occur being:

- *Cryptandra ciliata*;
- *Eucalyptus curtisii*, Plunkett Mallee; and

- *Rutidosia lanata*, Red-soil Woolly Wrinklewort.

Habitat for a near threatened species does not constitute an ESA, nor is it a PEM under the EO Act. The presence or potential presence of a near threatened species triggers requirements under the NC Act that are approved and managed separately to the EA. Therefore, the occurrence or potential occurrence of near threatened species or their habitat does not trigger any requirement to amend the SGP North EA however, the presence of these species is noted.

There are a number of areas in the north of the SGP North EA amendment area shown as 'high risk' on the Protected Plants Flora Survey Trigger Map (refer to **Appendix B**).

Terrestrial Fauna

The SGP North EA amendment area is dominated by eucalypt woodland to open forest habitats on depositional plains, low ridges, and floodplains. Ecosystem types on soils of low fertility, typically those REs associated with land zones 5 and 7, form the largest and most continuous tracts of vegetation, these have been heavily used for their timber resources with varying degrees of impact. In particular, habitats dominated by Narrow-leaved Ironbark species (*Eucalyptus crebra*), *E. elegans* and *E. woollsiana* have been logged to a such a degree that all mature canopy trees have been removed. The remaining vegetation comprises secondary growth with a thickened shrub layer forming the canopy.

The impact of logging is also evident in the majority of State Forests, including Barakula State Forest. However, general observations indicate that logging regimes within State Forests have been less severe than those applied to freehold land. While, on balance, the State Forests have retained greater conservation value than vegetation on freehold land, the future of these areas may be affected by changes to fire regime. EcoSmart (2017)¹⁹ (refer to **Appendix E**) noted the extensive canopy damage and, in places, complete canopy loss, resulting from a hot wildfire in 2012 that extended from Barakula State Forest south to near Miles. It is anticipated that while vegetation and habitat should recover in time (in the absence of further fire damage), the damage will affect flora and fauna community composition for decades to come.

A number of ecosystems appear more resilient to landscape-wide processes of degradation. In particular, *Eucalyptus fibrosa* subsp. *nubila* forest communities (RE 11.7.7) generally have a better-preserved canopy structure, a greater number of mature canopy trees and fewer large canopy gaps. This preservation is likely to be due to the quality and usefulness of the timber resource rather than an inherent ability to recover from disturbance.

The following broad habitat types are present within the SGP North EA amendment area based on ground-truth RE mapping (refer **Appendix B**):

- Eucalypt woodlands to open forests;
- Riparian woodlands to open forests;
- Acacia dominated open forest and woodlands;
- Heaths;

¹⁹ Surat Gas Project Terrestrial Ecology Report, Ecosmart, June 2017.

- Regrowth and non-remnant woody vegetation (cleared, fragmented, or disturbed); and
- Cleared areas.

Searches of DES's Wildnet database returned records for 17 threatened or near threatened NC Act listed fauna species within 10 km of the SGP North EA amendment area. Of these:

- Five (5) are also listed as MNES, have approved maximum disturbance limits under the EPBC approval 2010/5344 and have been excluded from further assessment;
- One (1) species (the Diamond Firetail) considered unlikely to occur based on known habitat preferences and the availability of that habitat within the SGP North EA amendment area (refer **Appendix B**) ; and
- Those fauna species considered known or likely to occur in the SGP North EA amendment area are addressed in Section 3.2.2 and 3.2.3 of **Appendix B**.

5.4.3 Assessment of environmental impacts

Biodiversity impact assessment methodology

Coal seam gas developments apply an iterative process in terms of locating wells and gathering lines to manage competing constraints associated with the location of surface infrastructure, including ecological values, landholder preferences, geological features, existing infrastructure, and access tracks. Planning and management of surface activities and ground disturbance is undertaken utilising a set of hierarchical management principles to avoid, minimise and mitigate impacts to environmental values. These principles are:

- Avoid: Arrow Energy's first preference is to avoid PEMs, threatened ecological communities and the habitat of PEMs listed threatened species.
- Minimise: where other competing constraints or the scale and location of PEMs communities or species habitat dictate that avoidance is not possible (e.g. where there is riparian vegetation that need to be crossed or large areas of suitable habitat for wide ranging species such as the koala, Greater Glider or Painted Honeyeater), Arrow Energy's will preferentially locate infrastructure in a manner that minimises the impact to these values (e.g. cross the riparian vegetation at the narrowest or most degraded part or where practicable on the edge of suitable habitat for listed species so as not to bisect good quality habitat).
- Mitigate: implement mitigation measures to further minimise the direct and indirect impacts on ecological values.
- Remediate and rehabilitate: actively remediate and rehabilitate impacted areas to promote and maintain long term recovery.
- Offset: Arrow Energy will offset unavoidable significant residual impacts to PEMs.

The SGP North EA amendment area retains significant native vegetation cover compared with other parts of the Brigalow Belt bioregion, with approximately 76% of the total land area (64,092 ha) supporting remnant native vegetation and a further 9% supporting regrowth and non-remnant vegetation. As such, it is not possible to access the gas resource for SGP North without clearing remnant vegetation, with 325 wells proposed in remnant areas.

Where possible, facilities requiring larger areas of clearing have been located in cleared areas or lesser quality (non-remnant or regrowth) vegetation. This includes the siting of key facilities for the SGP North development on land purchased by Arrow Energy in 2012 (Girrawheen Station), including the field compression station (FCS), a warehouse, office facility, camp, laydowns, pipe yards, quarries, and laydowns on land. This property includes large areas mapped as Category X (non-remnant) which have been ground-truthed as containing a mix of cleared, non-remnant, regrowth, and some remnant vegetation. All facilities on Girrawheen Station have been sited to take advantage of existing cleared areas, with minor clearing in adjoining regrowth or remnant areas required for establishment.

For facilities beyond Girrawheen Station, there is a requirement to clear remnant vegetation given the highly vegetated nature of the amendment area.

Habitat fragmentation occurs when continuous areas of habitat are subdivided into a number of separate components. This term encompasses two interrelated components; habitat loss (i.e. a reduction in the amount of habitat) and fragmentation (i.e. the breaking apart of habitat)(Bennett, 2006). The impacts of habitat fragmentation are also scale-dependent and may differ depending on the species or community under consideration.

Impacts on terrestrial flora and fauna values are provided in **Appendix B**.

Direct impacts

Vegetation clearing impacts

The most significant impact associated with the development of SGP North is the direct loss of the following resulting from the establishment of well pads, gathering and associated infrastructure:

- 1,102 hectares of remnant (representing approximately 2.3% of the total remnant within the EA amendment area); and
- 98.5 ha or regrowth native vegetation (representing approximately 4% of the total regrowth in the amendment area).

Given the highly vegetated nature of the SGP North EA amendment area, clearing of remnant vegetation and associated habitat is an unavoidable aspect of the Project development however, the majority of the clearing proposed is in widespread, least concern vegetation types (predominantly RE 11.5.1, RE 11.7.4 and RE 11.7.7) (refer to **Appendix B**). To date, impacts to MSES has been avoided for existing approved scope.

Habitat loss or fragmentation and connectivity impacts

While the overall clearing areas are large, clearing within remnant vegetation for gasfield development is undertaken in 'chunks', with disturbance areas of 1-2 ha for individual well pads or linear corridors of 20-27 m width with surrounding vegetation left intact. However, the Landscape Fragmentation and Connectivity (LFC) Tool which has determined the impacts on connectivity areas within the SGP North EA amendment area to be significant. Impact values generated by the LFC Tool have been included in the PEMs table in **Appendix B** and **Appendix G**.

Indirect impacts

Indirect impacts on ecological values that may arise as a result of the SGP North development include:

- edge effects resulting from the creation of smaller patches of vegetation with a greater edge to surface ratio, including increased exposure to weed invasion, light and wind penetration (which can alter microclimate features) potentially resulting changes in community structure and composition over time.
- dust generation during construction, which has the potential to smother plants, reducing photosynthesis and resulting in decreased vegetation health and condition;
- increased noise from the vegetation clearing operations, the operation of machinery and vehicle traffic which may affect the behaviour of wildlife (typically limited to the construction period); and
- increased lighting during construction and operation, with the potential to disrupt the behaviour of nocturnal species; and
- mortality resulting from vehicle collision.

Indirect impacts on the ecological values of the SGP North EA amendment area will be managed in accordance with Arrow Energy's existing Environmental Management Framework (refer to [SGP EIS Chapter 8](#)).

Impacts on State Forests

Limited works are proposed in Barakula State Forest and Binkey State Forest with disturbance totalling 48.5 ha and 20 ha respectively. Well pads and gathering lines from the well head to the initial compression facility constitute 'essential petroleum activities' as defined in the SGP North EA and are therefore authorised under *Schedule F, Table 1 – Authorised activities in Environmentally Sensitive Areas*, however, the following proposed activities within the State Forest areas trigger a requirement to amend the EA as currently formulated:

- Barakula State Forest – 5.2 ha of disturbance for 'non-essential' petroleum activities comprising a construction camp (1 ha), a communication tower (1 ha), local laydown area (3 ha) and extra work area (0.2 ha); and
- Binkey State Forest – 0.4 ha of disturbance for 'non-essential' petroleum activities comprising extra work areas.

All impacts in State Forest areas are associated with Least Concern RE types.

Specific EA amendments to the SGP North EA Schedule F – Protecting Biodiversity Values

Biodiversity impacts associated with the development of the Project require amendments to the SGP North EA, specifically:

- the inclusion of conditions to authorise impacts to ESAs where the petroleum activities proposed are not in accordance with *Schedule F, Table 1 – Authorised petroleum activities in environmentally sensitive areas and their protection zones* (refer to **Appendix B** and **Appendix G**); and
- amendments to *Schedule F, Table 3 – Significant residual impacts to prescribed environmental matters* where the impact areas proposed by the Project exceed the authorised limits in the SGP North EA (refer to **Appendix B** and **Appendix G**).

Specific changes to conditions under *Schedule F – Protecting Biodiversity values* within the SGP North EA to address the abovementioned biodiversity impacts are provided in **Appendix A** and **Appendix G**.

For offsets related to the proposed EA amendments refer to Section 6.3.

5.4.4 Proposed management practices

Arrow Energy implements environmental management controls and practices through its Environmental Management Framework (the framework) and the Health Safety and Environment Management System (HSEMS).

The principal objective of the environmental framework is to protect the environmental values of the project development area (as defined in government policies and regulations or as an attribute of the environment that is conducive to ecological health, public amenity, or safety), and to identify appropriate environmental management controls for the Project activities having regard to the constraints imposed by the environment values.

Implementation of the environmental framework allows Arrow to:

- Address uncertainty about potential impacts of the location and timing of coal seam gas infrastructure development;
- Identify constraints to coal seam gas development in the project development area having regard to the sensitivity of identified environmental values;
- Document the constraints through mapping or the establishment of guidelines (including buffers, thresholds, and trigger levels) to inform site and route selection for coal seam gas infrastructure;
- Develop environmental management controls to address the identified constraints; and
- Integrate the environmental framework with the HSEMS.

The framework approach ensures planning and development of coal seam gas fields will occur in an orderly manner through the application of environmental management controls such as avoidance, mitigation, and management, that are reflective of the level of sensitivity of environmental values. The sensitivity or vulnerability of an environmental value to change provides an indication of the level of constraint it poses to the development of coal seam gas infrastructure, which then determines the recommended environmental management controls, such as avoidance, separation distances, or buffers, or site specific management.

In summary, the level of environmental constraints provides an indication of the Project activities that could occur in a particular area, subject to the application of appropriate environmental management controls, and also of those activities that should not occur in certain areas. Controls and mitigation measures are incorporated into the standard operating procedures.

The standard operating procedures describe the process and frequency of updates to the constraints maps (i.e., GIS layers), and incorporate the following requirements:

- A periodic review of the constraints criteria to ensure they reflect state and federal government policy, guidelines and listings, and the results of any environmental impact assessment undertaken by Arrow Energy;

- A periodic update of the Project GIS to incorporate updated government datasets and the results of any ecological surveys, and any environmental impact assessment processes undertaken by Arrow; and
- A constraints analysis, as required, to ensure constraints mapping is up to date.

Specific standard operating procedures include:

- Site and route selection;
- Ecological and pre-construction clearance surveys; and
- Equipment and materials selection and facility design.

For further detail and information regarding Arrow Energy's Environmental Framework, refer to [SGPEIS Chapter 8 Environmental Framework](#).

5.5 Biosecurity

5.5.1 Applicable legislation

The following legislation are relevant to identifying values and mitigating and managing impacts on biosecurity matters:

- *Biosecurity Act 2014* (Qld) and Regulation 2016: Biosecurity matters are defined in Section 15 as *Prohibited matters* and *Restricted matters*, and include: high risk weeds, pest animals, disease, viruses, fungi, insects, and parasites.
- *Local Government Act 2009* (Local Government Act) (Qld): Other weeds are declared under this act as local law.
- *Australian Weeds Strategy 2017-2027* (Cwlth): Further the identifies introduced plants that are agreed by Australian governments to be Weeds of National Significance (WONS).

5.5.2 Description of environmental values

High risk biosecurity matters identified within the Western Downs Regional Council local government area and of relevance to Arrow Energy are included in **Table 5-16**.

Table 5-16 High risk biosecurity matters

Biosecurity Matter	Categories
Pest Plants	
African boxthorn (<i>Lycium ferocissimum</i>)	WONS, Restricted matter category 3
African love grass (<i>Eragrostis curvula</i>)	Local Law (BSC)
Asparagus fern (<i>Asparagus aethiopicus</i> , <i>A. africanus</i> and <i>A. plumosus</i> , <i>A. scandens</i>)	WONS, Restricted matter category 3
Athel pine (<i>Tamarix aphylla</i>)	WONS, Restricted matter category 3
Broad-leaved pepper tree (<i>Schinus terebinthifolius</i>)	Restricted matter category 3
Cabomba (<i>Cabomba caroliniana</i>)	WONS, Restricted matter category 3
Cactus: (<i>Cylindropuntia</i>) Snake cactus (<i>C. spinosior</i>) Coral cactus (<i>C. fulgida</i>) Jumping cholla (<i>C. prolifera</i>) Devils rope pear (<i>C. imbricata</i>)	WONS, Restricted matter category 3

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Cactus: (<i>Harrisia</i>) <i>Harrisia cactus</i> (<i>H. martinii</i> , <i>H. tortuosa</i> and <i>H.pomanensis</i> syn. <i>Cerus pomanensis</i>)	Restricted matter category 3
Cactus: (<i>Opuntia</i>) Bunny ears (<i>O. microdasys</i>) <i>O. elata</i>	WONS, Restricted matter category 2,3,4,5
Cactus: (<i>Opuntia</i>) Prickly pear (<i>Opuntia stricta</i> syn. <i>O.inermis</i>) Velvet tree Pear (<i>O.tomentosa</i>) Tiger pear (<i>O.aurantiaca</i>) Drooping tree pear (<i>O.monacantha</i> syn. <i>O.vulgaris</i>) Westwood pear (<i>O.streptacantha</i>)	WONS, Restricted matter category 3
Camphor laurel (<i>Cinnamomum camphora</i>)	Restricted matter category 3
Cats claw creeper (<i>Dolichandra unguis-cati</i>)	WONS, Restricted matter category 3
Chinese celtis (<i>Celtis snensis</i>)	Restricted matter category 3
Fire weed (<i>Senecio madagascariensis</i>)	WONS, Restricted matter category 3
Giant parramatta grass (<i>Sporobolus fertilis</i>)	Restricted matter category 3
Giant rats tail grass and other weedy <i>Sporobolus</i> species (<i>Sporobolus pyramidalis</i> , <i>S.natalensis</i> , <i>S.jacquemontii</i> , <i>S.fertilis</i>)	Restricted matter category 3
Groundsel bush (<i>Baccharis halimifolia</i>)	Restricted matter category 3
Hymenachne or Olive hymenachne (<i>Hymenachne amplexicaulis</i> and hybrids)	WONS, Restricted matter category 3
Karoo thorn (<i>Vachellia Karoo</i>)	Prohibited matter
Lantana (<i>Lantana camara</i>), Creeping lantana (<i>L. montevidensis</i>)	WONS, Restricted matter category 3
Leucaena (<i>Leucaena leucocephala</i>)	Local law (BSC & RRC)
Madeira vine (<i>Anredera cordifolia</i>)	WONS, Restricted matter category 3
Mesquite (<i>all Prosopis spp.</i> And hybrids other than <i>P. glandulosa</i> , <i>P.pallida</i> and <i>P.velutina</i>)	WONS, Prohibited matter
Mother-of-millions (<i>Bryophyllum delagoense</i> syn. <i>B. tubiflorum</i> , <i>Kalanchoe delagoensis</i> , hybrid <i>Bryophyllum x houtonii</i>)	Restricted matter category 3
Parkinsonia (<i>Parkinsonia aculeata</i>)	WONS, Restricted matter category 3
Parthenium weed (<i>Parthenium hysterophorus</i>)	WONS, Restricted matter category 3
Privet: (<i>Ligustrum</i>) Broad-leaf privet (<i>L. lucidum</i>) Chinese privet (<i>L. sinense</i>)	WONS, Restricted matter category 3
Rubber vine (<i>Cryptostegia grandiflora</i>)	WONS, Restricted matter category 3
Serrated tussock grass (<i>Nassella trichotoma</i>)	WONS, Prohibited matter
Silver-leaf nightshade (<i>Solanum elaeagnifolium</i>)	WONS, Restricted matter category 3

Biosecurity Matter	Categories
Water hyacinth (<i>Eichhornia crassipes</i>)	WONS, Restricted category 3
Yellow bells (<i>Taecomia stans</i>)	Restricted matter category 3
Pest Animals	
Carp (<i>Cyprinus carpio</i>)	Restricted matter category 3,5,6,7
Dingo (<i>Canis lupus dingo</i>)	Restricted matter category 3,4,5,6
European rabbit (<i>Oryctolagus cuniculus</i>)	Restricted matter category 3,4,5,6
European red fox (<i>Vulpes vulpes</i>)	Restricted matter category 3,4,5,6
Feral cat (<i>Felis catus</i> and <i>Prionailurus bengalensis</i> x <i>Felis catus</i>), other than a domestic cat	Restricted matter category 3,4,6
Feral deer Chital axis deer (<i>Axis axis</i>) Fallow deer (<i>Dama dama</i>) Rusa deer (<i>Rusa timorensis</i> , syn. <i>Cervus timorensis</i>) Red deer (<i>Cervus elaphus</i>)	Restricted matter category 3,4,6
Feral pig (<i>Sus scrofa</i>)	Restricted matter category 3,4,6
Wild dog (<i>Canis lupus familiaris</i>), other than a domestic dog	Restricted matter category 3,4,6
Disease and Virus (Pathogens)	
Bacterial blight (<i>Xanthomonas axonopodis</i>)	Prohibited matter
Verticillium wilt (<i>Verticillium dahlia</i>)	Prohibited matter

Three exotic flora species, all of which are classified as weeds, are considered to have a high potential for impact within the project development area due to the favourable climatic conditions and habitats available:

- African lovegrass (*Eragrostis curvula*) is an aggressive and difficult-to-control, grassy weed that is widely established on road verges. The species has the long-term potential to displace native pasture grasses and decrease grazing productivity. African lovegrass provides a potential threat to the integrity of native grassland and associated listed species.
- Parthenium (*Parthenium hysterophorus*) colonises weak pastures with disturbed ground cover. A few widely scattered occurrences have been recorded on roadsides within and in the vicinity of the project development area; however, no major infestations are known.
- Mesquite (*Prosopis glandulosa* var. *glandulos*, *Prosopis velutina*), which forms dense impenetrable thickets in riparian areas that can outcompete native vegetation, is known from a few scattered records around Brookstead and Millmerran on heavy soils.

Fauna species considered to have a moderate potential for increased distribution as a result of project activities include:

- Cane toad (*Rhinella marina*).
- European red fox (*Vulpes vulpes*).

- Feral cat (*Felis catus*).
- Wild dog (*Canis familiaris*).
- Feral pig (*Sus scrofa*).

The European rabbit does not pose a threat within the area due to unfavourable ecological conditions.

5.5.3 Assessment of environmental impacts

If exotic plants are not managed, the project has the potential to increase their abundance and facilitate dispersal which may have negative economic and social effects as well as negative impacts on native vegetation and biodiversity. Mechanisms of weed dispersal and spread of pathogens from project activities are generally associated with:

- Movement of equipment and machinery, particularly machinery sourced from adjacent regions.
- Ground disturbance, such as grading, removal, and relocation of topsoil.

Project-related activities have the potential to increase pest fauna abundance, which could lead to increased competition with and predation of native fauna and habitat degradation (e.g., through wallowing and foraging by feral pigs). In particular, pest fauna abundance and distribution may increase due to:

- The construction of linear infrastructure, which may create pathways and increase dispersal capability.
- The construction of dams, which can provide a permanent water source for feral animals, thereby increasing their abundance and distribution. In addition, dams may attract cane toads, increasing the risk of toxic ingestion in predatory species, such as grey snake, common death adder and black-necked stork.
- Putrescible waste dumps, which can become a food resource for a variety of pest fauna species, leading to an increase in their abundance.

5.5.4 Proposed management practices

Arrow Energy implements its Biosecurity Procedure (ORG-ARWE-HSM-PRO-00187) to manage biosecurity risks and to facilitate compliance with obligations under the *Biosecurity Act 2014*. This procedure adopts a risk-based approach to managing biosecurity, which allows greater flexibility and more responsive approaches to manage each specific circumstance.

Arrow Energy's Vehicle, Machinery, Equipment and Load Hygiene Procedure (ORG-ARW-HSM-PRO-00138) is implemented to minimise the likelihood of introducing biosecurity matters when undertaking a journey, transporting loads, and moving equipment.

During project planning, a preliminary ecology survey is undertaken to identify the presence, abundance, and distribution of biosecurity matter. The records of biosecurity matter findings are uploaded to Arrow Energy's GIS spatial repository. Any relevant findings are used to inform future management requirements and, subject to the biosecurity matters identified, whether a location specific biosecurity plan is required.

Pre-disturbance biosecurity surveys are undertaken prior to construction and updated information captured. Commensurate with risk, monitoring for biosecurity matters on

site is ongoing during construction. Specific actions undertaken during construction to avoid, mitigate and manage biosecurity impacts include (as necessary):

- Progressive clearing and rehabilitation as soon as practicable.
- Training and inductions to ensure all relevant personnel are made aware of the location and extent of biosecurity matters in the vicinity of the work area and the risks involved in moving from one site or property to another.
- When sourcing materials, ensure that such materials as bedding sand, topsoil, straw bales, and sand bags are only brought to site after it is ascertained that the materials are not contaminated with weeds and plant or animal pathogens.
- Washdown facilities will ensure that runoff is contained on site and does not transfer weed seeds, spores, or infected soils to adjacent areas. No wash down of vehicles is permitted in watercourses. Wash down of vehicles and equipment that have potentially been in contact with weeds and pathogens will be undertaken before entering new work sites.
- Disposal, storage and management of food scraps and general waste in appropriate storage facilities or containers that prevent animal access.

Vehicle, Machinery, Equipment and Load Hygiene

Arrow Energy is required to minimise the likelihood of introducing biosecurity matters when undertaking a journey, transporting loads, and moving equipment and must comply with the obligations in Section 15 of the Land Access Code 2016. Refer to the Vehicle, Machinery, Equipment and Load Hygiene Procedure (ORG-ARW-HSM-PRO-00138) for obligations and management requirements.

5.6 Surface Water

5.6.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on water quality for the project.

- *Environmental Protection Act 1994* (Qld) (EP Act): The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development, and it governs the management of surface water in regard to coal seam gas fields. The *Environmental Protection Regulation 2019* provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to ESAs.
- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity)): This policy sits under the EP Act, and its purpose is to achieve the object of the EP Act in relation to waters and wetlands, that is, protecting Queensland's water environment while allowing for development that is ecologically sustainable.
- *Coal Seam Gas Water Management Policy 2012* (Qld) (CSG Water Policy): This policy was developed to give direction to CSG operators for the treatment and disposal of coal seam gas water and to the role the government wishes to play in facilitating greater beneficial use of CSG water.
- *Water Act 2000* (Qld): This act provides the framework to deliver sustainable water planning, allocation management and supply processes to ensure the improved security of water resources. The project is within the region covered by the Water Resource (Condamine and Balonne) Plan 2004, which lies under the Water Act.

The plan sets a requirement for the taking of or interfering with overland flow; therefore, such activities need an operational works approval under Schedule 3, Table 4 of Sustainable Planning Regulation 2009.

- *Environment Protection and Biodiversity Act 1999* (Cwlth) (EPBC Act): This Commonwealth act provides for the protection of matters of national environmental significance, including listed aquatic species and Ramsar sites. Changes to surface water systems have the potential to impact aquatic species and Ramsar sites. Any action with the potential for a significant impact on these must be referred to the Minister for the Department of Sustainability, Environment, Water, Population and Communities and may require approval under this act.
- *Fisheries Act 1994* (Qld): This act provides for the management, use and protection of fisheries resources in Queensland. In the event that Arrow needs to establish waterway barriers during watercourse crossings, approval must be sought under the Fisheries Act. The Fisheries (Freshwater) Management Plan 1999 under this act lists noxious species.

5.6.2 Description of environmental values

The regional surface water environment within the Project area is comprised of two drainage basins which intersect the development area. The basin in the southern portion of the North project area is the Condamine-Culgoa Basin (primarily associated with the Balonne River catchment). The Condamine-Culgoa basin forms part of the Murray-Darling drainage division. The main watercourse is Dogwood Creek which flows into the Balonne River downstream of Miles.

The northern portion of the project area is located in the Fitzroy Drainage Basin which forms part of the North East Coast Drainage Division. Juandah Creek is the largest stream in this portion. This creek flows into the Dawson River and then the Fitzroy River.

The main channels of the major streams throughout the Project area are set within broad floodplains dominated by fine-grained, often cohesive alluvium. The larger streams such as Juandah and Dogwood Creeks have a dominant main channel and often several flood channels.

The hydrology of the surface waters flowing through the Project area has been extensively modified by land clearance, dams, weirs, and pumping infrastructure. Overland flow characteristics also vary, with vast areas of low-gradient floodplains or terraced surfaces generating little runoff except when saturated or under intense rainfall. When runoff is generated, expansive areas may be inundated.

Major floods occur on an average of every two years and generally in the months of late spring, summer, and autumn.

5.6.3 Surface water quality objectives and indicators

The environmental protection objectives for surface waters are:

- To avoid or minimise any degradation to water quality, water access, and the physical and biological characteristics of the watercourses and wetlands; and
- To maintain surface water amenity for the local community.

5.6.4 Assessment of environmental impacts

Potential impacts on surface water environmental values from the project's construction, operation and decommissioning activities include:

- Changes to physical form;
- Changes to hydrology; and
- Surface water quality degradation.

While the SGP EIS and SREIS, available on Arrow Energy's website, provide details on potential impacts, the following is an overview. Most importantly, the planning for CSG development in regard to development on floodplains must consider the RPI Act Statutory Guideline (02/14) *Carrying out resource activities in a Priority Agricultural Area* (July 2017), given that a significant portion of lands in the Project area has been designated as a Priority Agricultural Area (PAA).

During construction, operation, and decommissioning of wells, gathering lines and associated facilities such as access roads, the following impacts could occur:

- Changes to physical form and diminished water quality from the removal of riparian vegetation and subsequent reduced bank stability and increased erosion and sediment mobilisation.
- Diminished water quality from the removal of terrestrial vegetation leading to increased runoff and sedimentation in the watercourses.
- Diminished water quality from controlled and uncontrolled releases of hydrotest fluids.
- Diminished water quality from spills of hazardous materials or drilling muds.
- Damage to farmers' assets (including cropland) from placement of infrastructure in floodplains.
- Diminished water quality from earthmoving and soil stockpiling leading to increased sedimentation in watercourses.
- Flooding, changes to physical form and changes to hydrology by placing infrastructure in surface water flow paths.
- Changes to physical form and diminished water quality from pipeline or vehicle watercourse crossings causing bed and bank erosion and subsequent mobilisation of sediment.
- Changes to hydrology due to blockages in streams from pipeline watercourse crossings.

Potential impacts from flooding are the inundation of infrastructure and diversion of overland flows caused by inappropriately sited well production facilities. Diverted flows can cause erosion, loss of topsoil and prolonged inundation of crops leading to losses. As there are no processing facilities proposed for the development area, floodplain management for this EA report is focussed on the effects of wells and gathering lines and associated infrastructure.

5.6.5 Proposed Management practices

Primary mitigation measures to manage impacts to surface waters will include the following:

- Avoid permanent pools, chains of ponds, and alluvial islands, where practicable, when selecting watercourse crossing points.
- When siting facilities, avoid wetlands and consider the following:
 - Stream processes that may result in channel migration (either over time or as a result of project activities) and areas that are highly susceptible to erosion.
 - Downstream values of nearby watercourses or wetlands.
 - Minimising changes to natural drainage lines and flow paths.
 - Flooding regimes and areas subject to inundation.
 - Implement a 100 m wide buffer zone from the high bank of all watercourses to ensure that no development or clearance occurs within these buffers (other than construction of watercourse crossings for roads and pipelines and associated stream monitoring equipment).
 - Minimise watercourse crossings, where practicable, during route selection. Where required, select crossing locations to avoid or minimise disturbance to aquatic flora, waterholes, watercourse junctions and watercourses with steep banks.
 - Construct watercourse crossings in a manner that minimises sediment release to watercourses, stream bed scouring (e.g., the crossing location will be at low-velocity, straight sections, with the pipeline or road orientated as near to perpendicular to water flow as practicable), obstruction of water flows and disturbance of stream banks and riparian vegetation. Avoid, where practicable, the use of rock gabions, as they are unsuited to watercourses of the region.
 - Minimise the disturbance footprint and vegetation clearing.
 - Clear areas progressively and implement rehabilitation as soon as practicable following construction and decommissioning activities.
 - Grade soil away from watercourses.
 - Control sediment runoff from stockpiles.
 - Apply appropriate industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels, and lubricants).

The following measures address potential impacts to stream hydrology:

- Check for flood warnings or subscribe to flood warning services where relevant during construction of watercourse crossings.
- Plan construction of watercourse crossings to occur during periods of low rainfall and low flow, where practicable.
- Avoid disrupting overland natural flow paths, and where avoidance is not practical, maintain connectivity of flow in watercourses.

Degradation to surface water quality will be minimised with the following measures:

- Develop an erosion and sediment control plan and install and maintain appropriate site specific controls.
- Locate soil stockpiles away from watercourses to minimise potential for sediment runoff to enter the watercourse.

- Use CSG water for dust suppression on roads or for construction and operations activities in accordance with the water quality parameters described in the EA.

Monitoring of surface water quality will be implemented to verify the residual impacts throughout the life of the project and to ensure mitigation measures are effective. Monitoring will be undertaken to demonstrate achievement of objectives and compliance with commitments.

Inspection and monitoring measures will include:

- Routinely monitor buffer zones and project footprint.
- Visually inspect physical form and monitor hydrology, turbidity, and pH upstream and downstream of crossings immediately prior to, during and after construction of watercourse crossings.
- Inspect erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures is maintained.
- Routinely inspect spill containment controls and spill response kits.

A Coal Seam Gas (CSG) Water Management Plan (CWMP) for the SGP has been developed in accordance with Section 126 of the EP Act and is provided in **Appendix E**. Information to satisfy Section 126 and 126A of the EP Act which is specific to the SGP North tenures is presented in Section 3.

5.7 Groundwater

5.7.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on groundwater quality or availability for the project.

- *Environmental Protection Act 1994* (Qld) (EP Act): The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development, and it governs the management of groundwater in regard to coal seam gas fields. The *Environmental Protection Regulation 2019* provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to ESAs.
- *Water Act 2000* (Qld): This act provides the framework to deliver sustainable water planning, allocation management and supply processes to ensure the improved security of water resources. The project is within the region covered by the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017 and the Water Plan (Condamine and Balonne) 2019, both of which lie under the Water Act.
- *Environment Protection and Biodiversity Act 1999* (Cwlth) (EPBC Act): This Commonwealth act provides for the protection of matters of national environmental significance, including groundwater resources that relate to coal seam gas development. Any action with the potential for a significant impact on these matters must be referred to the Minister for the Department of Climate Change, Energy, the Environment and Water and may require approval under this act.
- *Petroleum and Gas (Production and Safety) Act 2004* (Qld): The purpose of this Act is to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient, and viable petroleum and fuel gas industry, including the management of underground water resources.

Current approvals for groundwater management under which Arrow Energy operates, in addition to the SGP North EA, are:

- The Underground Water Impact Report (UWIR) 2021 for the Surat Cumulative Management Area, prepared by the Office of Groundwater Impact Assessment (OGIA) under the Water Act 2000 (Qld); and
- The EPBC Approval 2010/5344, including the Stage 1 (2018) and Updated (2019) Water Monitoring and Management Plan (WMMP), under the EPBC Act.

5.7.2 Description of environmental values

Quaternary aged alluvial deposits are associated with the main streams in the development area, Juandah Creek in the north and Dogwood Creek in the south. These alluvial deposits are generally fine grained and cohesive, and confined to the floodplains of the streams. The physical aspects of these alluvial aquifers within the shallow groundwater system make them highly resilient to depressurisation impacts. The shallow groundwater system is dynamic, with several recharge mechanisms. Shallow aquifers in the project development area are predominantly recharged from surface drainage, however diffuse recharge and bedrock recharge can also occur.

The Jurassic aged Westbourne Formation, Springbok Sandstone, and Walloon Coal Measures of the Surat Basin are the main units that outcrop in the development area and subcrop under the alluvium, and overlie the Eurombah Formation, Hutton Sandstone, Evergreen Formation and Precipice Sandstone which outcrop further to the northeast of the development area. The Westbourne Formation, Eurombah Formation and Evergreen Formation are considered tight aquitards, the Springbok Sandstone and Hutton Sandstone are partial or tight aquifers, and the Precipice Sandstone is a regional aquifer as described by OGIA²⁰. The Walloon Coal Measures are considered an interbedded aquitard, where the coal seams are thin, spatially limited water yielding zones interbedded in an otherwise tight aquifer.

Table 5-17 provides a summary of the values which relate to the groundwater system where impacts are predicted from the identified resource activities on the respective PL. Based on this, any impacts to environmental values will be in line with that presented in the SGPEIS, the UWIR 2021, and the WMMP.

Table 5-17 Existing environmental values that may be affected by the exercise of underground water rights

Existing Environment/ Groundwater System	Intrinsic Characteristics and Hydrogeological Processes
Springbok Sandstone	<ul style="list-style-type: none"> • Groundwater from this system is of moderate biological importance due to generally better water quality than that of coal seam gas formations. • There are no known areas of physical connection between this groundwater system and surface features within Arrow tenements. • This aquifer is not known to support specific areas of cultural or spiritual significance. • This aquifer can provide a supply generally suitable for agricultural uses, excluding irrigation. • This aquifer forms a regional aquifer system across the GAB, and equivalent aquifers are common in many areas.

²⁰ Refer to the [Surat Cumulative Management Area \(CMA\) and its groundwater systems report](#), 31/03/2022.

Existing Environment/ Groundwater System	Intrinsic Characteristics and Hydrogeological Processes
	<ul style="list-style-type: none"> • There are multiple recharge mechanisms producing a moderately resilient system that can recover over the medium term. • Rehabilitation can be achieved when impacts are removed.
WCM	<ul style="list-style-type: none"> • Groundwater from this system is of low biological importance due to generally poorer water quality than other groundwater systems. • There are no known areas of physical connection between this groundwater system and surface features within the project development area. • The aquifers in the coal seam gas groundwater system provide a brackish to saline supply generally suitable for industrial uses or stock watering. • The coal seam gas groundwater system is a regional aquifer system across the GAB, and equivalent aquifers are common in many areas • The coal seam gas groundwater system is less dynamic than other shallower systems, with limited recharge mechanisms. The aquifers within the coal seam gas groundwater system are recharged through rainfall only where outcropping and through inter-aquifer leakage and can recover from groundwater drawdown slowly. • Rehabilitation can be achieved when impacts are removed.
Hutton Formation	<ul style="list-style-type: none"> • Groundwater from this system is of moderate to high biological importance due to higher water quality than other groundwater systems. Aquifers in the deep groundwater system have the potential to naturally discharge to surface features. • There are no known areas of physical connection between this groundwater system and surface features within the project development area; however, they may exist within the groundwater model extent of the larger Surat CMA. • The aquifers in the deep groundwater system have historical cultural significance as artesian supply in the Surat CMA, however the Hutton is sub-artesian within the project area. • The aquifers in this groundwater system provide a supply generally suitable for agricultural uses. • The deep groundwater system is a locally unique aquifer system; however, equivalent regional aquifers are common across the GAB. • The physical aspects of the aquifers within the deep groundwater system provide some resilience to depressurisation impacts. • The deep groundwater system is less dynamic than other shallower systems, with limited recharge mechanisms and lower resilience. The aquifers within the deep groundwater system are recharged through rainfall in distal areas where formations outcrop and through inter-aquifer leakage and can have long recovery periods. • Rehabilitation can be achieved when impacts are removed.

Groundwater Dependant Ecosystems (GDE)

Assessment of potential impacts to GDEs as part of the SGPEIS/SREIS has been updated to inform the Stage 1 and Updated CSG Water Monitoring and Management Plan (CSG WMMP²¹) to address the approval conditions. The assessments included:

- Identification of potential GDEs in the vicinity of the SGP.
- Use of numerical groundwater modelling to predict areas of potential impact.

²¹ [SGP Water Monitoring and Management Plan](#), December 2018.

- Correlation of potential GDEs with areas of potential impact to identify potentially at risk GDEs. This included consideration of:
 - Direct observation during site visits to confirm the presence or otherwise of groundwater dependent vegetation.
 - Site conceptualisation, including stratigraphy, depth to groundwater (including historical variability), characteristics of vegetation present and position in landscape.
 - Interpreted GDE source aquifer.
 - Ecosystem resilience and adaptability.

The technical studies and assessments identified an area directly to the north of the PL494 boundary, within ATP610 and 1km west of the Burunga Pilot Dam (refer to **Figure 5-6**) for further investigation. This further investigation included installation of groundwater monitoring bores, coring to identify rooting depth, stable isotope analysis (of groundwater, soil, and plant xylem water) to identify dominant source of water, and leaf water potential to identify level of water stress during dry periods.

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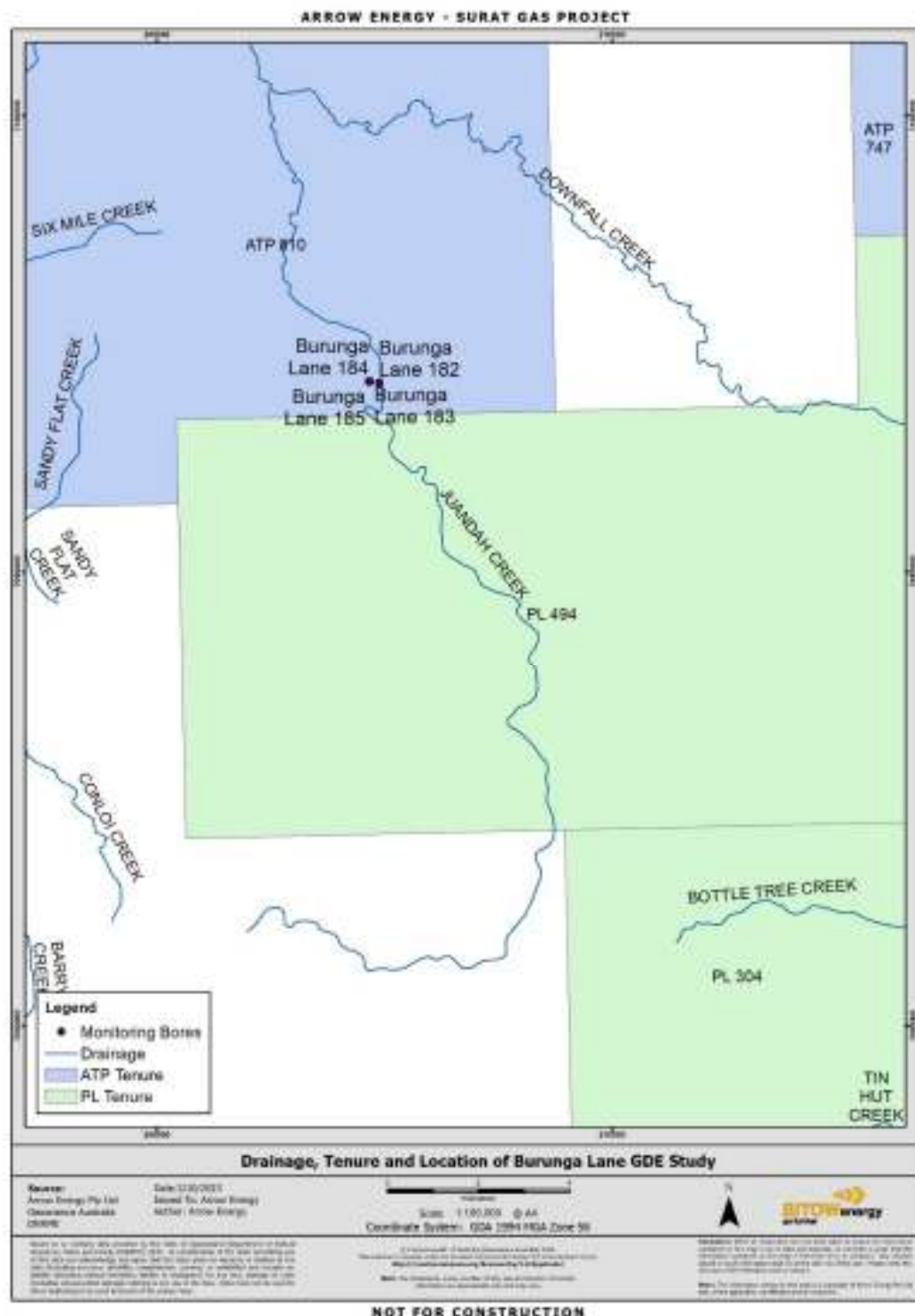


Figure 5-6 Drainage, Tenure and Burunga Lane GDE Investigation

The study objective at Burunga Lane was to identify aquifer connectivity and if mapped vegetation (i.e. River Red Gums or Poplar Box) are groundwater dependent in the identified area. A total of 4 monitoring bores were drilled and constructed targeting the following underlying geological formations.

- Three monitoring bores were drilled and completed to depths of 25 m, 40 m, and 85 m into the Wambo Unit of the Walloon Coal Measures, and

- One shallow monitoring bore drilled to completed depth of 7 m into the overlying alluvium.

The drilling results indicate the Wambo Unit of the Walloons Coal Measures directly underlie the alluvium at the Burunga Lane location.

Multiple lines of evidence from the field investigations demonstrated that ecosystems at the site is unlikely to be dependent on the regional groundwater systems and therefore unlikely to be at risk of impact from groundwater extraction associated with cumulative CSG development in the Surat CMA. The following are salient findings:

- The deeper-rooted trees are considered likely to be tapping downward-percolating water moving under gravity through a near-saturated vadose zone.
- The depth to the regional aquifer (which could be subject to CSG depressurisation) is considerably deeper than: (i) the deepest observed rooting depth; (ii) the inferred likely zone of predominant soil moisture uptake by trees.
- The relatively shallow maximum tree root depths observed in comparison to the maximum anticipated depth threshold of 18 m based on literature studies (3D Environmental/Earth Search 2018).
- Limited potential for hydraulic connection between the WCM and overlying aquifers.

Subsidence

Arrow Energy's subsidence monitoring program involves use of airborne Light Detection and Ranging (LiDAR) and satellite imaging using Interferometric Synthetic Aperture Radar (InSAR) which provides baseline data and a regular interpretation of ground movement over the area of CSG extraction or planned extraction which includes and covers the 6 PLs.

InSAR technology provides high temporal resolution and wide coverage of change in elevation, while LiDAR provides high spatial resolution targeted coverage of terrain including slopes. Arrow Energy also collect geodetic measurement of ground movement at selected locations by conventional survey as well as a continually operating reference station (CORS) to provide a ground-truthing check on the InSAR results, as shown in **Figure 5-7**.

Development of a subsidence monitoring program that utilises information available, together with dedicated subsidence measuring devices, establishes trigger thresholds and defines an action plan for trigger exceedances has been developed, and includes:

- Calculated assessments of indicated subsidence for different regions within areas potentially affected by CSG drawdown.
- A risk assessment process to establish locations for strategic geodetic monitoring and/or extensometers.
- Trigger thresholds, derived from the calculated assessments of potential subsidence, and considering the outcomes of the risk assessment process.
- A program for annual monitoring or longer term monitoring if considered necessary.
- Reporting of the results of the ongoing monitoring, including interpretation, and an action plan for trigger exceedances that would be included in the annual reporting.

The objective of the subsidence monitoring program is to identify whether assets or the environment are adversely affected by ground subsidence resulting from SGP CSG extraction activities.

The Stage 1 WMMP submitted for Federal approval included trigger thresholds that have been developed for CSG induced subsidence as required by approval condition 13 (g). They are derived from the calculated risk assessments of potential subsidence, and considering the outcomes of the risk assessment process.

Review of potential impacts on various assets indicates that differential settlement or change in slope is more relevant than total subsidence. A three-step assessment process is set out. Initial assessment would involve screening of areas where significant subsidence is occurring based upon the annual rate of subsidence reported from InSAR monitoring results.

In areas where this significant movement is recorded, further investigation will be carried out to identify movement with potential to impact on particular assets. The assets identified where potential impacts are identified will be subject to further investigation including using LiDAR and conventional survey to check movement against the trigger thresholds. The three-step assessment process includes:

- Screening level

Initial screening will involve identification of areas where significant subsidence is occurring based upon the annual rate of subsidence reported from InSAR monitoring results. This initial screening will involve identification of areas of 1 km by 1 km where more than 50% of the InSAR monitoring points indicate an annual subsidence rate of more than 8 mm/year (a movement rate discernible using InSAR methods). In areas where this level of movement is recorded, further assessment will be carried out.

- Investigation Levels

In areas where the screening level is exceeded, further assessment of relevant data relating to subsidence will be undertaken. This will include an assessment of the CSG-related subsidence component of the reported InSAR measurements with consideration for the cumulative industry impact and reported subsidence since the commencement of the Arrow SGP operations.

Investigation levels have been defined in the Stage 1 WMMP. The maximum subsidence predicted within the project area in the 2021 UWIR is 0.1m, for comparison the natural ground movement was typically less than 0.05 m but up to 0.126 m within the project area between 2015 and 2022 as shown on **Figure 5-7**. As the topography is gently undulating and there is no low slope irrigated or broadacre strategic cropping land within the project area, the potential for material impact from subsidence is low. However, where the CSG-related subsidence exceeds the investigation levels, further assessment will be carried out to assess the site-specific infrastructure that may be impacted and identify whether an impact has occurred as a result of the Arrow SGP operations.

- Trigger threshold

Where the investigation levels are breached, additional investigation of the affected area will be carried out. The results of the investigation will be tested against asset-specific thresholds. Where adverse impacts are identified to have occurred based on

the results of the site-specific investigation, a trigger threshold is considered to have been exceeded and mitigation measures will be employed.

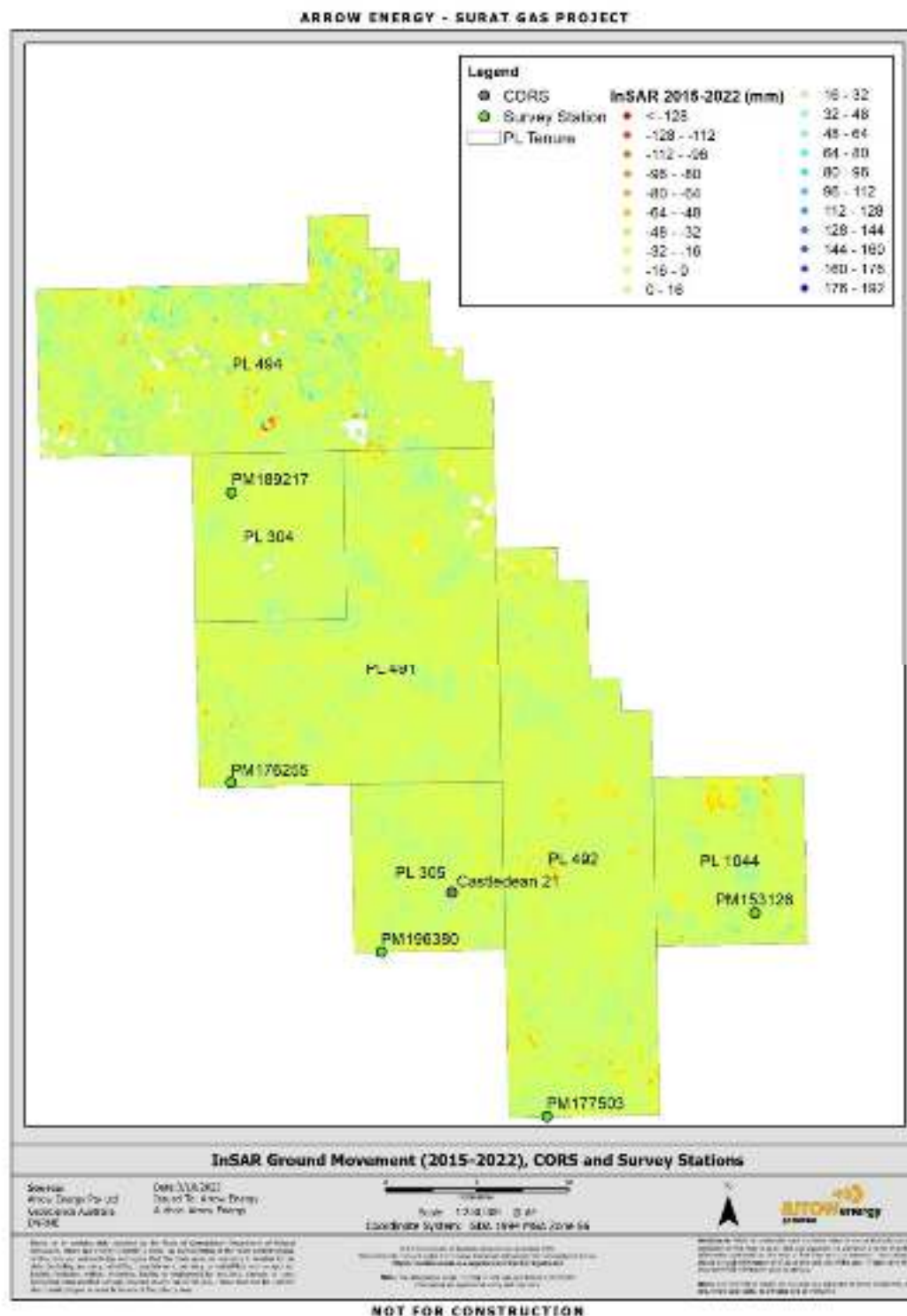


Figure 5-7 InSAR Historical Ground Movement, and Location of CORS and Survey Stations

5.7.3 Groundwater quality objectives and indicators

A water monitoring strategy (WMS) is included in the Surat CMA UWIR and reflected in the WMMP for Arrow obligations. The WMS includes an integrated regional

monitoring network to collect data on water pressure and water quality in the Surat CMA across a network of monitoring points and sites, monitoring all major aquifers and aquitards in the Surat CMA. The objectives of the WMS are to:

- Establish background trends;
- Identify changes in aquifer conditions within and near areas of petroleum development;
- Identify changes in aquifer conditions near critical groundwater use;
- Identify changes in aquifer condition near springs;
- Improve future groundwater flow modelling; and
- Improve understanding of connectivity between aquifers.

The WMS assigns requirements to petroleum tenure holders to establish the regional monitoring network, undertake routine monitoring and reporting of results and report water production data from petroleum gas and wells. The OGIA will routinely assess the monitoring results and report on these annually. Arrow will implement the elements of the UWIR WMS for which it has been assigned responsibility.

Arrow has installed a comprehensive regional groundwater monitoring network (that satisfies Arrow's obligations as described in the groundwater impact reports in the SPGEIS and SREIS and confirmed in Chapter 9 of the 2021 UWIR, and Chapter 6 and 7 of the Stage 1 and Updated WMMP respectively) to:

- Establish baseline groundwater level and groundwater quality conditions;
- Assess natural variation (i.e. seasonal variations) in groundwater levels;
- Monitor groundwater levels during the operations phase;
- Establish suitable datum levels for each aquifer system;
- Target sensitive areas where more frequent monitoring and investigation is required (e.g. groundwater dependent ecosystems);
- Monitor groundwater drawdown as a result of CSG extraction;
- Monitor impacts in accordance with the Water Act and regulations;
- Provide an 'early warning system' that identifies areas potentially impacted by project activities to allow early intervention; and
- Comply with the commitments presented in the adaptive management framework described above.

While the SGPEIS/SREIS described locations to be monitored, many locations required change due to the absence of any CSG processing and CSG water discharges within the development area. The monitoring network requirements are adaptive, and reviewed and updated every three years by OGIA as part of the UWIR cycle under Chapter 3 of the Water Act. Arrow will implement the elements of the UWIR WMS for which it is assigned responsibility as part of any review by OGIA.

5.7.4 Assessment of environmental impacts

Potential groundwater impacts of the Project have been assessed in the SGPEIS and the SREIS²² while the Underground Water Impact Report (OGIA, 2021 - herein the UWIR) has assessed potential impacts on groundwater levels arising from CSG extraction in the Surat Basin CMA (considering all existing and proposed CSG projects, including the 588 wells already approved in the current SGP North EA) and identified 'Immediately Affected Areas' (IAA) and 'Long-term Affected Areas' (LAA).

The 2021 Surat CMA UWIR identifies aquifers where groundwater levels are predicted to fall by more than the trigger threshold as determined in the Water Act 2000 due to the exercise of underground water rights by all petroleum tenure holders. The areas are defined as the Immediate Affected Areas (IAA) where within 3 years the water level drawdown exceeds trigger thresholds of 5 m in consolidated and 2 m in unconsolidated aquifers. The Long Term Affected Area (LAA) is defined as areas where water levels are to decline by more than the trigger thresholds at any time.

The 2021 Surat CMA UWIR model, which included all well development proposed by Arrow, produced outcomes that indicate that sections of all 6 PLs are within the IAA for the WCM (refer to **Figure 5-8**) and all are within the LAA for the WCM (refer to **Figure 5-9**).

²²Refer to [SGPEIS Chapter 14. Groundwater](#) and to [SGPSREIS Chapter 8. Groundwater](#), and associated appendices.

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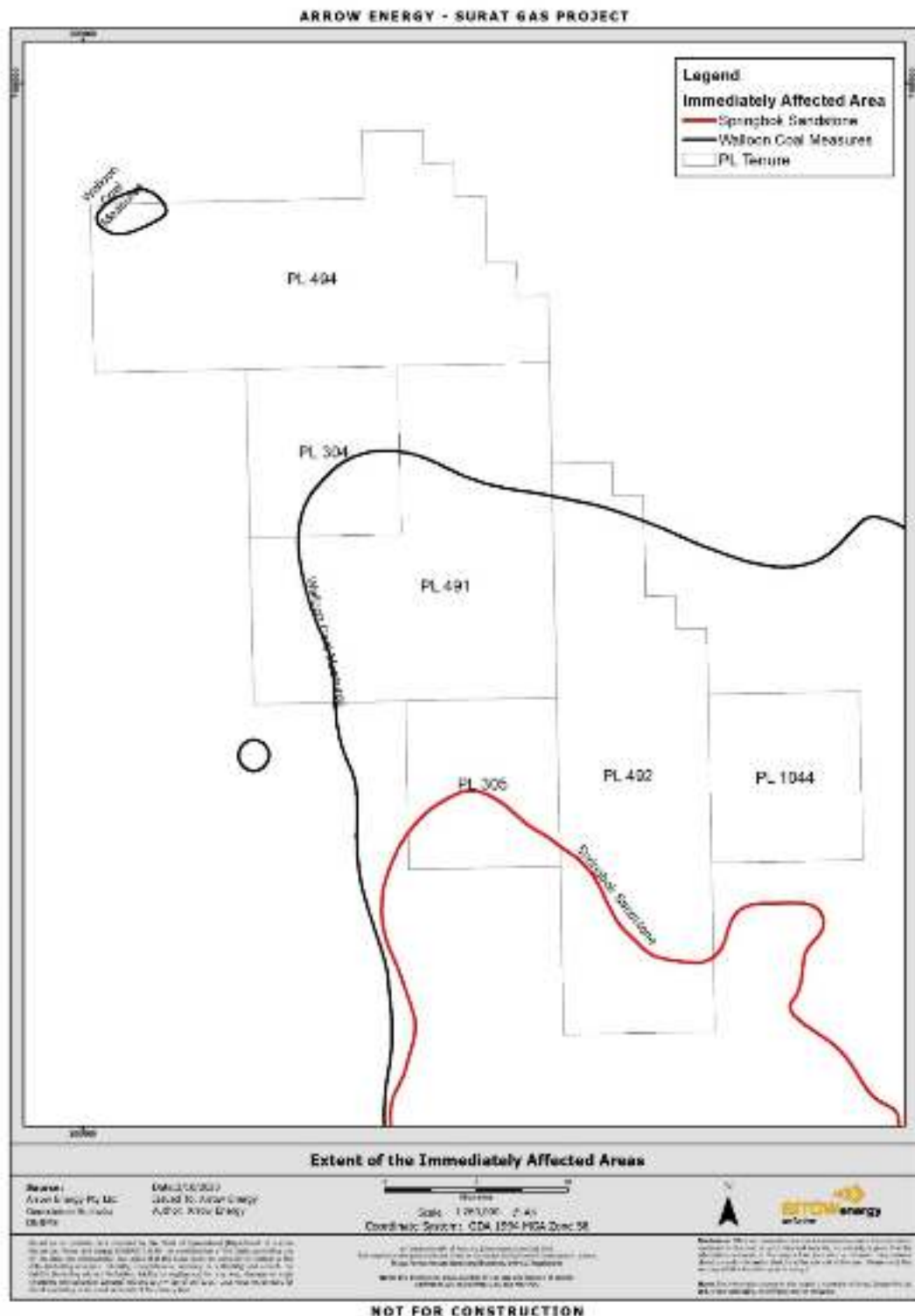


Figure 5-8 Extent of the Immediate Affected Areas – Springbok Sandstone and Walloon Coal Measures

The IAA for the Springbok Sandstone intersects the southern boundary of PL305 and PL492 (Figure 5-8), while the LAA extends further into these PLs and into PL304, PL491 and PL494 (refer to **Figure 5-9**). The LAA for the Bandanna Formation, a deeper interbedded aquitard of the Bowen Basin, intersects PL494 as shown in **Figure 5-9**,

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and is a result of other tenure holder operations to the north and west, however there are no water bores within this formation in the project area.

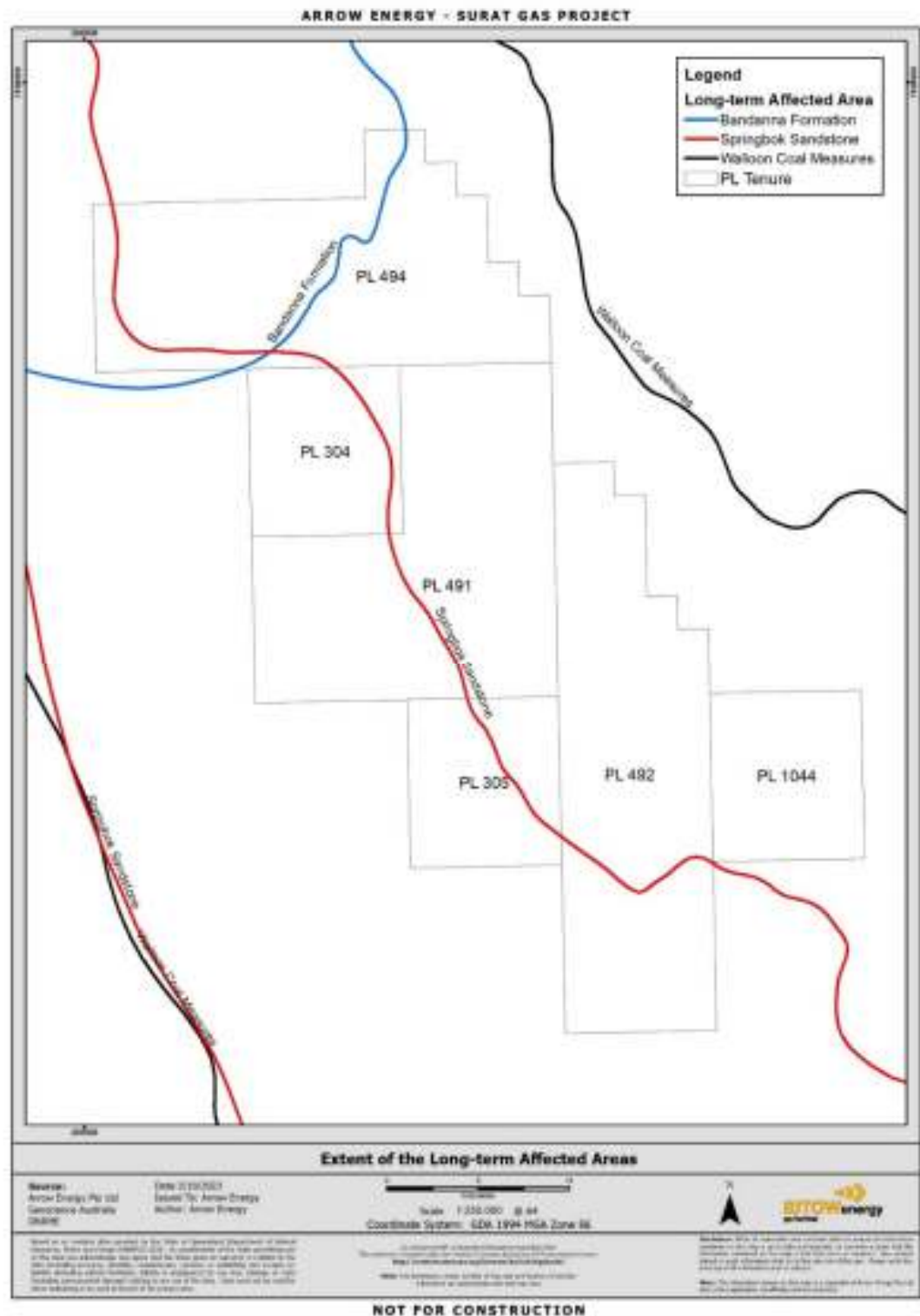


Figure 5-9 Extent of the Long-term Affected Areas (LAA) – Springbok Sandstone, WCM and Hutton formation

In summary, the extraction of CSG will result in depressurisation of the Walloon Coal Measures which will lower aquifer pressures, which could potentially result in the following direct impacts:

- Reduced groundwater flow to groundwater-dependent ecosystems or areas of cultural and spiritual importance fed by the Walloon Coal Measures.
- Reduced groundwater supply to existing or future groundwater users accessing groundwater from the Walloon Coal Measures.
- Subsequent indirect depressurisation of adjacent aquifers has the potential to cause aquifer interflow and groundwater drawdown, resulting in the following indirect impacts:
 - Diminished groundwater quality in aquifers above and below the Walloon Coal Measures. This relates to groundwater mixing as drawdown in the Walloon Coal Measures aquifers induces flow across deeper and shallower aquifers.
 - Reduced groundwater flow to groundwater-dependent ecosystems or areas of cultural and spiritual importance fed by the adjacent aquifers.
 - Reduced groundwater supply to existing or future groundwater users accessing groundwater from the adjacent aquifers.
 - Land subsidence and changes to surface water flow regimes and landforms.
 - Surface activities that can impact groundwater values include:
 - Leaks and spills of chemicals, fuels and oils stored at the surface in association with CSG production facilities may result in contamination of the intersected aquifers.
 - Discharges of liquid domestic wastes and effluent to land have the potential to contaminate groundwater systems.
 - Reduced rain water infiltration and subsequent reductions in aquifer recharge from the surface due to:
 - Construction of impervious surface coverings associated with CSG production facilities.
 - Land disturbance activities resulting in reduced porosity and permeability of surface profiles.

5.7.5 Proposed management practices and monitoring

Arrow Energy will implement the commitments it made in the EIS and updated in the SREIS in order to effectively manage and monitor the effects of CSG water extraction on local and regional groundwater values. These commitments are consistent with the existing legislative framework, specifically Chapter 3 of the Water Act.

These legislative requirements are further detailed in the UWIR (Sections 8 to 11, where applicable to the SGP). The commitments summarised below will be adapted to allow management decisions to be made based on an increased knowledge base developed over time.

Potential impacts on groundwater systems for Arrows tenements including the 6 PLs will be managed through a hierarchy of mitigation, monitoring and management options that form the basis for an adaptive management framework. This is detailed in Arrows SGP EIS and SREIS.

Arrow undertakes groundwater monitoring in 19 bores (these bores have 37 water pressure monitoring zones, 18 of which can also be sampled for water quality) on the 6 PLs as tabulated below. Data recording instrumentation has been installed targeting selected formations/units to be monitored in each of the bores. The monitoring stations and locations within each bore and aquifer is presented below:

- Eight (8) monitoring zones in the Westbourne Formation;
- Seven (7) monitoring zones in the Springbok Sandstone;
- Twelve (12) monitoring zones in the WCM;
- Three (3) monitoring zones in Eurombah Formation; and
- Seven (7) monitoring zones in the Hutton Formation.

The 2021 Surat CMA UWIR sets out regional monitoring requirements for groundwater pressure, quality, and springs. Arrow, where assigned as Responsible Tenure Holder, is compliant with the water monitoring strategy and spring impact management strategy as prescribed in the 2021 Surat CMA UWIR. This process has resulted in the collection of a significant data set describing baseline groundwater pressure and quality for reference purposes as required for the larger area and not limited to the 6 PLs, the subject of this EA Application. Arrow is also compliant with its Make Good obligations as set out in the 2021 Surat CMA UWIR.

The larger UWIR baseline monitoring network as indicated above was designed and is underpinned by numerical groundwater modelling. The selection of baseline monitoring locations considers the predicted extent and timing of aquifer depressurisation due to CSG development, as well as the need to acquire pre-development groundwater baseline data. The monitoring network design considers:

- Establishment of baseline data;
- The spatial extent and timing of aquifer depressurisation;
- Specific geological formations and environmental features that require monitoring to be targeted;
- Groundwater pressure impacts that are anticipated to occur;
- Existing groundwater monitoring locations; and
- Potential siting constraints for new locations (i.e. land access and/or government approvals)

The groundwater monitoring program is based upon collection of groundwater pressure and quality data to establish baseline conditions for the groundwater resources, and also to:

- Provide for the early detection and ongoing monitoring of impacts;
- Trigger responses where early warning conditions and trigger thresholds are exceeded;
- Avoid the exceedance of groundwater limits; and
- Provide data for decision making and groundwater modelling.

Groundwater monitoring will be conducted to collect ongoing site specific data during production, which will allow for future comparisons to be made and evaluated against the presented baseline data for the 6 PLs.

In addition to this, Arrow has an obligation to make good impairment to the adequacy of water supply from bores resulting from water extraction. These obligations are detailed in the 2021 Surat CMA UWIR.

Management practices during design and planning

The following measures have been developed to manage the potential impacts on groundwater values during the design and planning phase of the project.

- Apply appropriate international, Australian and industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels, and lubricants).
- Prepare a baseline assessment plan to establish benchmark data in registered third party bores (where possible) prior to the commencement of Arrow Energy extraction activities in the SGP North project area accordance with the Water Act 2000, including the preparation and implementation of a groundwater monitoring and investigation strategy.
- Consider local biological, groundwater and surface water conditions when identifying sites for CSG infrastructure including storages.
- Consider local groundwater conditions when identifying sites and routes for the installation of buried infrastructure (e.g. gathering lines).
- Avoid unnecessary impervious surface coverings and minimise land footprint and vegetation clearing when designing facilities.
- Develop make-good agreements that include the outcome of bore assessments and implementation of make-good measures in the event that impaired capacity occurs.
- Continue a program of aquifer testing in dedicated groundwater monitoring to increase the predictability of aquifer properties and groundwater movement.
- Ongoing collection of relevant geological and hydrogeological data from existing and future production wells, monitoring bores and registered third party bores (where possible) together with information collated collaboratively with other proponents and regulatory authorities.
- Maintain water balance models for long-term planning and management of CSG water. Review and update modelling in alignment with the production forecasting schedule.

Management practices during construction

The following mitigation, monitoring and management measures have been developed to address the potential impacts on groundwater values during the construction phase of the project:

- Avoid disturbance of contaminated soil and groundwater when it is identified or observed during intrusive works;
- Manage contaminated soil or groundwater that cannot be avoided through physical investigation; manage quantification of the type, severity, and extent of

contamination; and remediate or manage in accordance with the relevant Queensland Government legislation and guidelines;

- Construct all monitoring bores in accordance with the *Minimum Construction Requirements for Water Bores in Australia*, Fourth Edition (2020) and the minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland, or the Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland, Version 2 (2019) as appropriate;
- Select drilling fluids to minimise potential groundwater impacts. Oil based drilling fluids will not be used; and
- Ensure well drilling is monitored by a suitably qualified geologist to ensure aquifers are accurately identified for correct well construction.

Management practices during operations

The following measures have been developed to address the potential impacts on groundwater values during the operations phase of the project:

- Carry out corrective actions immediately upon the identification of any contamination of soil or groundwater that has occurred as a result of project activities.
- Manage potential impacts to identified spring complexes by:
 - Supporting the identification of specific aquifers that serve as a groundwater source for discharge springs;
 - Assessing springs that are predicted to be subject to unacceptable impacts through the source aquifer;
 - Developing monitoring and mitigation strategies to avoid or minimise unacceptable impacts;
 - Implement a well integrity management system during commissioning and operation of production wells;
 - Minimise impacts of groundwater depressurisation on sensitive areas (e.g. groundwater dependent ecosystems);
 - Develop a procedure for investigating any impaired capacity of third party bores that may become evident through monitoring and landholder liaison;
 - If impaired capacity is confirmed (bore can no longer produce quality or quantity of groundwater for the authorised purpose, and the impact is due to CSG activities), implement make-good measures in accordance with the Water Act; and
 - Incorporate procedures into an emergency response plan or water management plan for the controlled discharge of CSG water under emergency conditions. Procedures will include water balance modelling, weather monitoring and forecasting, stream flow data, notification, and reporting.

Management practices during decommissioning

All production wells and monitoring bores will be decommissioned or repaired either at the end of their operating life span or, in the event of a failed integrity test, in accordance with the Minimum Construction Requirements for Water Bores in Australia, Fourth Edition (2020) and the Water Act 2000 and regulations or the *Code of Practice for the construction and abandonment of petroleum wells and associated bores in*

Queensland, Version 2 (2019) as appropriate. Should production wells be converted into monitoring bores, it will be done in accordance with relevant regulations.

Groundwater monitoring program

The following describes in broad terms the monitoring program and has been provided to the Federal Government consistent with Condition 13 and 17 (Stage 1 and Updated CSG Water Monitoring and Management Plan) of the EPBC approval for the Surat Gas Expansion Project (EPBC 2010/5344). While the SGPEIS and SREIS described locations to be monitored, many locations may require change due to the absence of any CSG processing and CSG water discharges within the SGP North project area.

A water monitoring strategy (WMS) is included in the Surat CMA UWIR. The WMS includes an integrated regional monitoring network to collect data on water pressure and water quality in the Surat CMA across a network of monitoring points and sites, monitoring all major aquifers and aquitards in the Surat CMA. The objectives of the WMS are to:

- Establish background trends;
- Identify changes in aquifer conditions within and near areas of petroleum development;
- Identify changes in aquifer conditions near critical groundwater use;
- Identify changes in aquifer condition near springs;
- Improve future groundwater flow modelling; and
- Improve understanding of connectivity between aquifers.

The WMS assigns requirements to petroleum tenure holders to establish the regional monitoring network, undertake routine monitoring and reporting of results and report water production data from petroleum gas and wells. The OGIA will routinely assess the monitoring results and report on these annually. Arrow Energy will implement the elements of the UWIR WMS for which it has been assigned responsibility.

Arrow Energy has installed a comprehensive regional groundwater monitoring network (that satisfies Arrow Energy's obligations as described in the groundwater impact reports in the SGPEIS/SREIS and confirmed in Chapter 9 of the 2021 UWIR, and Chapter 6 and 7 of the Stage 1 and Updated WMMP respectively) to:

- Establish baseline groundwater level and groundwater quality conditions;
- Assess natural variation (i.e. seasonal variations) in groundwater levels;
- Monitor groundwater levels during the operations phase;
- Establish suitable datum levels for each aquifer system;
- Target sensitive areas where more frequent monitoring and investigation is required (e.g. groundwater dependent ecosystems);
- Monitor groundwater drawdown as a result of CSG extraction;
- Monitor impacts in accordance with the Water Act and regulations;

- Provide an 'early warning system' that identifies areas potentially impacted by project activities to allow early intervention; and
- Comply with the commitments presented in the adaptive management framework described above.

While the SGPEIS/SREIS described locations to be monitored, many locations will require change due to the absence of any CSG processing and CSG water discharges within the development area. The monitoring network requirements are adaptive, and reviewed and updated every three years by OGIA as part of the UWIR cycle under Chapter 3 of the Water Act. Arrow will implement the elements of the UWIR WMS for which it is assigned responsibility as part of any review by OGIA.

5.8 Geology, Landform and Soils

5.8.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values, mitigating, and managing impacts on geology, landform, and soils, and to management of potential impacts associated with land contamination during construction, operations and decommissioning of the Project.

- *Environmental Protection Act 1994* (Qld): protects Queensland's environment while allowing for development that improves total quality of life, both now and in the future. It also includes provisions for the management of land that is contaminated, or that has supported land uses that may have resulted in land contamination, or that supports activities that could result in land contamination. Generally, activities that could result in land contamination are notifiable. Land parcels where notifiable activities have been or are conducted are listed on the Environmental Management Register (EMR). Land parcels that are proven to be significantly contaminated are listed on the Contaminated Land Register (CLR).
- *Vegetation Management Act 1999* (Qld): aims to ensure that vegetation clearance does not lead to land degradation, and to manage the environmental effects resulting from clearance.

Relevant industry guidelines and codes of practice include:

- *Best Practice Erosion and Sediment Control Manual (IECA, 2008)*: This manual outlines how to manage erosion and sedimentation through the planning and construction stages of development.
- *Code of Environmental Practice - Onshore Pipelines (APGA 2022)*: This code provides information on methods and techniques to manage environmental impacts associated with construction of onshore pipelines.
- *Draft Guidelines for the Assessment and Management of Contaminated Land 1998* (Qld) (DE, 1998): These guidelines establish the processes for all aspects of the assessment and management of contaminated land and serve to facilitate compliance with the Environmental Protection Act. Although the guidelines remain in draft form, they set an industry-accepted standard for works on contaminated lands.

5.8.2 Description of environmental values

The Project area is characterised by typically low topographical relief, with elevation across the petroleum leases ranging between 310 and 370 mAHD. The landscape is strongly linked to the underlying geology and geomorphological evolution of the area.

Other landscape features in the project area are loamy and sandy plains and plateaus (land zone 5) and ironstone jump-ups (land zone 7). Topography throughout the project area is typically flat to gently undulating, with some low hills, jump-ups, and excised river/creek banks.

Geologically, the tenures are underlain by the Surat Basin, the surface geology of which comprises the following stratigraphic units (from youngest to oldest):

- Quaternary-aged alluvial deposits associated with the Condamine River, Dogwood Creek, and tributaries;
- Jurassic-aged Kumbarilla Beds consisting of the Westbourne Formation overlying the Springbok Sandstone; and
- Jurassic-aged Walloon Coal Measures.

Of these, the Quaternary alluvium, Kumbarilla Beds, and Walloon Coal Measures are the most relevant in the context of impacts from seepage. Shallow aquifers tend to exist within the Quaternary alluvium and Kumbarilla Beds.

The SGP North EA authorises the construction and operation of three dams as regulated structures, namely, Kedron Dam in PL304, Castledean Dam in PL305, and Punchbowl Dam in PL1044. There is no change to the land on which the activities will be carried out resulting from this amendment.

A review of the dominant soil order mapping shows that the dominant soil across the project development area is Sodosols with some Vertosols to the west and Chromosols to the north.

Soil types across the development area have been classified under the Australian Soil Classification System and divided into seven broad types:

- Gilgai Clays: Occurring on flat to gently undulating terrain. Generally poorly drained areas. Limited in extent.
- Cracking Clays: Common in cropland in the north of the Project area on gently undulating terrain.
- Uniform Non-cracking Clays: Occurring on undulating plains and rises, and mid to upper slopes of hills.
- Texture Contrast Soils: Sharp textural contrast between surface and subsoil horizons of low agricultural value. Common throughout southern portion of the Project area.
- Sands and Sandy Loams: Consists of alluvial and residual sands found on plains, commonly near larger watercourses.
- Skeletal, Rocky or Gravelly Soils: Occur adjacent to rocky outcrops.

Soils have been mapped in the SGP EIS. Further delineation of soil types and implications for project development and rehabilitation will be undertaken prior to wellfield development.

Land can become contaminated through a range of activities and land uses. The Queensland Government defines such activities as notifiable activities under the EP Act. Although many of the listed notifiable activities are 'industrial' in nature, a significant number may be reasonably expected in an environment where agricultural activities predominate.

EMR and CLR searches will be undertaken for the land parcels the subject of this EA application within which disturbance is proposed. It is possible that sites where notifiable activities have occurred may not have been reported and/or are not included in the applicable registers. In addition to the specified notifiable activities, uncontrolled and otherwise unidentified activities may also have contributed to contamination of land within the project development area. Such uncontrolled activities may include but are not necessarily limited to:

- Dumping of waste materials in rural areas;
- Unreported spillage of agricultural chemicals, fuels, or lubricants;
- Broad acre application of persistent organic chemicals; and
- Bulk disposal of stock carcasses after disease, flood, or drought.

As Arrow develops land for the project, areas of contamination caused by uncontrolled activities may potentially be encountered.

5.8.3 Assessment of environmental impacts

As described in the SGPEIS, Potential impacts on geology, landform and soils values from project activities include:

- Land degradation – erosion and associated sedimentation, dust generation and reduction in soil quality; and
- Land contamination - through disturbance of existing contaminated land. and the potential to cause land contamination through project activities.

Activities with the potential to cause these adverse impacts on geological, landform and soils values during the construction, operations and decommissioning phases of the project are described below:

Construction

- Increased erosion resulting from ground disturbance, vegetation clearance, alteration of natural drainage and flow concentration due to construction activities (i.e., excavation, trenching, drilling, earthmoving) during any activity that disturbs the ground (e.g., the construction of production wells, gathering lines, production facilities and associated infrastructure);
- Deposition downslope or downstream of eroded sediment as flow velocities decrease as an indirect result of project activities that cause erosion (e.g., construction of production wells, gathering lines, production facilities and associated infrastructure);
- Topographic alteration from the construction of borrow pits for the use of material in construction activities; and
- Leaks or spills from fuel storage and handling leading to soil contamination.

Operations

- Increased surface or subsurface erosion and waterlogging resulting from flow concentration due to differential settlement of pipeline backfill and padding; and
- Leaks or spills from fuel storage and handling or overflow from brine dams leading to soil contamination.

Decommissioning

- Reprofilling of microrelief leading to patchy exposure of sodic and saline subsoils from inversion of the soil profile during backfill of materials during rehabilitation.

Contaminated land

The following mechanisms may contribute to the realisation of impacts associated with contaminated land:

- The siting of project infrastructure over contaminated land;
- Disturbance of contaminated soil and/or groundwater during the drilling of coal seam gas wells, excavation of trenches for the installation of gathering infrastructure, gas pipelines and other utilities associated with the development or during civil works;
- Uncontrolled movement of contaminated soil and/or groundwater after disturbance by project activities; and
- Transport to the surface of groundwater that has become contaminated through notifiable or uncontrolled activities (creating an exposure pathway that would otherwise not exist).

Impacts that may be realised through the above mechanisms include:

- Exposure of the public, wildlife, stock or native or cultivated vegetation to contaminants;
- Exposure of project workers to contaminants; and
- Contamination of land and water resources (including surface water and groundwater) that are otherwise unaffected by contamination and accordingly have high environmental value.

Various aspects of the proposed project activities have the potential to result in land contamination. The potential for project activities to result in the contamination of land from notifiable activities includes, but may not be limited to:

- Leaks and spills from onsite fuel storage tanks and chemical storage facilities;
- Leaks and spills (fuels and lubricants) from the operation of earthmoving, drilling, and associated equipment;
- Leaks and spills (lubricants and chemicals) from the operation of gas compression and associated equipment;
- Leaks and spills (chemicals) from the operation of coal seam gas water treatment and transfer facilities;
- Waste generated through the drilling of coal seam gas wells (e.g., waste drilling muds); and
- Brine generated as a by-product of the treatment of coal seam gas water.

5.8.4 Proposed management practices

The primary means by which avoidance is achieved for potential geological-, landform- and soil-related impacts is through design and site selection. Arrow's framework approach focuses on early identification of sensitive locations that should be avoided by project activities.

For activities that involve disturbance to land, vegetation and soil, Arrow undertakes activities in accordance with its Land Disturbance Procedure. This procedure outlines

mandatory environmental requirements to avoid, minimise or mitigate environmental harm associated with land disturbance activities and covers vegetation clearing, soil management, site preparation and erosion and sediment control for all Arrow controlled activities during exploration, drilling, construction, and operating phases. Site stabilisation and rehabilitation are undertaken in accordance with Arrow's Land Rehabilitation Procedure (Section 4.3)

The guiding principles for land disturbance include:

- Avoid disturbing sensitive environmental values (for example - flora, fauna, watercourses, wetlands); and disturbing land outside the approved area;
- Minimise the footprint (area) of the site (i.e. the total area of land disturbance within the approved area); the duration of soil disturbance; water movement across the site; and removing vegetation, especially native woody vegetation/grasses (i.e. utilise previously disturbed areas);
- Mitigate impacts by developing and implementing effective Erosion and Sediment Control Plans (ESCPs) and soil management measures based on anticipated soil type, scale of disturbance, weather and construction conditions, and time/length of disturbance; maintaining all erosion and sediment control (ESC) measures in proper working order; stabilising and/or rehabilitating sites promptly; and providing biodiversity offsets where required (Section 5.4); and
- Manage contaminated soil or groundwater that cannot be avoided through physical investigation; manage quantification of the type, severity, and extent of contamination; and remediate or manage in accordance with the Queensland Auditor Handbook for Contaminated Land (DEHP, 2016), previously the Queensland Government's Draft *Guidelines for the Assessment and Management of Contaminated Land* (DE, 1998).

5.9 Cultural Heritage

5.9.1 Applicable legislation

The following legislation is relevant to identifying values of, and mitigating and managing impacts to, Indigenous and non-Indigenous cultural heritage during construction, operation, and decommissioning of the Project.

- *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act): protects natural, historic, and Indigenous places on the World Heritage List, Commonwealth Heritage List and National Heritage List.
- *Native Title Act 1993* (Cwlth): provides for the recognition and protection of native title. If a petroleum tenement is to be granted over land where native title has not been extinguished, Native Title Act requirements must be met before the petroleum tenement can be granted. The Native Title Act provides valid statutory processes to allow the parties to reach agreement and for state and territory governments to grant interests over that land. Where Arrow plans to conduct petroleum activities on land where native title exists or is being negotiated, agreements have been reached with relevant Aboriginal parties.
- *Australian Heritage Council Act 2003* (Cwlth): appoints the Australian Heritage Council as the principal advisory body to the Australian Government on heritage matters. The Australian Heritage Council nominates places for inclusion on the National Heritage List and Commonwealth Heritage List, and maintains the Register for the National Estate.

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cwlth): aims to preserve and protect, from injury or desecration, areas, and objects on land or in Australian waters that are of particular significance to Indigenous peoples and their traditions.
- *Queensland Heritage Act 1992* (Qld): sites deemed significant for both their non-Indigenous and Indigenous values are protected under this act.
- *National Trust Act 1963* (Qld): establishes the Queensland National Trust to protect non-Indigenous cultural heritage in Queensland. Listing on the Register of the Queensland National Trust represents a major indication of a community's feeling about the value of buildings, precincts, places of natural environment and culturally significant artefacts.
- *Aboriginal Cultural Heritage Act 2003* (Qld) (ACH Act): recognises and protects significant Indigenous cultural heritage in Queensland and sets out requirements for the protection and management of Indigenous cultural heritage. The ACH Act also places a 'duty of care' on any persons or company whose activities may harm or threaten Indigenous cultural heritage. Duty-of-care guidelines have been established to guide persons and companies on how to comply with the Indigenous cultural heritage duty of care requirements. Under the ACH Act, a cultural heritage management plan (CHMP) Indigenous land use agreement (ILUA) that addresses cultural heritage management and is registered in accordance with the Commonwealth Native Title Act is required for the project.
- *The Burra Charter*: The Australian International Council on Monuments and Sites (ICOMOS) Charter for Places of Cultural Significance 1999 (Australia ICOMOS, 2000): provides guidance on applicable criteria for assessment of the significance of cultural heritage areas, objects, and values in terms of cultural and social, scientific, historical, educational, economic, and aesthetic significance.

5.9.2 Description of environmental values

Assessment undertaken to prepare the SGPEIS, identified that the key Indigenous cultural values were associated with either archaeological significance (i.e., including physical evidence) or cultural significance (i.e., of significance to indigenous peoples for cultural, spiritual, or historical reasons).

Aspects of the existing environment that contributed to the compilation of a set of Indigenous cultural heritage values included the following:

- Places with identified Indigenous values that are EPBC Act-listed and included on the Register of the National Estate;
- Places that are included in the Queensland Indigenous Cultural Heritage Database;
- Places, objects, and areas of cultural heritage value identified during previous investigations conducted by Aboriginal parties on behalf of Arrow Energy. Where Aboriginal parties have allowed it, the details of these sites are retained on Arrow Energy's GIS database; and
- Potential for places, objects and areas of cultural heritage value that are currently not identified, including those that become known through preconstruction field surveys.

In relation to non-Indigenous heritage, no sites of national or world heritage significance were identified within the project area. Sites with state heritage values identified are all located within town centres and will not be impacted by the project. A number of

regionally known sites have been identified. These sites are not currently listed on any registers but hold historical interest to the local community and comprise infrastructure (settlements, homesteads, industry, and places of worship), schools and former schools sites, cemeteries and war-related sites and memorials.

5.9.3 Assessment of environmental impacts

Potential impacts to Indigenous heritage places and values are considered to be most significantly associated with construction activities and, to a lesser extent, operations and, to an even lesser extent, decommissioning activities. Clearing activities and ground disturbance associated with the construction of the project have the potential to impact on known and unknown Indigenous cultural heritage, places, objects, and evidence. Without the implementation of appropriate management controls, project activities could:

- Destroy, damage, or disturb objects of physical heritage (i.e., archaeological evidence) in the landscape; and/or
- Encroach upon or disturb places of cultural significance to Indigenous persons.

Arrow Energy has undertaken survey for non-Indigenous historical heritage, of which a small number of historical sites have been identified within the wider project area. No sites of world heritage, national, State, or local significance have been identified within the development area the subject of this EA amendment application.

Potential impacts to non-Indigenous sites could occur through chance-find discoveries of previously unknown sites that are uncovered during construction activities.

5.9.4 Proposed management practices

Arrow Energy operates on an 'Avoidance Principal' in relation to impacts on cultural heritage and management of heritage sites, whether Indigenous or non-Indigenous, and aims to avoid impacts or provide mitigation measures to ensure the least amount of impact.

Arrow Energy has agreed Cultural Heritage Protocols (CH Protocols) within the Arrow Energy and Western Downs *Unclaimed Area Indigenous Land Use Agreement* (WD ILUA) that determines how cultural heritage impacts in the Project area will be managed. The WD ILUA includes eleven aboriginal groups within the agreement.

As part of the CH Protocols, any group with a Native Title claim or determination over the area, and lodged after the registration of the WD ILUA, also has rights under the WD ILUA.

Currently there is an Iman #4 Registered Claim in the SGP North Area, and Arrow Energy has entered into an ancillary Cultural Heritage Agreement, whereby the claimant group is solely responsible for looking after cultural heritage concerns. Arrow Energy and representatives of Iman #4 have undertaken cultural heritage surveys of the proposed project impact areas in the SGP North Area and have produced cultural heritage management plans to avoid or mitigate impact to cultural heritage. The surveys, to date, have identified over 100 Indigenous heritage sites. Arrow Energy maintains a GIS database of sites of Indigenous cultural heritage that are known or found during the course of investigations and works (where aboriginal parties allow the listing of the sites).

To manage potential impacts in relation to chance finds, site inductions provide cultural heritage awareness for places and objects (to avoid) and guidance on the appropriate procedures to follow should there be any new discoveries. Arrow Energy implements a 'chance finds' procedure for the discovery of unknown sites during construction. This includes a stop work requirement on initial discovery, appropriate reporting and recording, and management measures such as avoidance, salvage, or destruction.

5.10 Waste

5.10.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on waste for the Project.

- *Environmental Protection Act 1994 (Qld) (EP Act)*: The objective of the EP Act is to protect Queensland's environment by promoting ecologically sustainable development. The EP Act regulates the impacts to groundwater, surface waters, and biodiversity environmental values. The storage, tracking, and disposal of waste is regulated under a State environmental authority granted under the EP Act. The *Environmental Protection Regulation 2019* provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an environmentally relevant activity poses to Environmentally Sensitive Areas (ESAs).
- *Environmental Protection (Waste Management) Regulation 2000 (Qld)*: This regulation provides a mechanism to enforce the EP Act and aims to protect the environment by minimising the impact of waste on the environment, including, in particular, the impact of waste so far as it affects human health. The regulation establishes an integrated framework for minimising and managing waste under the principles of ecologically sustainable development.
- *Waste Reduction and Recycling Act 2011(Qld) (Waste Act)*: This act regulates additional obligations (e.g., reporting obligations) regarding to the management of waste (e.g., salt or brine disposal), and the beneficial use of salt and brine through an End of Waste (EOW) Approval or EOW Code.
- *Environmental Protection (Waste Management) Policy 2000 (Qld)*: This policy aims to achieve the objectives of the EP Act in relation to waste management by providing a framework for minimising waste generation, maximising the usage of waste, efficient use of resources and maintaining ecologically sustainable principles. The policy also provides the framework for waste management programs.
- *Coal Seam Gas Water Management Policy 2012*: This policy aims to encourage the beneficial use of CSG water in a way that protects the environment and that maximises its productive use as a valuable resource. To achieve this, the policy outlines prioritisation hierarchies for managing and using CSG water.

5.10.2 Description of environmental values

The proposed project activities expected to generate waste and the types of waste are outlined in Chapter 4 (refer to Section 4.10.6).

The environmental values to be protected from the waste streams through the management of waste, including the management of CSG water are:

- Biodiversity. The diversity of ecological processes and associated ecosystems and suitability of flora and fauna habitats (refer to 5.4.2).

- Water resources. Quality of surface waters and groundwater. Water quality that is suitable for sustaining human health, visual amenity, and suitability of aquatic ecosystems (refer to Section 5.6.2 and Section 5.7.2).
- Land and soils. Land use capability, having regard to economic consideration, habitat for flora and fauna, and quality of land to guarantee environmental sustainability. Soils quality, including structural and chemical properties (refer to Section 5.8.2).
- Visual amenity. Features of the existing environment that are important for visual amenity.
- Health and safety. The life, health, and wellbeing of people including the Project workers.

5.10.3 Waste management objectives

Potential waste management issues associated with the Project activities include uncontrolled and/or controlled releases of waste or emissions.

Failure to properly manage waste storage and containment systems could potentially result in soil and water contamination and impacts on visual amenity.

The discharge of wastewater and air emissions could potentially lead to adverse health and ecological impacts, e.g., discharge of raw sewage and the generation of air pollutants.

Arrow Energy aims to minimise the release of any harmful substances to the air, water, or the land, through the responsible management of its wastes. Potential impacts from the Project waste streams will be managed with the implementation of the standard waste hierarchy of avoidance, reuse, recycling, and disposal.

The environmental protection objectives that Arrow Energy is committed to for waste management are:

- The implementation of a waste management hierarchy;
- Minimising resource utilisation by reuse and recycling of waste;
- Reducing impacts to the environment from the management of waste;
- Reducing the quantity of waste that is sent to landfills by the recycling and reuse of waste.

Specific waste management objectives depending on the waste stream and type of waste and the Project phase are provided in **Table 5-18**.

Table 5-18 Waste Management Objectives

Project Activity	Waste Stream / Characteristic	Waste Management Objectives
Construction of wells, gathering systems, and facilities	Solid and Liquid / Regulated	Authorised final disposal ²³ Bioremediation or landfarming where applicable Reuse or recycle where possible Irrigate with treated sewage ²⁴ as per MEDLI studies
	Solid / Organic & Inert	Stockpile ²⁴ on-site for use in rehabilitation

²³ Collection and disposal through an authorised waste contractor to an offsite authorised regulated waste facility

²⁴ In compliance with per current applicable legislation.

Project Activity	Waste Stream / Characteristic	Waste Management Objectives
	Solid / Recyclable	Reuse or Recycle ²⁴
	Gaseous / NO _x , SO ₂ , CO, PM	Compliance with regulatory air quality objectives (refer to Section 5.1.4)
Operation of pipelines and facilities	Solid / Regulated	Authorised final disposal ²³
	Liquid / Regulated	Authorised final disposal ²³ No unauthorised and/or unplanned CSG water releases Maintain CSG water levels below the Design Storage Allowance (DSA) at 1 November at all regulated dams and no breaches of the Mandatory Reporting Level (MRL) Regulated dams annual inspections completed as per legislation Reuse of treated CSG water for dust suppression, construction activities, irrigation, town water supply where appropriate of quality, agricultural use, or injection into aquifers Irrigate with treated sewage ²⁴ as per MEDLI studies
Decommissioning and rehabilitation	Solid / Regulated	Authorised final disposal ²³
	Solid / Inert	Recycle or reuse ²⁴ , or bury on site
	Solid / Recyclable	Recycle ²⁴

5.10.4 Assessment of environmental impacts

Potential impacts from waste can come from the construction of production wells, gas and water gathering systems, the construction and operation of facilities, and from decommissioning and land rehabilitation. These potential impacts may be:

- Loss of biodiversity values and associated ecosystems;
- Loss of water quality;
- Loss of land use and soil quality; and
- Loss of visual amenity, and impacts to health and safety.

5.10.5 Waste management

Waste will be managed through the application of the waste management hierarchy as shown in **Figure 5-10**.

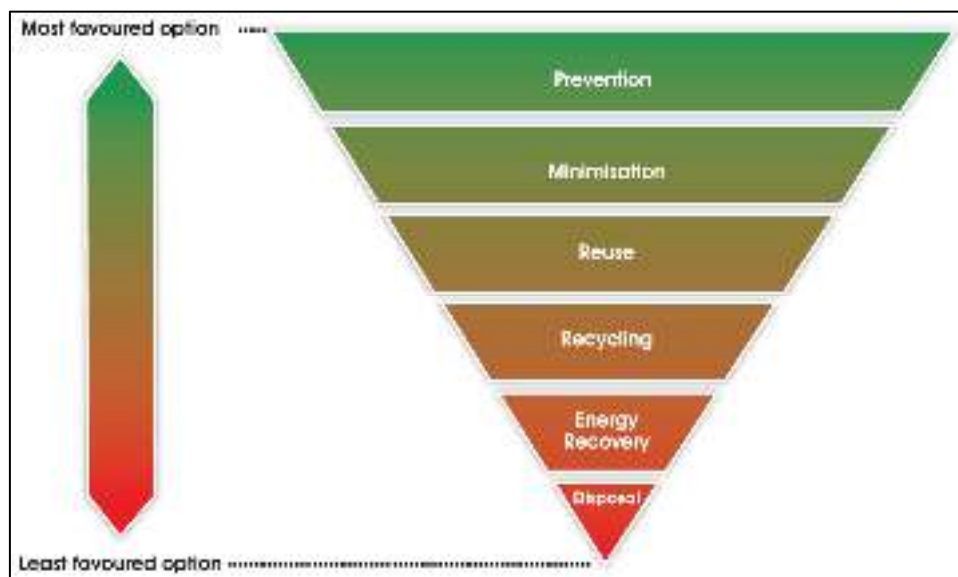


Figure 5-10 Waste Management Hierarchy

Reduction of waste sources

Waste avoidance and source reduction is achieved primarily in the design phase of the project through cleaner production. Production technologies will be designed, and production practices implemented to minimise resource consumption and increase production efficiency. Materials will be procured in bulk, where practicable, to minimise containers and movement of material.

Waste reuse

The reuse of waste will be determined largely by the salvage value of the material. Reuse requires onsite segregation and storage and will include the following measures:

- Reuse of cleared vegetation for mulch and soil erosion control.
- Reuse of brine for production of potentially saleable salt products
- Segregation of wastewater streams, i.e., contaminated stormwater, waste waters and coal seam gas water.
- Reuse of treated waste water for dust suppression, construction activities or irrigation.
- Reuse of hydrotest water.
- Reuse of treated water for agricultural use, industrial use, potable water supply or injection into aquifers.
- Treatment and reuse of solid wastes, such as drilling muds and cuttings, where practicable.

Waste recycling

Recycling is a central element of waste management for the Surat Gas Project. The marketability of the waste is the primary driver for recycling. Arrow will maximise marketable volumes of recyclable waste to local and regional businesses. Highly marketable wastes include oil, metals, lead acid batteries and process vessels that have been decommissioned. Lower marketable waste includes aluminium cans, paper and box board and pipes.

Waste disposal

General waste will be segregated, treated if necessary and stored onsite prior to disposal.

Segregation will include the separation of liquid from solid waste, separation of regulated from non-regulated waste, and separation of reusable and recyclable from non-reusable and nonrecyclable waste.

Solid waste segregation will be achieved by the allocation of bins for different waste streams.

Appropriate domestic waste disposal facilities will be provided at designated work sites to assist in segregation of waste.

Contaminated soil or groundwater that cannot be avoided through physical investigation will be managed through quantification of the type, severity, and extent of contamination, and remediated or managed in accordance with the Queensland Government's Draft Guidelines for the Assessment and Management of Contaminated Land (DE, 1998).

Onsite waste treatment will be used for such purposes as sewage, coal seam gas water and other specified wastes.

Sewage will be treated in packaged sewage treatment plants. Sewage treatment plants will be located at production facilities and include settlement, digestion, aeration, clarification, and disinfection equipment. Coal seam gas water will be contained in dams for treatment through reverse osmosis. The storage capacity of coal seam gas water will be designed to be sufficient to manage waste liquids until such time that permanent disposal options are operational.

Water dams will be designed in accordance with relevant legislation and Queensland standards and DERM guidelines.

Onsite waste storage areas will be developed in accordance with industry practice and relevant waste management regulations.

Waste that cannot be reused or recycled will be disposed of at appropriately licensed facilities. Potential waste facilities close to the Project Area may be used.

Liquid waste generated (other than coal seam gas water and sewage) will be stored and periodically removed for disposal or recycling. All waste fluids and muds resulting from drilling activities will be contained in properly lined dams or storage tanks for in situ treatment or disposal. Putrescible solid waste will be stored in covered containers to prevent odours, public health hazards and access by fauna.

Arrow will comply with Queensland Government waste tracking requirements. Regulated wastes will be handled, stored, and disposed of in accordance with relevant standards and *the Environmental Protection (Waste Management) Regulation 2000*.

Project activities are likely to generate solid, liquid, and gaseous waste streams. The main waste streams generated by the Project activities and the management objectives are provided in **Table 4-4** and **Table 5-18**.

Produced water (CSG Water) management

CSG Water is defined as waste under the EP Regulation 2019, as category 2 regulated waste. It can be approved as a resource through an EOW code or approval issued by

DES. If CSG Water is not used in accordance with the EOW code or approval, it remains a waste and its use, including beneficial use, is regulated under the EP Act.

Planning for the management of CSG Water from the Project requires forecasting of production rates, storage volumes, and quality of the CSG Water for the life of the Project. Arrow Energy has developed a strategy for the management of CSG Water (refer to **Appendix F**), which outlines the management of CSG Water resulting from activities arising from the development of the SGP gas fields. This strategy provides a basis for compliance with government policy, and sets out the method for managing produced water for Arrow's Surat Basin tenements.

Arrow Energy aims to conduct an effective containment of CSG water throughout its transmission via pipelines from the wells to beneficial use or final disposal. Regular monitoring and maintenance of pipelines will be conducted in accordance with Arrow Energy's Plant Maintenance Data Management Manual. Process safety will be applied in the design of the pipelines and in the implementation of controls, so no reportable unplanned releases of CSG water occur.

Forecasting of CSG Water

The forecast of CSG Water that will be produced by the Girrahween Development Phase 1 is presented in **Figure 5-11**.

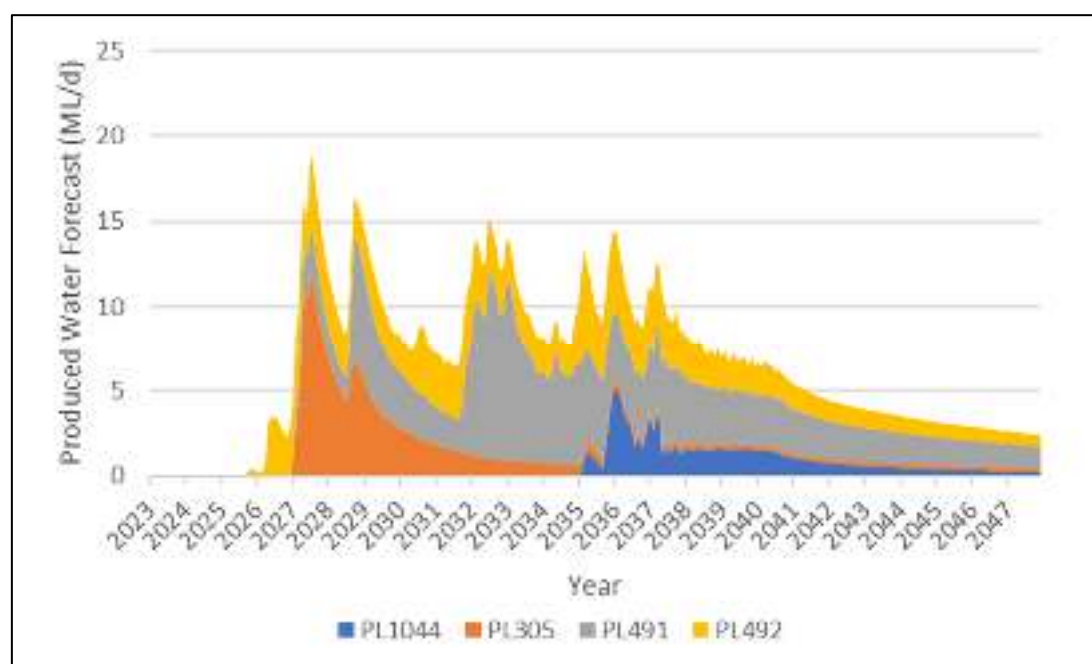


Figure 5-11 Forecast of CSG Water Production Girrahween Development Phase 1

Storage of CSG Water

The storage of CSG water in dams (regulated) will also be operated and maintained in accordance with regulatory approvals to effectively contain CSG water, including activities such as:

- annual dam integrity inspections;
- groundwater monitoring programs;
- scheduled maintenance of infrastructure and facilities;

- implementation of dams operational plans; and
- conducting a water balance modelling to develop the dams' operating philosophy and strategy.

A CSG Water Management Plan for the project has been developed in accordance Section 126 of the EP Act and is included in **Appendix E**.

Quality of CSG Water

The expected average water quality parameters values for the produced CSG water within the Girrahween development are presented in **Table 5-19**.

Table 5-19 Expected CSG water quality

Parameter	Unit	Average Quality for CSG Water ²⁵
Electrical Conductivity @ 25°C	µS/cm	7070
pH Value	pH Unit	8.385
Suspended Solids (SS)	mg/L	100.5
Total Dissolved Solids @180°C	mg/L	4215
Turbidity	NTU	50

CSG water produced by PLs 305, 491 and 492 will be transferred to QGC's McNulty Pond for management under the Arrow-QGC Water Services Agreement. Treatment of produced water originating from the Girrahween development will occur at the QGC operated Kenya Water Treatment Plant (WTP).

Treated water will be provided to third parties to promote the beneficial use of CSG water. Supply will primarily be for irrigation of cropping land, but water may also be supplied for other authorised beneficial uses (e.g., domestic, stock, stock intensive). Supply of water for beneficial use will also address Arrow Energy's commitment to offset its impact to the Condamine Alluvium.

The management of CSG water, or produced water, is not proposed to be amended as part of this application to what is already authorised under EA0001399.

This EA application does not seek approval for CSG water releases to watercourses.

Appendix F provides detail regarding the management of CSG water for the SGP, including relevance to the management of CSG Water for the Project.

Brine management

Arrow Energy's CSG Water Management Strategy (refer to **Appendix F** Error! Reference source not found.) includes options for the treatment and disposal of brine, which is a byproduct of water treatment using reverse osmosis.

Arrow Energy is currently exploring a range of brine management options, as specific measures are required to manage the storage, use, and/or disposal of brine. Until a specific brine management option is selected, Arrow Energy will store brine in its regulated dams which have been constructed in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES,

²⁵ CSG Water quality data based on available data from Arrow Energy's Surat Bason tenures.

2016). All treatment of CSG water originating from the Project will occur off-tenure at QGC's Kenya WTP, and Brine stored in the associated dams. No new brine dams are located on any of the PLs subject of this EA amendment application.

Base case for the brine management option is disposal to a suitably licensed landfill.

Other regulated waste management

Appropriate international, Australian and industry standards and codes of practice will be applied for the design and installation of infrastructure associated with the storage and management of hazardous materials such as chemicals, fuels, and lubricants, where applicable.

Regulated waste generated by the Project activities will be managed through the utilisation of an authorised waste management contractor, and handled, stored, and disposed of in accordance with relevant standards under the *Environmental Protection (Waste Management) Regulation 2000*.

Emergency response and spill response procedures will be developed and implemented to minimise any impacts that could occur as a result of releases of hazardous materials or any loss of containment of storage equipment.

Sewage management

Sewage from the warehouse and offices, and camp facilities will be carted off site for treatment, or treated through Sewage Treatment Plants and the treated effluent will be irrigated as per MEDLI assessments conducted by a specialised external consultant. A MEDLI assessment will be submitted to the administering authority.

5.11 Landscape and Visual Amenity

5.11.1 Applicable legislation

The following legislation, policy and guidelines are relevant to identifying values and mitigating and managing impacts on landscape and visual amenity from the Project.

- *Vegetation Management Act 1999* (Qld) (VM Act): This act regulates the clearing of vegetation in a way that: (a) conserves remnant vegetation that is an 'endangered' or an 'of concern' or a 'least concern' regional ecosystem; and (b) conserves vegetation in declared areas; and (c) ensures the clearing does not cause land degradation; and (d) prevents the loss of biodiversity; and (e) maintains ecological processes; and (f) manages the environmental effects of the clearing; and (g) reduces greenhouse gas emissions; and (h) allows for sustainable land use.
- *Planning Act 2016* (Qld): This act establishes an efficient, effective, transparent, integrated, coordinated, and accountable system of land use planning, development, assessment, and related matters that facilitates the achievement of ecological sustainability.
- *Western Downs Planning Scheme (2017)*: This planning scheme has been prepared in accordance with the *Planning Act 2016* as a framework for managing development in a way that advances the purpose of the *Planning Act 2016*.
- *Material Change of Use Performance Criteria Codes*: These are applicable to the requirements set out in the planning schemes within the Western Downs Regional Council which might specify height restrictions, lighting nuisance and performance criteria dependant on the zoning.

5.11.2 Description of environmental values

The Project area is located in the Darling Downs Region, within the Western Downs Regional Council (WDRC). The area is a rural area predominantly comprised of cattle, wheat, and other grain activities. The geography is dominated by pastures, crop lands, roads, bush, ridges, and creeks. Limited agricultural activity exists in areas of higher elevation and within state forests.

As presented in the SGPEIS, the visual baseline is described in terms of views from selected representative viewpoints, which correspond to the location of residents, settlements, work places, recreational features, recognised vantage points, tourist trails, and roads.

The description of environmental values from a community perspective and landscape characteristic for the Project are provided in **Table 5-20**.

Table 5-20 Environmental Values – Community and Landscape

Environmental Values	Description
Land use	<ul style="list-style-type: none"> The land use pattern for the Project area is predominantly rural with a focus on pastoral and agricultural activities as well as areas of remnant vegetation. Most of the land within the Project area is 'freehold land' held by agricultural/pastoral families, mining, infrastructure or pastoral companies, or State Government entities. The proposed Project area does not contain any areas zoned for urban development. Farming homesteads and associated farming infrastructure and/or dwellings are present. Multiple overlapping mining and coal tenures are present within the Project area.
Stakeholders, sensitive receptors, and commercial places	<ul style="list-style-type: none"> The closest towns to the Project Area are Wandoan and Miles, lying within close proximity to the proposed project activities. There are approximately 438 Lot on Plan identified within the Project Area. Commercial stakeholders include existing industry of mining and gas. Other stakeholders include the Western Downs Regional Council (WDRC), the Banana Shire Council, and other State and Government departments. Modern day communities have evolved from agricultural settlements established in the 1800s, and retain a rural and agricultural character. Community values include relative proximity to services, relaxed lifestyle, safe and family-friendly community, and the rural outlook with open space and opportunity recreation.
Landscape ²⁶	<p>Mainly Lowland Native Forest. Includes the Barakula state forest. Landscape characteristics include:</p> <ul style="list-style-type: none"> Smoothly undulating landform incised by several narrow dry gullies and creeks. Creek valleys contain a muddy character, with distinctive rocky outcrops and well-treed valley sides. Dominant species are cypress pine, wilga and poplar box. Tree heights in the range of 8 to 12 m. Occasional cleared areas used for native pasture grazing. Sparsely settled character, with only small towns and property homesteads and cottages.

²⁶Source: [SGPEIS Chapter 18 Landscape and Visual Amenity](#)

Environmental Values	Description
	<ul style="list-style-type: none"> • Forest encroached by power infrastructure and CSG facilities. • Generally comprises a high level of naturalness with a strong sense of remoteness away from major roads. • Dense forest has a strong sense of visual continuity, providing an important natural element.

The landscape around the Project Area has been shaped by variations in geology, soils, landform, vegetation, and the settlement and use by people. As mentioned in **Table 5-20**, the topography, or landscape character type, of the Project Area is mainly *Lowland Native Forest*, with the key characteristics of this type of landscape provided in **Table 5-20**.

5.11.3 Assessment of environmental impacts

Impact assessment method and pre-mitigation impact assessment

In order to assess the impacts on landscape and visual amenity from the Project activities, the following aspects need to be considered.

- Analysis and description of the landscape character, including landscape features, and visual amenity;
- Identification of the sensitivity of the landscape resource and viewers (i.e., visual receptors) in relation to the Project;
- Identification of the potential impacts on the landscape character and visual amenity of the viewers during project activities; and
- Identification of options for design, mitigation, and management of potential landscape and visual impacts associated with the Project activities.

An assessment of landscape effects deals with the effects of change and development on landscape as a resource, and how the Project will affect the elements that make up the landscape, the aesthetic, and the perceptual aspects of the landscape and its distinctive character.

The evaluation of overall potential impacts from the Project activities on landscape and amenity is based on the sensitivity to change of the existing landscape and the magnitude of change that is likely to occur²⁷.

The landscape sensitivity and the extent to which it can accept change of a particular type and scale without adverse effects on its character must be assessed.

Landscape sensitivity can vary according to the type of development proposed and the nature of the landscape, including:

- Its inherent landscape value (its condition, perceptual qualities, cultural importance, and any specific values that may apply, e.g., planning designations based on scenic amenity).
- The likely congruency of the proposed change (i.e., the extent to which the proposal may fit or be 'visually absorbed' into the scale, landform, land use, pattern, texture of the existing landscape).

²⁷There are no prescribed or existing methods for assessing the significance of landscape impacts, therefore professional judgement and experience are applied to identify the level of significance.

Sensitivity can be described as: high, medium, low, or negligible (refer to **Table 5-21**).

Table 5-21 Landscape Sensitivity Categories Definitions

Attributes of Landscape Sensitivity Categories	Landscape Sensitivity
A landscape protected by national designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.	High
A moderately valued landscape, perhaps a regionally important landscape and / or protected by regional/state designation, or where its character, land use, pattern and scale may have some capacity to accommodate a degree of the type of change envisaged.	Medium
A landscape valued to a limited extent, perhaps a locally important landscape or where its character, land use, pattern and scale is likely to have the capacity to accommodate the type of change envisaged.	Low
A landscape which is not valued for its scenic quality or where its character, existing land use, pattern and scale are tolerant of the type of change envisaged, and the landscape has capacity to accommodate change.	Negligible

The magnitude of change affecting a landscape or visual receptor (refer to **Table 5-22**) depends on the nature, scale and duration of the particular change that is expected to occur. In a landscape, the magnitude of change will depend on the loss, change or addition of any feature, or any change in the backdrop to, or outlook from a landscape that affects its character.

The effect on a view will depend on the extent of visibility, degree of obstruction of existing features, degree of contrast with the existing view, angle of view, duration of view and distance from the development.

Magnitude of change can be described as: dominant, considerable, noticeable, and imperceptible.

Table 5-22 Landscape Magnitude of Change Definition

Attributes of Landscape Magnitude of Change Categories	Landscape Sensitivity
<u>Dominant change</u> : A clearly evident and frequent/continuous change in landscape characteristics affecting an extensive area, which is likely to fundamentally change the character of the landscape.	High
<u>Considerable change</u> : A considerable change in landscape characteristics, frequent or continuous and over a wide area or a clearly evident change, but over a restricted area.	Medium
<u>Noticeable change</u> : A noticeable change in landscape characteristics over a wide area or a considerable change over a restricted area but will not fundamentally change the character of the landscape.	Low
<u>Imperceptible change</u> : An imperceptible, barely, or rarely perceptible change in landscape characteristics.	Negligible

The significance level of potential visual impacts due to activities from the Project is then derived from the definitions as per **Table 5-21** and **Table 5-22**. Visual impacts are then classified as major, high, moderate, low, or negligible.

The topography characteristic of the Project Area is predominantly *Lowland Native Forest* (refer to **Table 5-20**). As per the SGPEIS, the landscape and visual amenity value sensitivity of this topography characteristic type was assessed as 'Medium'. The magnitude of the impact, pre-mitigation measures was assessed as 'noticeable' to 'considerable', which final impact was assessed as 'Moderate'.

Potential impacts to visual amenity from dust during construction and operation are covered in Section 5.1. Traffic impacts, including road safety impacts, resulting from the Project are outside the scope of the EP Act, except in so far as the Project's traffic movements may result in environmental impacts. As per Section 4.8.2, there are estimated light vehicle and heavy vehicle traffic volumes as provided in **Table 4-2**.

Mitigation measures to reduce the impact from the Project to landscape and visual amenity are provided in Section 5.11.4 and **Table 5-23**.

5.11.4 Proposed management practices

Arrow Energy Standards

Arrow Energy has a number of existing management and mitigation strategies designed to manage actual and potential impacts to landscape and visual amenity. Arrow Energy's Amenity Standard is in place to ensure that amenity impacts from Arrow Energy's activities are managed appropriately.

The requirements under Arrow Energy's Amenity standard include:

- Processes must be implemented to ensure compliance with relevant legislation and regulatory requirements associated with amenity management.
- Ensure that the appropriate amenity risk assessments are conducted, and controls implemented to reduce risks to as low as reasonably practicable. Assessments shall consider noise, light, odour, landscaping, and visual intrusion impacts, and shall be undertaken at the design phase of an activity as well as at subsequent stages as relevant.
- Where identified as part of the risk assessment:
 - locate, design, and operate infrastructure to minimise amenity impacts;
 - determine potential noise impacts and implement controls to manage the impacts of noise associated with activities;
 - minimise the extent of disturbed areas that are visible from public roads, residences, and towns;
 - minimise the visual contrast between equipment and structures and the surrounding landscape;
 - avoid making permanent changes to natural landforms where practical
 - document amenity impact control measures;
 - develop appropriate monitoring programs; and
 - maintain management and monitoring records.
- All personnel associated with amenity management shall receive awareness training, and all personnel carrying out monitoring activities shall be trained and competent to do so.
- Landholder requirements for amenity management, as documented in land access conditions, shall be complied with.

- Sensitive receptors shall be identified where there is potential for impact from Arrow's activities.
- Ensure that stakeholders are consulted to identify and understand local environmental values to be protected, prior to commencing activities that have the potential to cause impacts.
- Ensure all complaints associated with amenity are managed in accordance with Arrow's Complaints Management System.

Avoidance, mitigation, and management measures

Environmental and social protection objectives for landscape and visual amenity include:

- Avoiding or minimising the impact on sensitive viewsheds within the project area.
- Avoiding or minimising moderate to high impacts to landscape character.

Avoidance, mitigation, and management measures are proposed to be implemented for each phase of the Project to minimise potential impacts to changes in landscape character and visual amenity.

Project activities and post-mitigation measures

Project activities likely to cause impacts on landscape and visual amenity values can be described depending on the project phase, i.e., during construction, operation, and decommissioning.

Planning is also considered an important project phase, as adequate planning will determine the most appropriate location of infrastructure in order to minimise visual disturbance on visual receptors.

The impact from the construction activities on landscape and visual amenity will vary, depending on its nature (e.g., construction of a production well versus construction of a gas production facility), and the type of landscape and location of visual receptors. Construction activities will involve:

- Excavation, trenching, drilling, earthmoving, vegetation clearance/trimming and temporary lighting; and
- Presence of workforce, construction camps and associated transport (e.g., large trucks, 4WD vehicles, graders, excavators, and tractors, etc.).

During operations, the nature of the impact will largely be determined by the size of the infrastructure and type of landscape. The following project activities could impact upon landscape and visual amenity values:

- The presence and operation of production wells, gathering lines, power generation and distribution, production facilities and associated infrastructure, including the FCS and the multi-point ground flare (MPGF), water storage facilities, and the warehouse; and
- The presence of maintenance crew, their accommodation facilities and associated transport.

During decommissioning the potential impacts upon landscape and visual amenity values include:

- Decommissioning, deconstruction, and removal of production wells, gathering lines, power reticulation, production facilities and associated infrastructure; and

- The presence of workforce, possible construction camps, and associated transport (e.g., large trucks, 4WD vehicles, graders, excavators, and tractors, etc.).

Mitigation measures to reduce the potential impacts to landscape and visual amenity are presented in **Table 5-23**.

Table 5-23 Summary of Landscape and visual amenity impacts mitigation measures

Project phase	Mitigation measures
Planning	<ul style="list-style-type: none"> • Where practicable, locate project infrastructure in the landscape of lowest sensitivity and maintain the maximum distance practicable from (and minimise visual disturbance on) the most sensitive visual receptors. • Avoid visually sensitive locations and landscapes, where practicable. • Where appropriate to the landscape sensitivity, hide or screen project infrastructure using natural landscape elements. • Consult with potentially impacted visual receptors in locating project infrastructure.
Construction	<ul style="list-style-type: none"> • Restrict lighting to the minimum required for safety and security during drilling. • Minimise footprint disturbance and vegetation clearing to reduce the magnitude of change on the affected landscape. • Implement progressive rehabilitation as soon as practicable following construction. • Locate topsoil and spoil mounds in visually unobtrusive locations. • Where practicable, use existing roads. • Maximise alignment of roads with existing landscape features such as fencing and natural drainage. • Minimise the length and width of roads. • Implement erosion control measures during construction of well pads and access roads. • Minimise construction time near sensitive visual receptors.
Operation	<ul style="list-style-type: none"> • Maintain erosion control measures. • Minimise dust and rutting along roads. • Ensure screening barriers adhere to required vegetation heights at different distances for fire mitigation measures.
Decommissioning	<ul style="list-style-type: none"> • Remove surface infrastructure and reinstate disturbed areas as soon as practicable to pre-disturbance landscape characteristics; or consult with landowners regarding reinstatement objectives.

With the implementation of the mitigation measures as outlined in **Table 5-23**, the magnitude and significance of the residual impact for the topography landscape type of the Project (i.e., Lowland native forest) was assessed as imperceptible and low, respectively²⁶.

Additional management measures during project phases

Construction

There will be some localised impacts on visual amenity on local roads due to increased traffic movements and vehicle movements above normal traffic volumes for local rural roads during daylight hours during construction. During night-time vehicle movements would be reduced and impacts temporary in nature. Landholders and property owners immediately adjacent to the site entrance to the FCS and additional infrastructure location on Arrow Energy's own land could notice an increase in traffic movements and vehicles from above the expected number of vehicle movements on rural roads.

An assessment of the proposed infrastructure as part of the EA amendment has been determined as low given the siting of infrastructure is located on Arrow Energy's own property. The nearest sensitive receptors are located approximately at 3.2 km to the

North of the proposed FCS and power station facilities, and 3.1 Km to the West. Other sensitive receptors are located along Retreat Road between 600 m and 1.0 km , of the proposed warehouse facilities location..

Given the proposed height of the fence around the MPGF and existing remanent vegetation within the surrounding area, it is expected that there only be localised visual impacts to vehicles traversing Retreat Rd, which would be limited to local landholders given the location of the proposed site away from main roads and highways. Given the height of existing remanent vegetation along road corridors and within the Arrow owned property and distance set back from the road, views of the proposed infrastructure would be low based on **Table 5-22**. The proposed FCS site including the MPGF, and radiation fence would be approximately 2.4 km from the nearest road, with the proposed warehouse facility only approximately 500 m from the nearest road.

Operation

During operation, a MPGF will be used to manage distressed gas. Potential visual impacts from the MPGF can include the MPGF components, such as: burners, a radiation shield (staggered fence panels) around the flare; pipe connections; a slug catcher for removing water in gas lines; and a cyclone separator to remove solids/fines in gas lines; and from the MPGF itself, with a maximum flame height anticipated to be up to 12 m high. As presented in **Appendix D**, the MPGF is expected to feature a 16.7 m radiation fence surrounding the flare in order to: minimise radiation impacts, and to reduce visibility of the flare flame. A typical MPGF fence is shown in **Figure 5-12**.



Figure 5-12 Indicative Multi-Point Ground Flare radiation fence

As noted above, the proposed MPGF will be located approximately 2.4 km from the closest roads, so impacts during daylight operations are considered low. In the event of flaring during the day at the FCS through the MPGF, impacts would be considered low and visual impacts impeded and hidden behind the radiation wall.

At night, impacts from lighting around the facilities such as warehouse, camps and the FCS would be noticeable with visible night glow due to little to no other sources of light in a rural environment. However, lighting can be directed down and shielded to reduce light spill into the surrounding environment. Given the distance from the nearest

sensitive receptors and that landholders would likely be inside during the night, impacts from lighting at the proposed infrastructure is unlikely to impact on the visual amenity or would be considered temporary from vehicles travelling on Retreat Road.

In the event of flaring during the night at the FCS through the MPGF, impacts would be considered low based on **Table 5-22**. Whilst there will be a noticeable night glow from the flare due to no other light sources in the rural environment at night which would have the likelihood to be seen much further afield due to the likely intensity of the flare, the frequency of which flaring would occur under normal operating conditions is low. As noted in previous sections the frequency of flaring could be once or twice a year, however the intention is to minimise flaring as much as possible, and may occur during upset or abnormal operating conditions. Similar to lighting around the facility, if flaring was to occur at night, landholders at nearby sensitive receptors would likely be inside their residences or asleep.

There will be some localised impacts on visual amenity on local roads due to increased traffic movements and vehicle movements above normal traffic volumes for local rural roads during daylight hours. During night-time vehicle movements would be reduced and impacts temporary in nature.

6. Impact Assessment for Environmental Values and Matters of State Environmental Significance

6.1 Potential impacts to identified environmental values

Table 6-1 describes the environmental values identified as relevant to the proposed activity, based on surveyed and indicative alignments, and assesses potential impacts to identified values.

Table 6-1 Assessment of potential for proposed activities to affect environmental values

Environmental Aspect	Relevant Environmental Values	Assessment of Impact
Air	<p>The proposed activity is located in a rural area, predominantly characterised by grazing and bushland, including the Binkey State Forest and Barakula State Forest.</p> <p>Additionally, mineral extraction encroaches on the western and southern boundaries of the Project area. Thus, depending on the location of infrastructure, post operational land use will include forestry, mining, grazing, or cropping.</p> <p>A total of 17 sensitive places were identified as relevant locations for impact assessment (refer to Section 5) due to the construction and operation of the Girrahween FCS. These sensitive places are all dwellings or residential premises.</p> <p>The <i>Environmental Protection (Air) Policy 2019</i> identifies environmental values to be enhanced or protected in relation to the air environment.</p> <p>The environmental values to be enhanced or protected under the policy, which are relevant to this application are <i>the qualities of the air environment that are conducive to human health and wellbeing</i>.</p>	<p>Air quality impacts, such as dust, will be minor and restricted to the worksite for a minimal period during construction. Dust suppression measures will be implemented to minimise dust deposition as required.</p> <p>During operation, the air quality assessment shows that the air quality criteria for protection of all air quality values listed in the <i>Environmental Protection (Air) Policy 2019</i> are achieved in the immediate area.</p> <p>The proposed activity would comply with existing EA conditions regarding the air environment, and air quality conditions are being requested to be added to the SGP North EA as part of this EA amendment (see Section 5.1.5 and Appendix A).</p> <p>Air environmental values and any potential impacts, managed and authorised by the existing conditions, are expected to remain unchanged as a result of the proposed activities. This is demonstrated in the air quality modelling studies conducted as part of this EA Amendment.</p>

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Environmental Aspect	Relevant Environmental Values	Assessment of Impact
		Refer to Section 5.1.5, Section 5.2.5.
Noise	<p>The proposed activity is situated in a rural location that is expected, in general, to have a low background noise level.</p> <p>The location is also within active petroleum tenure, so some values of the noise environment may be affected by authorised resource activities.</p> <p>A total of 18 sensitive places were identified as relevant locations for impact assessment (refer to Section 5.3.6) due to the construction and operation of the Girrahween FCS. These sensitive places are all dwellings or residential premises.</p> <p>The <i>Environmental Protection (Noise) Policy 2019</i> identifies and declares environmental values of the acoustic environment.</p> <p>The environmental values identified and declared by the policy which are relevant to this application are:</p> <p><i>a. the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems;</i></p> <p><i>b. The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following: sleep, study or learn or be involved in recreation, including relaxation and conversation, and</i></p> <p><i>c. the qualities of the acoustic environment that are conducive to protecting the amenity of the community.</i></p>	<p>Construction and operational noise impacts on the surrounding amenity of the rural community are assessed and are appropriately managed by Arrow Energy, including stakeholder engagement, low-noise equipment, restricted hours of operation and / or alternative arrangements as required.</p> <p>The proposed activity would comply with existing SGP North EA conditions regarding the acoustic environment.</p> <p>Acoustic environmental values and any potential impacts, managed and authorized by the existing conditions, are expected to remain unchanged as a result of the proposed variations.</p> <p>Refer to Section 5.3.6.</p>
Land	Environmental values to protect and enhanced in relation to land are not identified by an environmental protection policy under the <i>Environmental Protection Act 1994</i> (Qld).	Please refer to the attached third-party report in Appendix B for a description of potential impacts to regulated

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Environmental Aspect	Relevant Environmental Values	Assessment of Impact
	<p>Regional Ecosystems</p> <p>The Queensland Herbarium has developed a methodology for mapping regional ecosystems across Queensland in the Regional Ecosystem Description Database.</p> <p>Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform, and soil.</p> <p>Please refer to the attached third-party report 'Matters of State Environmental Significance Clunie Field' by AECOM Australia Pty Ltd, for a description of regional ecosystems at the locations of proposed activities.</p> <p>Protected species</p> <p>Areas with a validated record of, and / or containing habitat likely to have, one or more endangered, vulnerable or near threatened (EVNT) species, are identified in State mapping as Essential Habitat for fauna, or Flora Trigger Map 'high risk' areas for flora.</p> <p>Please refer to the attached third-party report 'Matters of State Environmental Significance Clunie Field' by AECOM Australia Pty Ltd, for a description of protected species habitat at the locations of proposed activities.</p>	<p>vegetation and protected species at the locations of proposed activities.</p> <p>The proposed activities' locations avoids and / or minimises disturbance in regulated vegetation, ESAs, protected plants and EVNT species habitat, to the greatest extent practicable.</p> <p>Because of the extent of ESAs / PZs on the properties, some activity in these areas is unavoidable. However, proposed activities within ESAs / PZs have been collocated on, or with, areas of pre-existing disturbance wherever practicable. For example, by upgrading and using existing landholder access tracks.</p> <p>Save for the proposed amendments, the proposed activities would comply with existing EA conditions regarding land, biodiversity, and rehabilitation.</p> <p>The environmental values of the land, including soils, landforms, rehabilitation and flora and fauna would be appropriately managed in accordance with Arrow Energy's existing management plans.</p> <p>No material change to the environmental values protected by the current EA conditions, are expected as a result of the proposed activities.</p> <p>Refer to Section 5.4 and 5.8.</p>

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Environmental Aspect	Relevant Environmental Values	Assessment of Impact
Community	<p>Persons and communities that may be impacted by the proposed amendment are the surrounding sensitive receptors.</p> <p>The proposed petroleum activities are located in the Western Downs Regional Council area. The closest settlement is Dalby, approximately 30 km to the North-East.</p> <p>The closest verified sensitive receptor to the proposed activity is a dwelling located approximately 130m away.</p>	<p>Environmental and social factors are considered as part of AWP process, in deciding appropriate locations for proposed petroleum activities.</p> <p>Construction and operational noise impacts on the surrounding amenity of the rural community are assessed and are appropriately managed including stakeholder engagement, restricted hours of operation and / or alternative arrangements as required.</p> <p>There will be no greater impact on any affected persons or affected community as a result of this amendment application.</p> <p>Refer to Section 1.6 and Section 4.1.</p>
Waste	<p>The environmental values to be protected from the waste streams through the management of waste, including the management of CSG water are:</p> <ul style="list-style-type: none"> • Biodiversity • Water resources • Land and soils • Visual amenity • Health and safety. 	<p>The proposed amendment will not generate any waste expected to affect existing environmental values, including the life, health, and wellbeing of people; the diversity of ecological processes and associated ecosystems; and the land use capability.</p> <p>Refer to Section 5.10.</p>
Water and Wetlands, and Cultural Heritage.	<p>The <i>Environmental Protection (Water and Wetland Biodiversity) Policy 2019</i> identifies environmental values for waters and wetlands to be enhanced and protected.</p> <p>The environmental values of wetlands to be enhanced or protected, relevant to this application are:</p> <ul style="list-style-type: none"> • Health of wetland ecosystems; • Natural state and biological integrity; and • Natural hydrological cycle; and interaction with other ecosystems. 	<p>The proposed activities avoid watercourses and wetlands.</p> <p>Erosion and sediment control would be appropriately managed, in accordance with the existing EA and Arrow Energy's management plans.</p> <p>The proposed activities would comply with existing EA conditions regarding the water and wetlands environment.</p> <p>Water and wetland environmental values and any potential impacts, managed and authorised by the existing</p>

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Environmental Aspect	Relevant Environmental Values	Assessment of Impact
	<p>The environmental values of waters to be enhanced or protected, relevant to this application are described in the <i>Condamine River Basin Environmental Values and Water Quality Objectives</i>:</p> <ul style="list-style-type: none"> • Aquatic ecosystems; • Irrigation; • Farm supply/use; • Stock water; • Aquaculture; • Human consumers; • Visual recreation; • Industrial use; and • Cultural and spiritual values. <p>State mapping identifies all wetlands, lakes, or springs in locations greater than 200 m away from the proposed activities;</p> <p>State mapping identifies all watercourses in locations greater than 100 m away from the proposed activities; and</p> <p>Field surveys by suitably qualified persons confirmed all proposed activities are located outside wetland, lake, spring, and watercourse buffers.</p> <p>The Aboriginal Party for the area surveyed the location and provided recommendations with respect to aboriginal cultural duty of care.</p>	<p>conditions, are expected to remain unchanged as a result of the proposed activities. Refer to Section 5.6.</p> <p>Arrow Energy meets its aboriginal cultural heritage Duty of Care under a Cultural Heritage Management Plan developed with the Aboriginal Party for the area. Refer to Section 5.9.</p>
Underground water rights	Refer to Section 5.7.	The proposed amendment involves above ground activity that will not affect the exercise of underground water rights (refer to Section 5.7).

6.2 Summary of Matters of State Environmental Significance

Table 6-2 also describes MSES identified as relevant to the proposed activity based on surveyed and indicative alignments, and assesses potential impacts to identified MSES Environmental Values.

Table 6-2 Assessment of potential for proposed activities to affect MSES

MSES	Presence	Impact
Regulated Vegetation	Please refer to Section 3.1.1 of the attached third-party report ' <i>Biodiversity Impact Assessment for Environmental Authority (EA0001399) Amendment</i> ' (refer to Appendix B), for a description of regional ecosystems at the locations of proposed activities.	Please refer to Section 4.2.1 of the attached third-party report (refer to Appendix B) for a description of potential impacts to regulated vegetation at the locations of proposed activities. Activities with an SRI on 'endangered' and 'of concern' Regional Ecosystems are within the existing approved limits set under the current SGP North EA.
Connectivity Areas	DES's Landscape Fragmentation and Connectivity (LFC) tool was used to assess potential for the proposed activity to affect remnant ecosystem connectivity.	The output from the LFC tool indicates that there is a significant residual impact on connectivity areas as a result of the activities proposed in this application. An SRI of 1,092 ha is proposed for inclusion in <i>Schedule F, Table 3 – Significant residual impacts to prescribed environmental matters</i> .
Wetland and Watercourses	The <i>Environmental Protection (Water and Wetland Biodiversity) Policy 2019</i> identifies environmental values for waters and wetlands to be enhanced and protected. The environmental values of wetlands to be enhanced or protected, relevant to this application are: <ul style="list-style-type: none">• Health of wetland ecosystems;• Natural state and biological integrity; and• Natural hydrological cycle; and interaction with other ecosystems. The environmental values of waters to be enhanced or protected, relevant to this application are described in the	The proposed activity avoids wetlands. Impacts on waterways are generally restricted to waterway crossings for linear infrastructure ROWs. Erosion and sediment control would be appropriately managed, in accordance with the existing EA and Arrow's management plans. The proposed activity would comply with existing EA conditions regarding the water and wetlands environment. Water and wetland environmental values and any potential impacts, managed and authorised by the existing conditions, are expected to remain unchanged as a result of the proposed activities.

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MSES	Presence	Impact
	<p>Dawson River Sub-basin Environmental Values and Water Quality Objectives:</p> <ul style="list-style-type: none"> • Protection of aquatic ecosystems; • The suitability of the water for agricultural purposes • Suitability for visual recreational use; and • Cultural and spiritual values of the water. <p>State mapping identifies all wetlands, lakes, or springs in locations greater than 200 m away from the proposed activities;</p> <p>State mapping identifies all watercourses in locations greater than 100 m away from the proposed activities; and</p> <p>Field surveys by suitably qualified persons confirmed all proposed activities are located outside wetland, lake, spring, and watercourse buffers.</p>	
Protected Wildlife Habitat	<p>Please refer to Section 3.2.2 of the attached third-party report '<i>Biodiversity Impact Assessment for Environmental Authority (EA0001399) Amendment</i>' (refer to Appendix B) for a description of protected wildlife habitat at the locations of proposed activities.</p>	<p>Please refer to Section 4 of the attached third-party report (refer to Appendix B) for a description of potential impacts to protected wildlife habitat at the locations of proposed activities. Impact areas for affected species have been included in the proposed amendments to <i>Schedule F, Table 3 – Significant residual impacts to prescribed environmental matters</i>.</p> <p>Arrow Energy would implement the management strategies and mitigation measures described in the Species Impact Management Plan.</p> <p>Planned actions include: marking of adjacent no-go zones; the presence of a suitably qualified fauna spotter during vegetation clearing; and slow sequential clearing to allow movement of wildlife away from activities and avoid habitat fragmentation.</p>

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MSES	Presence	Impact
Koala Habitat in SEQ	The surveyed area of the proposed activities is not within SEQ.	None.
Protected Areas	The surveyed area of the proposed activities is not within any National Parks or Nature Refuges.	None.
Fish Habitat	The surveyed area of the proposed activities is not within any declared fish habitat areas.	None.
Fish Passage	State mapping identifies all wetlands, lakes, or springs in locations greater than 200 m away from the proposed activities; State mapping identifies all watercourses in locations greater than 100 m away from the proposed activities; and Field surveys by suitably qualified persons confirmed all proposed activities are located outside wetland, lake, spring, and watercourse buffers.	None.
Marine Plants	The surveyed area of the proposed activities is terrestrial and inland.	None.
Offset Areas	No legally secured offset areas were identified within the surveyed area of the proposed activities.	None.

6.3 Offset Strategy

The SGPEIS Assessment Report requested consideration of residual impacts on State Significant Biodiversity Values under the Queensland Biodiversity Offsets Policy (QBOP) and the potential provision of offsets. It is noted that the QBOP has now been replaced with the Environmental Offsets Act 2014 and the Queensland Environmental Offsets Policy.

Arrow developed the Surat Gas Project EPBC Species Impact Management and Offset Plan (SIMOP), which satisfied the assessment of impacts and the proposal of offsets for those threatened species and ecological communities listed under the EPBC Act. The SIMOP was submitted on 6 June 2018 and approved by the Department on 14 December 2018.

On 31 October 2018, the SGP EPBC Act Approval (EPBC 2010/5344) was varied to require a more detailed Offset Strategy (OS) to be submitted and approved prior to the commencement of the SGP. Updates to the Offset Strategy are required to be approved at least 3 months prior to the commencement of a subsequent stage.

Arrow submitted an Offset Strategy for the Proposed Stage 1 Activities on 28 June 2019, and this was approved on 7 July 2019. The Stage 1 Offset Strategy describes how Arrow will secure offsets for residual significant impacts to the relevant EPBC listed threatened species and EPBC communities.

The SGP commenced on the 22 October 2020. To satisfy condition 10B of the EPBC 2010/5344 approval, Arrow Energy submitted an Offset Area Management Plan (OAMP) for the Proposed Stage 1 Activities on 21 October 2021.

The OS does not address all of the residual impacts to matters of state environmental significance (MSES) for the SGP North. As the OS only addresses matters of national environmental significance (MNES), it provides a table that lists the potential residual impacts to all MNES. The table also identifies a maximum extent of impact for the SGP as a whole, and a maximum level of impact for Stage 1 of the SGP (where Stage 1 represents the first five years of proposed disturbance). Arrow has elected to include both the whole of SGP North and staged impacts in this EA application because:

- Disturbance activities in the SGP North will occur over a time period of approximately 20 years (and therefore can be readily divided into four stages of five years each allowing for continued refinement of the whole of project impact estimates);
- The whole of SGP North limits have been included so as not to require a Major EA amendment prior to the commencement of each stage; and
- The Stage 1 limits have been included to allow future offset debiting and crediting for individual stages of the project.

Given that whole of the SGP North and staged impacts are included in this EA amendment application, offsets will be delivered in accordance with DES's Streamlined Model Conditions for conditions Biodiversity 13 to Biodiversity 17. Of particular note, Arrow Energy will provide DES with a notice of election for the staged environmental offset no less than three months before the proposed commencement of that stage (as per condition Biodiversity 17). To further support the delivery of the offsets, Arrow will utilise both financial and land-based offsets. In the case of the latter, Arrow Energy

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have and are looking to secure further parcels of land for land based offsets which will form part of proposed advanced offsets to draw down over the stages of development. Arrow Energy will engage with DES where appropriate to secure advanced offsets and registration through appropriate mechanisms such as a voluntary declaration etc.

7. Legislative Requirements

7.1 EIS process and compliance with the EP Act

Arrow Energy prepared a voluntary Environmental Impact Statement (SGPEIS) and Supplementary Report to the EIS (SREIS) for the SGP under the EP Act. The EIS and the SREIS received both State and Federal government approval in 2013.

As stated in Section 1.2, the SGP North EA (EA0001399) was granted on 26 February 2019 which included all the infrastructure for the development of the gas fields to which the SGP North EA applies.

As per Section 139 (1) (b) of the EP Act, the EIS for the SGP was completed, and Arrow Energy considers that the proposed amendment does not significantly increase the level of environmental harm to that which was assessed and approved under the SGPEIS, as the way in which the approved activities will be carried out have not materially changed since the SGPEIS process was completed. This EA amendment only seeks to authorise Prescribed Environmental Matters and include infrastructure to be listed under the authorised petroleum activities.

However, the information stage, i.e, public notification as per Section 139 (2) (a), applies to this application as it is a variation to a site-specific EA, and as per Arrow Energy's assessment against Section 223 of the EP Act and provided in Section 7.2, it confirms the requirement of a major EA amendment.

This Supporting document to amend the SGP North EA (EA0001399) is to satisfy Section 125 (1) (I) of the EP Act, and has included the likely impacts of each relevant activity on the corresponding environmental values (refer to Section 5).

7.2 Requirements for Amendment Applications

Arrow Energy is applying to amend its SGP North EA (EA0001399) as per Section 224 of the EP Act as it proposes to carry out additional resource activities as part of the SGP Project for the development of the . for the development of the Girrahween Development Phase 1 (refer to Section 1.4).

An assessment of the proposed EA amendment has been conducted against the requirements under Section 223 of the EP Act for minor amendment (threshold) and is presented in **Table 7-1**.

Table 7-1 Threshold criteria for an amendment to an EA

Amendment Threshold Criteria (EP Act Section 223)	This EA Amendment Application (i.e., SGP North EA Amendment)
<p>a) is not a change to a standard condition identified in the authority as a standard condition, other than –</p> <ul style="list-style-type: none"> (i) a change that is a condition conversion; or (ii) a change that is not a condition conversion but that replaces a standard condition of the authority with a standard condition for the 	<p>The proposed amendment identifies changes to a number of standard conditions (refer to Appendix A).</p>

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Amendment Threshold Criteria (EP Act Section 223)	This EA Amendment Application (i.e., SGP North EA Amendment)
environmentally relevant activity to which the authority relates; and	
b) does not significantly increase the level of environmental harm caused by the relevant activity; and	The proposed amendment may lead to an increase in the risk of environmental harm, although the environmental risks associated with the Project activities, as assessed in the SGPEIS, have not materially changed.
c) does not change any rehabilitation objectives stated in the authority in a way likely to result in significantly different impacts on environmental values than the impacts previously permitted under the authority; and	There will be no change to the rehabilitation objective in the EA as a result of the proposed amendment.
d) does not significantly increase the scale or intensity of the relevant activity; and	The application does not seek to significantly increase the scale and intensity of the activity to what has previously been assessed and authorised under the SGP EIS and SREIS. This application seeks to authorise a field compression station and incidental activities to facilitate the development of the already approved 588 wells. In addition, the application seeks to update the ESAs and impact to PEMs (refer to Section 5.4.3 and Appendix B). As such Arrow do not believe that the proposed amendment significantly increases the scale and intensity of the activity.
e) does not relate to a new relevant resource tenure for the authority that is – (i) a new mining lease; or (ii) a new petroleum lease; or (iii) a new geothermal lease under the Geothermal Energy Act 2010; or (iv) a new greenhouse gas injection and storage lease under the Greenhouse Gas Storage Act 2009; and	No new resource tenure is proposed as part of this amendment.
f) Involves an addition to the surface area of the relevant activity of no more than 10% of the existing area; and	The proposed amendment will not increase the surface area for the relevant activity greater than 10% of the existing area, nor does it seek to authorise more than 10% of the existing authorised disturbance area.
g) For an environmental authority for a petroleum activity: (i) involves constructing a new pipeline that does not exceed 150km; or (ii) involves extending an existing pipeline so that the extension does not exceed	None of the proposed pipelines will exceed the defined thresholds.

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Amendment Threshold Criteria (EP Act Section 223)	This EA Amendment Application (i.e., SGP North EA Amendment)
10% of the existing length of the pipeline; and	
h) if the amendment relates to a new relevant resource tenure for the authority that is an exploration permit or greenhouse gas permit — seeks, in the amendment application under section 224, an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit.	No new resource tenure is required for the proposed amendment.

The assessment as outlined in **Table 7-1** demonstrates that the proposed amendment to the SGP North EA considered in this application is not a minor amendment.

The statutory requirements for amending an EA are set out in sections 226 and 226A of the EP Act.

Table 7-2 summarises the statutory requirements under Section 226 and the responses from Arrow Energy to each of these requirements.

Table 7-2 EP Act Section 226 requirements for amendment application generally and Arrow Energy's response

Statutory requirement under s226 of the EP Act	Arrow Energy's Response
(1) An amendment application must –	
(a) be made to the administering authority; and	This EA amendment application has been made to DES which is the administering authority for this EA (EA0001399).
(b) be in the approved form; and	Arrow Energy has applied for this EA amendment via DES's online Connect system. This report is provided as supporting information to this application.
(c) be accompanied by the fee prescribed under a regulation; and	Arrow Energy has elected to pay the fee prescribed under regulation by credit card on the DES's online Connect system.
(d) describe the proposed amendment; and	<p>Full details of this proposed EA amendment are included in this Supporting Document (refer to Section 2, Appendix A and Appendix G (i.e., marked-up EA)), so the administering authority, i.e., DES, can clearly determine the requested changes to the SGP North EA (EA0001399).</p> <p>The justifications of how this proposed EA amendment meets the criteria for a major amendment is provided in Table 7-1. This document and its Appendices provides the supporting information documentation to the SGP North EA amendment application.</p>

Statutory requirement under s226 of the EP Act	Arrow Energy's Response
(e) describe the land that will be affected by the proposed amendment; and	The Project will be carried out within existing designated areas of the SGP North EA, i.e., within PLs 305, 491, 492, and 1044. No new areas will be included (refer to Section 1.1, Section 1.4, Section 3.1, Section 3.2, and Section 5.8). Maximum disturbance to ESAs and PEMs are discussed and provided in Section 5.4.3 and Appendix B .
(f) include any other document relating to the application prescribed by regulation.	The CSG Water Management Plan, as prescribed by regulation, is included as part of this amendment application (refer to Appendix F).

Table 7-3 summarises the statutory requirements under Section 226A and the responses from Arrow Energy to each of these requirements.

Table 7-3 EP Act Section 226A requirements for amendment application and Arrow Energy's response

Statutory requirement under s226A of the EP Act	Arrow Energy's Response
(1) An amendment application must also –	
(a) describe any development permits in effect under the Planning Act for the carrying out of the relevant activity for the authority; and	Arrow Energy does not have any development permits in effect under the Planning Act for the carrying out of the relevant activities for the authority.
(b) state whether each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity; and	This is not relevant to Arrow Energy's application as the application is a site-specific EA amendment application.
(c) if the application states that each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity – include a declaration that the statement is correct; and	This is not relevant to Arrow Energy's application as the application is a site-specific EA amendment application.
(d) state whether the application seeks to change a condition identified in the authority as a standard condition; and	No changes to standard conditions are proposed with this EA amendment.
(e) if the application relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit – state whether the applicant seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit; and	This is not relevant as this application relates to the existing PLs authorised by the SGP North EA (EA0001399) and does not seek to include any new resource authorities.
(f) include an assessment of the likely impact of the proposed amendment on the environmental values, including –	
(i) a description of the environmental values likely to be affected by the proposed amendment; and	(i) See Section 5.
(ii) details of emissions or releases likely to be generated by the proposed amendment; and	(ii) See Section 5.1 (Air) and Section 5.6 (Surface water).

Statutory requirement under s226A of the EP Act	Arrow Energy's Response
<p>(iii) a description of the risk and likely magnitude of impacts on the environmental values; and</p> <p>(iv) details of the management practices proposed to be implemented to prevent or minimise adverse impacts; and</p> <p>(v) if a PRCP schedule does not apply for each relevant activity – details of how the land the subject of the application will be rehabilitated after each relevant activity ends; and</p>	<p>(iii) See Section 5.</p> <p>(iv) See Section 5.</p> <p>(v) Not applicable.</p>
(g) include a description of the proposed measures for minimising and managing waste generated by amendments to the relevant activity; and	The proposed amendment does not change any generation of waste by the relevant activities covered under the existing SGP North EA and the SGPEIS and SREIS. See Section 4.10.6 and Section 5.10.
(h) include details of any site management plan or environmental protection order that relates to the land the subject of the application.	Not applicable.

7.3 Requirements for Amendment Application for CSG Activities

CSG water management and underground water rights

Section 227 of the EP Act is not applicable to this proposed EA amendment as the proposed activities would not result in changes to the management of CSG water. Please refer to details provided in **Table 7-4** and the CSG Water Management Plan provided in **Appendix F**.

Table 7-4 EP Act Section 227 and Section 227AA requirements for amendment application and Arrow Energy's response

Amendment application for CSG activities	Arrow Energy's response
Statutory requirements under s227 of the EP Act – CSG Activities	
(1) This section applies for an amendment application if –	Applicability
(a) the application relates to an environmental authority for a CSG activity; and	Yes. This EA amendment relates to an environmental authority for a CSG activity
(b) the proposed amendment would result in changes to the management of CSG water; and	No. This EA amendment will not result in changes to the management of CSG water. Arrow Energy is providing a revision update of its CSG Water Management Plan (refer to Appendix F) which is consistent with the proposed changes in the EA conditions and EOW Codes.
(c) the CSG activity is an ineligible ERA.	Yes. The CSG activity is an ineligible ERA.

Amendment application for CSG activities		Arrow Energy’s response
(2) the application must also –		Applicability
(a) state the matters mentioned in section 126 (1); and	The matters under s126 (1) are stated in the CSG Water Management Plan as provided in Appendix F .	The requirements under this section are provided in the CSG Water Management Plan (refer to Appendix F).
(b) comply with section 126 (2)	Best practices environmental management for managing CSG water and alternative ways for managing water are provided in the CSG Water Management Plan (refer to Appendix F).	
Statutory requirements under s227AA of the EP Act – underground water rights		
(1) This section applies for an amendment application if –		
(a) the application relates to a site-specific environmental authority for -		Applicability
(i) a resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or	Yes. The application relates to a site-specific environmental authority that relates to a resource project which includes a resource tenure for a petroleum lease.	Applicable.
(ii) a resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and	Yes. The application relates to a site-specific environmental authority for which the relevant tenure is a petroleum lease.	Applicable.
(b) the proposed amendment involves changes to the exercise of underground water rights.	The proposed EA amendment involves above ground activity. The proposed amendments will <i>not</i> involve changes to the exercise of underground water rights (refer to Section 5.7).	Not applicable.

Transfer of CSG water

Arrow Energy has proposed to insert conditions into the SGP North EA (EA0001399) as proposed Condition (Waste 22) to Condition (Waste 26), as provided in **Appendix A** and **Appendix G**, to mimic the End of Waste (EoW) Code for *Associated water (including coal seam gas water)* (EoW ENEW07547018)²⁸, and to be consistent with the DES guideline for *Streamlined model conditions for petroleum activities*²⁹. This proposed inclusion of conditions will also not result in changes to the management of CSG water in relation to what is already authorised through other legislation, or as described in Arrow Energy's CSG Water Management Plan (refer to **Appendix F**).

²⁸End of Waste Code *Associated Water (including coal seam gas water)* ([ENEW07547018](#)), *Waste Reduction and Recycling Act 2011* (ESR/2019/4713, Version 1.03, 18 August 2023).

²⁹Guideline *Streamlined model conditions for petroleum activities* ([SMC](#)) under the EP Act (ESR/2016/1989, Version 2.02, 5 May 2016).

Appendix A. Summary of Proposed SGP North EA (EA0001399) Amendments

This appendix contains the detail of all changes to EA0001399, i.e., relevant condition changes, including ERAs, authorised petroleum activities, and administrative changes, and the justifications for these changes. For all changes as per this appendix, please also refer to **Appendix G** (marked-up EA).

EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable
Cover Page – Environmental Authority Number: EA0001399			
EA Cover Page	Cover page	Insert date (DD Month YYYY) on which the EA takes effect.	EA take effect date required.
Cover Page – Environmentally relevant activity and location details			
Environmentally relevant activity/activities	Environmentally Relevant Activities (ERAs) Table	<p>Remove repeated ERAs and modify column 'Location(s)' to include the PLs to which the ERAs apply.</p> <p>Remove from the column 'Environmentally relevant activity/activities' those ERAs that are repeated and group PLs for the applicable ERAs.</p>	Administrative change. To allow for less repetition of ERAs and better clarity by grouping the PLs to which the ERAs are applicable.
Environmentally relevant activity and location details	Environmentally Relevant Activities (ERAs) Table	<p>Add the following ERAs:</p> <ul style="list-style-type: none"> Schedule 2, Ancillary ERA 14 – Electricity Generation, 1: Generating electricity by using gas at a rated capacity of 10MW electrical or more. Schedule 2, Ancillary ERA 15 – Fuel burning: Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour. Schedule 2, Ancillary ERA 16 Extractive, and screening activities, 1: Extracting, other than by dredging, in a year, the following quantity of material – (b) more than 100,000t but not more than 1,000,000t. Schedule 2, Ancillary ERA 63 – Sewage Treatment, 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of – (a-i) 21 to 100EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme. <p>Schedule 2, Ancillary ERA 63 – Sewage Treatment, 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of– (b-i) more</p>	To include applicable ERAs due to additional ancillary activities. Section 2.2 and Section 4.10.1.

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable
		than 100 but not more than 1,500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.	
Signature page			
Enquiries section	N/A	Change wording to (in bold): Energy and Extractive Resources	Administrative change. To correct typo.
Table of Contents – SCHEDULES			
Schedule E – Protecting Land Values	After Schedule E General	Change 'Top soil' to ' Topsoil '	Administrative change. To correct typo.
Schedule A – General			
Schedule A – General	After title Schedule A - General	Add title: Authorised resource activities	Administrative change. To align with the <i>Streamlined model conditions for petroleum activities</i> DES guideline, ESR/2016/1989, Version 2.02, effective 05 May 2016.(SMC).
Schedule A – General Authorised resource activities	Condition (A1)	Amend condition by adding the text in bold : (A1) This environmental authority authorises the carrying out of the following resource activity(ies): a) The petroleum activities listed in Schedule A, Table 1 – Authorised petroleum activities to the extent they are carried out in accordance with the activity's corresponding scale and intensity (or both, where applicable); b) The following specified environmentally relevant activities (ERAs): i. Resource recovery and transfer facility operation – operating a facility for receiving and sorting, dismantling, baling, or temporarily storing (c) category 2 regulated waste; ii. Electricity generation – generating electricity by using gas at a rated capacity of 10MW electrical or more;	To include: <ul style="list-style-type: none"> ERA for already authorised regulated dams; and all ERAs that are triggered due to the addition of infrastructure activities as part of this EA amendment, namely, electricity generation, fuel burning, gravel pits, and sewage treatment plants. For further details, Refer to Appendix G .

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		<p>iii. Fuel burning - Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour;</p> <p>iv. Extractive and screening activities - Extracting, other than by dredging, in a year, the following quantity of material – (b) more than 100,000t but not more than 1,000,000t;</p> <p>v. Sewage treatment – operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (a-i) 21 to 100EP and (b-i) more than 100 but not more than 1,500, if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme; and</p> <p>vi. For the specified relevant activities listed in General A1 b) above, another activity where Schedule 2 of the Environmental Protection Regulation 2019 (the Regulation) provides exemption for the activity, but only to the extent of the circumstances stated in Schedule 2 of the Regulation; and</p> <p>c) Incidental activities that are not otherwise specified relevant activities.</p>	
Schedule A – General Authorised resource activities	Schedule A, Table 1 – Authorised petroleum activities	<p>Incorporate the following changes to <i>Schedule A, Table 1- Authorised petroleum activities</i>:</p> <p>Change wording to the following (in bold):</p> <ul style="list-style-type: none"> Change 'Coal seam gas production' on the 'Activity(ies)' column to 'Total coal seam gas wells, including: Core wells, Exploration wells, Development wells, Production wells, Monitoring wells.' Change title of third column to 'Scale / Intensity'. Remove '/maximum size'. <p>Remove:</p> <ul style="list-style-type: none"> Column 'Total scale of petroleum activities / infrastructure' (for wells, petroleum pipeline and location of regulated structures (i.e., dams)). 1.1 ha per well Line 'Petroleum pipeline' and '650 km of pipeline'. 	<p>To:</p> <ul style="list-style-type: none"> allow for the development of different types of wells; remove location column; remove specific disturbance per well (1.1 ha per well) and allow the full scale of petroleum activities already authorised under the SGPEIS, including gathering lines (see further justification below); include additional activities to the 'authorised petroleum

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable								
		<p>Add (in bold):</p> <ul style="list-style-type: none"> 588 wells to column 'Scale / Intensity' (new name as per above change) Kedron Dam – one (1) dam / Castledean Dam – one (1) dam / Punchbowl Dam – one (1) dam / Central gas processing facility (Field Compression Station) with 6 compressor units and a power station, a multi-point ground flare, and access tracks (quantity - one (1) facility / 13.18 ha of authorised disturbance) Communication towers (quantity - five (5), 5.00 ha of authorised disturbance) Sewage Treatment Plants (quantity – five (5) facilities of Less than 100EP (each); and one (1) facility of 100EP to 350EP). Gravel Pit(s) (quantity – two (2) , 19.90 ha of authorised disturbance) <p>Changes/Additions to table are below in bold, and crossed out text is to be removed.</p> <p>Schedule A, Table 1- Authorised petroleum activities</p> <table border="1"> <thead> <tr> <th>Tenures</th><th>Activity(ies)</th><th>Total scale of petroleum activities / infrastructure</th><th>Scale / Intensity / maximum size</th></tr> </thead> <tbody> <tr> <td> PL304 PL305 PL491 PL492 PL494 PL1044 </td><td> Coal seam gas production Total coal seam gas wells, including: Core wells Exploration wells Development wells Production wells Monitoring wells </td><td> 588 gas production wells: PL304 – 95 wells PL305 – 86 wells PL491 – 192 wells PL492 – 151 wells PL494 – 27 wells PL1044 – 37 wells </td><td> 1.1 ha per well 588 wells </td></tr> </tbody> </table>	Tenures	Activity(ies)	Total scale of petroleum activities / infrastructure	Scale / Intensity / maximum size	PL304 PL305 PL491 PL492 PL494 PL1044	Coal seam gas production Total coal seam gas wells, including: Core wells Exploration wells Development wells Production wells Monitoring wells	588 gas production wells: PL304 – 95 wells PL305 – 86 wells PL491 – 192 wells PL492 – 151 wells PL494 – 27 wells PL1044 – 37 wells	1.1 ha per well 588 wells	<p>activities' that trigger ERAs as per the EP Reg 2019.</p> <ul style="list-style-type: none"> allow authorised activity table to be consistent with other proponents and moves towards a more outcomes focused conditioning rather than prescriptive conditioning. The proposed changes allow for incidental infrastructure associated with developing the number of wells (maximum intensity). Include column 'Tenures' to provide the location of authorised petroleum activities under all the PLs of the SGP North EA (see example of the proposed table further down). The proposed amendments to Schedule A, Table 1 is to ensure consistency with other proponents' EAs, but also to provide for flexibility to where authorised petroleum infrastructure is authorised. Remove max size per well pad of 1.1 ha due to conflict with essential petroleum definition which authorises 1.5 ha for multi well pad, within this EA. It creates a compliance issue and confusion as to what is the
Tenures	Activity(ies)	Total scale of petroleum activities / infrastructure	Scale / Intensity / maximum size								
PL304 PL305 PL491 PL492 PL494 PL1044	Coal seam gas production Total coal seam gas wells, including: Core wells Exploration wells Development wells Production wells Monitoring wells	588 gas production wells: PL304 – 95 wells PL305 – 86 wells PL491 – 192 wells PL492 – 151 wells PL494 – 27 wells PL1044 – 37 wells	1.1 ha per well 588 wells								

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EA Section	EA Condition / Table / Location of change	Proposed changes				Justification and Report Section(s) where applicable
			Petroleum pipeline	PL304 – 90 km PL305 – 90 km PL491 – 200 km PL492 – 190 km PL494 – 30 km PL1044 – 50 km	650 km of pipeline	maximum size of well pad authorised, when its defined elsewhere in the EA. Request to remove the conflicting direction or standard within the same document (i.e., SGP North EA).
			Petroleum activities carried out on a site containing a regulated structure ² (high or significant consequence category dam)	PL304 – Kedron Dam PL305 – Castledean Dam PL1044 – Punchbowl Dam	Kedron Dam – 20 ha Castledean Dam – 14 ha Punchbowl Dam – 35 ha	
			Central gas processing facility (Field Compression Station) with six (6) compressor units and a power station, and a multi-point ground flare		13.18 ha	
			Communication towers		Five (5) Comms towers, 5.00 ha	
			Sewage treatment plants		Five (5) facilities, Less than 100EP (each) One (1) facility, 100 to 350EP	
			Gravel pit (s)		Two (2) gravel pits, 19.90 ha	

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable																		
		<p>1 The petroleum activities are authorised petroleum activities for the purposes of the <i>Petroleum and Gas (production and Safety) Act 2004</i> and the <i>Petroleum Act 1923</i>.</p> <p>2 Words underlined are currently defined in Schedule K – Definitions or the <i>Environmental Protection Act 1994</i> and/or its subordinate legislation.</p> <p>The new proposed modified <i>Schedule A, Table 1- Authorised petroleum activities</i> should look like the following.</p> <p>Schedule A, Table 1- Authorised petroleum activities</p> <table><tr><th>Tenures</th><th>Activity(ies)</th><th>Scale / Intensity</th></tr><tr><td rowspan="7">PL304 PL305 PL491 PL492 PL494 PL1044</td><td>Total coal seam gas wells, including: Core wells <u>Exploration wells</u> <u>Development wells</u> Production wells Monitoring wells</td><td>588 wells</td></tr><tr><td>Petroleum activities carried out on a site containing a regulated structure² (high or significant <u>consequence category dam</u>)</td><td>Kedron Dam – 20 ha Castledean Dam – 14 ha Punchbowl Dam – 35 ha</td></tr><tr><td>Central gas processing facility (Field Compression Station) with six (6) compressor units and a power station, and a multi-point ground flare</td><td>13.18 ha</td></tr><tr><td>Communication towers</td><td>Five (5) Comms towers, 5.00 ha</td></tr><tr><td>Sewage treatment plants</td><td>Five (5) facilities, Less than 100EP (each) One (1) facility, 100 to 350EP</td></tr><tr><td>Gravel pit (s)</td><td>Two (2) gravel pits, 19.90 ha</td></tr><tr><td></td><td></td></tr></table> <p>1 The petroleum activities are authorised petroleum activities for the purposes of the <i>Petroleum and Gas (production and Safety) Act 2004</i> and the <i>Petroleum Act 1923</i>.</p> <p>2 Words underlined are currently defined in Schedule K – Definitions or the <i>Environmental Protection Act 1994</i> and/or its subordinate legislation.</p>	Tenures	Activity(ies)	Scale / Intensity	PL304 PL305 PL491 PL492 PL494 PL1044	Total coal seam gas wells, including: Core wells <u>Exploration wells</u> <u>Development wells</u> Production wells Monitoring wells	588 wells	Petroleum activities carried out on a site containing a regulated structure ² (high or significant <u>consequence category dam</u>)	Kedron Dam – 20 ha Castledean Dam – 14 ha Punchbowl Dam – 35 ha	Central gas processing facility (Field Compression Station) with six (6) compressor units and a power station, and a multi-point ground flare	13.18 ha	Communication towers	Five (5) Comms towers, 5.00 ha	Sewage treatment plants	Five (5) facilities, Less than 100EP (each) One (1) facility, 100 to 350EP	Gravel pit (s)	Two (2) gravel pits, 19.90 ha			
Tenures	Activity(ies)	Scale / Intensity																			
PL304 PL305 PL491 PL492 PL494 PL1044	Total coal seam gas wells, including: Core wells <u>Exploration wells</u> <u>Development wells</u> Production wells Monitoring wells	588 wells																			
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	Gravel pit (s)	Two (2) gravel pits, 19.90 ha																			

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable
Schedule A – General	Condition (General 11) (a)	Change wording to (in bold): (c) for waters and aquatic environments, the Queensland Government's Monitoring and Sampling Manual 2018 - <i>Environmental Protection (Water) Policy 2009</i>	Administrative change. Minor amendment to update to most recent and current version of the EP Regulation.
Schedule A – General	Condition (General 11) (c)	Change wording to (in bold): (c) for noise, the <i>Environmental Protection Regulation 2019</i>	Administrative change. Minor amendment to update to most recent and current version of the EP Regulation
Schedule A – General	Condition (General 11) (d)	Change wording to (in bold), and delete crossed out text: (d) for air, the <i>Queensland Air Quality Sampling Manual</i> and/or Australian Standards 4323.1:1995 Stationary source emissions method 1: Selection of sampling positions , under 3580 Methods for sampling and analysis of ambient air , as appropriate for the relevant measurement	Administrative change. Minor amendment to update to most recent and current version of the EP Regulation.
Schedule A – General	Condition (General 11) (e)	Change wording to (in bold): (e) for soil, the <i>Guidelines for Surveying Soil and Land Resources, 2nd edition</i> (McKenzie <i>et al.</i> 2008), and/or the <i>Australian Soil and Land Survey Handbook</i> , 3rd edition (National Committee on Soil and Terrain, 2009, or subsequent versions).	Administrative change. To allow for future updates to bibliographic reference.
Schedule A – General – Notification	Condition (General 12) (f)	Change wording to (in bold): (f) when the seepage trigger action response procedure required under condition (Water 13 (g)) is or should be implemented.	Administrative change. To reference to the correct condition (i.e., (Water 13 (g)) rather than (Water 14 (g)).
Schedule A – General –	After condition (General 12) (k)	Remove title: Financial Assurance	Administrative change. To remove title as conditions (General 13), (General 14), and (General 15) are being requested to be removed.
Schedule A – General – Financial Assurance	Condition (General 13)	Remove condition (all wordings).	To be updated in line with the ERC decision under s298 of EP Act.

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Schedule A – General – Financial Assurance	Condition (General 14)	Remove condition (all wordings).	To be updated in line with the ERC decision under s298 of EP Act.
Schedule A – General – Financial Assurance	Condition (General 15)	Remove condition (all wordings).	To be updated in line with the ERC decision under s298 of EP Act.
Schedule A – General Contingency procedures for emergency environmental incidents	Condition (General 16) (f)	Change wording to (in bold): (f) training of staff to enable them to effectively respond to environmental emergency incidents .	Administrative change. To add 'environmental emergency incidents' for consistency with the section wording 'Contingency procedures for emergency environmental incidents'.
Schedule A – General Contingency procedures for emergency environmental incidents	After Condition (General 16) (g) - For conditions (General 17) to (General 19)	Add title: Plant and equipment operation and maintenance	Administrative change. For consistency regarding title structure of Schedule A - General
Schedule A – General Contingency procedures for emergency environmental incidents	Condition (General 19)	Change wording to (in bold), and remove crossed out text: Measures to prevent fauna being harmed from entrapment must be implemented during the construction, and operation, and decommissioning of well infrastructure, dams , pipelines , and pipeline trenches.	To add project/activity decommissioning stage, and reference to pipelines as petroleum activity. Removes ambiguity to ensure this condition is applicable during decommissioning and for pipelines.
Schedule B – Waste Management			
Schedule B – Waste Management – Authorised uses of produced water for petroleum activities	Condition (Waste 9)	Change wording of condition to (in bold): (Waste 9) Produced water may be used for construction and operational purposes provided the use:	To allow the use of produced water for operational purposes. The purpose of adding this is to include the use of produced water for operational activities, in consistency with other Arrow EAs.

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			<p>These 'operational' activities are mainly maintenance activities, as Arrow undertakes a significant number of operational maintenance activities which require the use of small volumes of water to enable these to be conducted safely and effectively. These activities are mainly for asset integrity and/or process safety purposes to ensure compliance with legislation and to ensure the early detection of events that may cause failures or create hazardous conditions. These operational activities include, but are not limited to:</p> <ul style="list-style-type: none"> • Water flow rate testing of wells(low flow rates); • Replacement of pipework and associated wellhead skid infrastructure; • Replacement of wellhead gas relief valves; • Leak detection surveys; • Ground and aerial patrols, • Pigging and cleaning of pipelines; and • High point vents (HPVs) and pup replacement at treated and produced water ponds.

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			All of the abovementioned conditions are operated in accordance with applicable EA conditions (including Condition (Waste 9) (a), (b), (c), and (d)), relevant permit conditions, and Arrow's Policies, procedures, and management plans. For gas and water pipelines and gathering lines, it includes operating in accordance with APGA Code of Practice for Upstream PE Gathering Lines in the CSG Industry, and the APGA Code of Environmental Practice: Onshore Pipelines.
Schedule B – Waste Management Use of produced water for irrigation activities	Condition (Waste C2) (b)	Change wording of condition to (in bold): (b) states water quality criteria, which has been determined in accordance with the assessment procedures outlines in Schedule B, Table 1 – Assessment procedures for quality criteria; and	Administrative change. To add word 'and'.
Schedule B – Waste Management	After Schedule B, Table 1 – Assessment procedures for water quality criteria	Add title: Use of treated sewage or grey water for irrigation activities - Sewage treatment works less than 350EP	Administrative change. For consistency regarding title structure of Schedule B – Waste Management
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works less than 500EP</i>	After Schedule B, Table 1 – Assessment procedures for water quality criteria	Remove condition (Waste 11).	Remove condition as per proposal to include new conditions linked to STP release limits. As such, propose to delete references to secondary treated class B standards and class C standards.

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			This will also link to similar STP limits across industry and STP suppliers.
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works less than 500EP</i>	Condition (Waste 12)	<p>Change condition (Waste 12) to the following (Add wording in bold and remove crossed out text):</p> <p>(Waste 12) The release of Treated sewage effluent or <u>greywater</u> from a treatment system with a daily peak design capacity of less than 350EP may be released to land provided it: authorised in condition (Waste 11) must:</p> <ul style="list-style-type: none"> (a) is to a fenced and signed contaminant release area(s); (b) does not result in pooling or run-off or aerosols or spray drift or vegetation die-off; (c) minimises deep drainage below the root zone of any vegetation; (d) does not adversely affect the quality of shallow aquifers; (e) does not adversely impact soil quality; and (f) is to a contaminant release area(s) that is kept vegetated with groundcover, that is: <ul style="list-style-type: none"> i. not a declared <u>pest</u> species; ii. kept in a viable state for transpiration and nutrient uptake; and iii. grazed or harvested and removed from the contaminant release area as needed, but not less than every three <u>months</u>. 	<p>Proposal to include STPs with capacity less than 350EP and outcome focused conditions, noting that STPs greater than 21EP will require a MEDLI model. It is noted that for STPs less than 21EP is considered a low risk based on the DES risk assessment for petroleum activities.</p> <p>Refer to Appendix G.</p>
Schedule B – Waste Management	After Condition (Waste 12)	<p>Add title:</p> <p>Use of treated sewage or grey water for irrigation activities – Sewage treatment works between 100EP and 350EP</p>	<p>Administrative change.</p> <p>For consistency regarding title structure of Schedule B – Waste Management</p>

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new title – <i>Use of treated sewage or grey water for irrigation activities – Sewage treatment works between 100EP and 500EP</i>	Add condition (Waste 13): (Waste 13) Sewage pump stations must be fitted with: (a) a stand-by pump; and (b) a visible or audible high-level alarm to warn of imminent pump station overflow, that operates without mains power or with a back-up power source that starts automatically in the event of a power failure.	To align with the SMC.
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 13)	Add condition (Waste 14): (Waste 14) All nominated locations and minimum contaminant release areas in condition (Waste 13) for sewage treatment works with a daily peak design capacity of greater than 100EP must be determined using the Model for Effluent Disposal using Land Irrigation (MEDLI) program or recognised equivalent.	Proposal to link limits and conditions to MEDLI output rather than prescriptive conditions which may not be site specific.
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 14)	Add condition (Waste 15): (Waste 15) A copy of the MEDLI program (or recognised equivalent) required in condition E18 must be submitted to the administering authority.	Proposal to link limits and conditions to MEDLI output rather than prescriptive conditions which may not be site specific.
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 15)	Add condition (Waste 16): (Waste 16) If, within 20 business days following the submission of the MEDLI program results the administering authority provides comments on the submission, the holder of the environmental authority must: (a) have due regard to that comment in the finalisation of the amended MEDLI program results; and	Proposal to link limits and conditions to MEDLI output rather than prescriptive conditions which may not be site specific.

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable																																
		(b) submit the finalised amended MEDLI program results within 40 business days after the administering authority provided comments; and (c) implement the amended MEDLI program results.																																	
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 16)	Add condition (Waste 17) (Waste 17) All treated sewage effluent or greywater released to land from a treatment system with a daily peak design capacity of greater than 100 EP must be in accordance with the contaminant release limits and monitored at the frequency as stated in <i>Schedule B, Table 2 – Treated Sewage Effluent Release Limits to Land</i> and the conditions of this environmental authority.	Proposal to link limits and conditions to MEDLI output rather than prescriptive conditions which may not be site specific.																																
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 17)	Add table <i>Schedule B, Table 2 – Treated Sewage Effluent Release Limits to Land</i> as per detail below. Schedule B, Table 2 – Treated Sewage Effluent Release Limits to Land <table><tr><th>Quality Characteristic / Contaminant</th><th>Sampling and <i>in situ</i> measurement point location</th><th>Unit</th><th>Limit Type</th><th>Release Limit</th><th>Frequency</th></tr><tr><td>5-day Biochemical oxygen demand (BOD)</td><td rowspan="6">Release pipe from sewage treatment plant</td><td>mg/L</td><td>maximum</td><td>20</td><td rowspan="4">Quarterly</td></tr><tr><td>Total Suspended Solids (TSS)</td><td>mg/L</td><td>maximum</td><td>30</td></tr><tr><td rowspan="2"><i>E. coli</i></td><td>CFU¹ /mL</td><td>80th percentile²</td><td>1,000</td></tr><tr><td>CFU/100 mL</td><td>maximum</td><td>10,000</td></tr><tr><td>Electrical Conductivity (EC)</td><td>-</td><td>monitor only</td><td>-</td><td rowspan="2">Monthly <i>in-situ</i> monitoring</td></tr><tr><td>pH</td><td>pH unit</td><td>range</td><td>6.0 – 9.0</td></tr></table> ¹ CFU = Coliform Forming Units. ² Based on at least five (5) samples with not less than 30 minutes between samples.	Quality Characteristic / Contaminant	Sampling and <i>in situ</i> measurement point location	Unit	Limit Type	Release Limit	Frequency	5-day Biochemical oxygen demand (BOD)	Release pipe from sewage treatment plant	mg/L	maximum	20	Quarterly	Total Suspended Solids (TSS)	mg/L	maximum	30	<i>E. coli</i>	CFU ¹ /mL	80 th percentile ²	1,000	CFU/100 mL	maximum	10,000	Electrical Conductivity (EC)	-	monitor only	-	Monthly <i>in-situ</i> monitoring	pH	pH unit	range	6.0 – 9.0	Proposal to link limits and conditions to MEDLI output rather than prescriptive conditions which may not be site specific. Arrow Energy is requesting the proposed conditions for STPs, which would involve purification in an STP and disposal of the treated effluent on an irrigation disposal area. The STP and irrigation disposal area operate together to provide integrated treatment which will minimise the impacts of pollutants on the environment. Both the STP and irrigation disposal system will have capacity to remove nitrogen and phosphorus from the effluent. Any MEDLI report submitted to DES will include a determination
Quality Characteristic / Contaminant	Sampling and <i>in situ</i> measurement point location	Unit	Limit Type	Release Limit	Frequency																														
5-day Biochemical oxygen demand (BOD)	Release pipe from sewage treatment plant	mg/L	maximum	20	Quarterly																														
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			on the predicted Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Total Nitrogen and Total Phosphorous nutrient concentration of the effluent in questions and will determine the area required for long-term average limits for the sustainable management of nutrients irrigated. The limits proposed in Table 2 would therefore provide a proxy for aforementioned limits, with the MEDLI ensuring the release of effluent is managed and irrigated appropriately. The proposed limits are similar to that of secondary treated class B standards, but as noted above removes TN and TP to link to outputs from the MEDLI model.
Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new table <i>Schedule B, Table 2 – Treated Sewage Effluent Release Limits to Land</i>	Add condition (Waste 18): (Waste 18) If the water quality assessment required by condition (Waste 18) demonstrates that the water is not suitable for release to land, then water must be collected and disposed of at an appropriate facility.	To align with the SMC.

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Schedule B – Waste Management – New title <i>Use of treated sewage or grey water for irrigation activities - Sewage treatment works between 100EP and 500EP</i>	After new condition (Waste 19)	Change numbering to conditions (Waste 15) to (Waste 17) as per below. (Waste 15) to (Waste 19) (Waste 16) to (Waste 20) (Waste 17) to (Waste 21)	Administrative change. To change conditions numbering due to the proposal of addition of conditions (Waste 13) to (Waste 18).
Schedule B – Waste Management	After newly numbered condition (Waste 21) (ex (Waste 17))	Add title: Transfer of coal seam gas water to a third party	Administrative change. For consistency regarding title structure of Schedule B – Waste Management
Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new title <i>Transfer of coal seam gas water to a third party</i>	Add condition (Waste 22): (Waste 22) The holder of this environmental authority must ensure that coal seam gas produced water is contained, is not released to land or waters, and is only used for purposes specifically authorised; (a) under this environmental authority; or (b) under the <i>Petroleum and Gas (Production and Safety) Act 2004</i> ; or (c) under the <i>Petroleum Act 1923</i> ; or (d) under a current beneficial use approval or end of waste code or approval issued under the <i>Waste Reduction and Recycling Act 2011</i> .	Proposal to include wording to the EA to remove ambiguity around transfer to CSG water and its authorisation under the various pieces of legislation which authorise its use (refer to Section 7.3).
Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new condition (Waste 22)	Add condition (Waste 23): (Waste 23) Produced water that is supplied or used under separate authorisation and in accordance with condition (Waste 22) is not further regulated under conditions of this authority.	Proposal to include wording to the EA to remove ambiguity around transfer to CSG water and its authorisation under the various pieces of legislation which authorise its use . (refer to Section 7.3)

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable
Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new condition (Waste 23)	<p>Add condition (Waste 24):</p> <p>(Waste 24) <u>Coal seam gas water</u> may be transferred to a third party to be used for the following purposes subject to compliance with conditions (Waste 25) and (Waste 26):</p> <p>(a) dust suppression if the <u>coal seam gas water</u> quality complies with the limits specified in <i>Schedule B, Table 3 – Water Contaminant Release Limits</i>;</p> <p>(b) <u>construction and operational purposes</u> if the <u>coal seam gas water</u> quality complies with the limits specified in <i>Schedule B, Table 3 – Water Contaminant Release Limits</i>;</p> <p>(c) irrigation and livestock watering purposes;</p> <p>(d) the following industrial purposes:</p> <p>i. coal washing;</p> <p>ii. power stations; and</p> <p>iii. water treatment facilities.</p>	Proposal to include provision within the EA the ability to transfer water to third party rather than through an EOW code (refer to Section 7.3).
Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new condition (Waste 24)	<p>Add condition (Waste 25):</p> <p>(Waste 25) Any <u>coal seam gas water</u> supplied to a third party for <u>irrigation and/or livestock watering purposes</u> in accordance with Condition (Waste 24)(c) must comply with the relevant trigger values contained in ANZECC and ARMCANZ Water Quality Guidelines 2000, or subsequent versions thereof.</p>	Proposal to include provision within the EA the ability to transfer water to third party rather than through an EOW code, whilst aligning with the limits within the EOW Codes (refer to Section 7.3).

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EA Section	EA Condition / Table / Location of change	Proposed changes	Justification and Report Section(s) where applicable																						
Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new condition (Waste 25)	<p>Add table <i>Schedule B, Table 3 – Water Contaminant Release Limits</i></p> <p>Schedule B, Table 3 – Water Contaminant Release Limits</p> <table border="1"> <thead> <tr> <th>Water Quality Characteristics</th><th>Unit</th><th>Limit</th><th>Limit Type</th></tr> </thead> <tbody> <tr> <td>pH</td><td>pH units</td><td>6.0 to 9.0</td><td>Range</td></tr> <tr> <td rowspan="2">Sodium Adsorption Ratio</td><td rowspan="2">ratio</td><td>6</td><td>80th Percentile</td></tr> <tr> <td>12</td><td>Maximum</td></tr> <tr> <td>Total Dissolved Solids (TDS)</td><td>mg/L</td><td>1500</td><td>Maximum</td></tr> <tr> <td>Total Petroleum Hydrocarbons (TPH)</td><td>mg/L</td><td>10</td><td>Maximum</td></tr> </tbody> </table>	Water Quality Characteristics	Unit	Limit	Limit Type	pH	pH units	6.0 to 9.0	Range	Sodium Adsorption Ratio	ratio	6	80 th Percentile	12	Maximum	Total Dissolved Solids (TDS)	mg/L	1500	Maximum	Total Petroleum Hydrocarbons (TPH)	mg/L	10	Maximum	Proposal to add water contaminant release limits for CSG water (refer to Section 7.3)
Water Quality Characteristics	Unit	Limit	Limit Type																						
pH	pH units	6.0 to 9.0	Range																						
Sodium Adsorption Ratio	ratio	6	80 th Percentile																						
		12	Maximum																						
Total Dissolved Solids (TDS)	mg/L	1500	Maximum																						
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Schedule B – Waste Management – New title <i>Transfer of coal seam gas water to a third party</i>	After new table <i>Schedule B, Table 3 – Water Contaminant Release Limits</i>	<p>Add condition (Waste 26):</p> <p>(Waste 26) If the responsibility of <u>coal seam gas water</u> is given or transferred to a third party in accordance with Condition (Waste 24), the <u>holder</u> of environmental authority must ensure that:</p> <p>(a) the responsibility of the <u>coal seam gas water</u> is given or transferred in accordance with a written agreement (the third party agreement); and</p> <p>(b) the third party is made aware of the General Environmental Duty under section 319 of the <i>Environmental Protection Act 1994</i>.</p>	Proposal to include provision within the EA the ability to transfer water to third party rather than through an EOW code (refer to Section 7.3).																						
Schedule D – Protecting Air Values																									
Schedule D – Protecting Air Values	Before Condition (Air 1)	<p>Add title:</p> <p>Venting and flaring</p>	For consistency regarding title structure of Schedule D – Protecting Air Values																						

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Schedule D – Protecting Air Values	After Condition (Air 1)	Add title: Fuel burning and combustion facilities – authorised point sources	For consistency regarding title structure of Schedule D – Protecting Air Values																																																												
Schedule D – Protecting Air Values	After Condition (Air 1)	Add conditions (Air 2A) and (Air 2B) (all below): (Air 2A) A <u>fuel burning, or combustion facility</u> must not be operated unless it is listed in Schedule D, Table 1 – Authorised point sources . (Air 2B) If a fuel burning or combustion facility is listed in Schedule D, Table 1—Authorised point sources , the fuel burning or combustion facility must be operated so that the releases to air do not exceed the limits specified in Schedule D, Table 1—Authorised point sources at the specified release point reference. and add Table Schedule D, Table 1 Authorised point sources. Schedule D, Table 1 Authorised point sources <table><tr><th rowspan="2">Resource Authority Tenure</th><th rowspan="2">Facility</th><th rowspan="2">Release point reference</th><th rowspan="2">Unit description</th><th rowspan="2">Minimum release height (m)</th><th rowspan="2">Minimum efflux velocity (m/s)</th><th colspan="2">NOx as Nitrogen dioxide (NO₂)</th></tr><tr><th>Maximum concentration (mg/Nm³)</th><th>Maximum mass emission rate (g/s)</th></tr><tr><td rowspan="8">PL305</td><td rowspan="8">Girraheen Field Compression Station (FCS) Power Station</td><td>A1</td><td>Generator Stack 1</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A2</td><td>Generator Stack 2</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A3</td><td>Generator Stack 3</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A4</td><td>Generator Stack 4</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A5</td><td>Generator Stack 5</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A6</td><td>Generator Stack 6</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A7</td><td>Generator Stack 7</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr><tr><td>A8</td><td>Generator Stack 8</td><td>5</td><td>32</td><td>750</td><td>1.5</td></tr></table>	Resource Authority Tenure	Facility	Release point reference	Unit description	Minimum release height (m)	Minimum efflux velocity (m/s)	NOx as Nitrogen dioxide (NO ₂)		Maximum concentration (mg/Nm ³)	Maximum mass emission rate (g/s)	PL305	Girraheen Field Compression Station (FCS) Power Station	A1	Generator Stack 1	5	32	750	1.5	A2	Generator Stack 2	5	32	750	1.5	A3	Generator Stack 3	5	32	750	1.5	A4	Generator Stack 4	5	32	750	1.5	A5	Generator Stack 5	5	32	750	1.5	A6	Generator Stack 6	5	32	750	1.5	A7	Generator Stack 7	5	32	750	1.5	A8	Generator Stack 8	5	32	750	1.5	Proposed changes to authorise the inclusion of fuel burning or combustion facility and need for additional air conditions including point source monitoring (refer to Section 5.1).
Resource Authority Tenure	Facility	Release point reference							Unit description	Minimum release height (m)	Minimum efflux velocity (m/s)	NOx as Nitrogen dioxide (NO ₂)																																																			
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PL305	Girraheen Field Compression Station (FCS) Power Station	A1	Generator Stack 1	5	32	750	1.5																																																								
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		A7	Generator Stack 7	5	32	750	1.5																																																								
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Schedule D – Protecting Air Values	After adding Condition (Air 2B) and table Schedule D, Table 1 – Authorised point sources	Add title: Point source air monitoring	Administrative change. For consistency regarding title structure of Schedule D – Protecting Air Values
Schedule D – Protecting Air Values	After adding Condition (Air 2B)	Add condition (Air 3) as per the following: (Air 3) Point source air monitoring for each fuel burning or combustion facility listed in Protecting air values, Table 1—Authorised point sources must: (a) be undertaken once: i. in the first three months after each release point is first commissioned, and then ii. every year thereafter (for seven of eight listed release points) (b) be carried out when the release point the subject of the sampling is operating under maximum operating conditions for the annual period; and (c) demonstrate compliance with the limits listed in Schedule D, Table 1—Authorised point sources at each release point reference.	Proposed changes to authorise the inclusion of fuel burning or combustion facility and need for additional air conditions including point source monitoring. Modifications to conditions to allow for 'monitoring in the first three months after commissioning' is because not all compressors will come online simultaneously including a spare compressor. As such the proposed wording is including to take into consideration a staged delivery rather than all online at once.
Schedule F – Protecting Land Values			
Schedule E – Protecting Land Values – Pipeline operation and maintenance	Condition (Land 6)	Correct wording to (in bold): Pipeline operation and maintenance must be in accordance, to the greatest practicable extent, with the relevant section of the <i>APGA Code of Environmental Practice: Onshore Pipelines</i> (2013 or more recent editions).	Administrative change. To correct 'typo'.
Schedule E – Protecting Land Values – Pipeline reinstatement and revegetation	Condition (Land 9) (d)	Add wording (in bold): (d) vegetated with groundcover which includes suitable native species of vegetation for the location and not a declared pest species, and which is established and <u>growing</u> .	Administrative change. For consistency with SMC.

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Schedule F – Protecting Biodiversity Values			
Schedule F – Protecting Biodiversity Values	After Condition (Biodiversity 5)	Add title: Authorised disturbance to Environmentally Sensitive Areas	Administrative change. For consistency regarding title structure of Schedule F – Protecting Biodiversity Values.
Schedule F – Protecting Biodiversity Values	After new title <i>Authorised disturbance to Environmentally Sensitive Areas</i>	Add condition (Biodiversity 6) as per below: (Biodiversity 6) Despite condition (Biodiversity 5 (c)), should the quality of protection zone land be deemed historically disturbed (subject to assessment by a suitably qualified person), or of low environmental value, then condition (Biodiversity 5) (c) is silent.	Proposed addition of Condition (Biodiversity 6) is to include a despite process to allow petroleum infrastructure in areas where it can be demonstrated and recorded that the site is historically cleared and that a restriction on right of way widths is not applicable. This is also an existing condition in Arrow's EA and ensures consistency as part of constraints planning and compliance with conditions. F
Schedule F – Protecting Biodiversity Values	Condition (Biodiversity 8a)	Remove crossed out wording (in bold): (Biodiversity 8a) Despite condition (Biodiversity 8), the total scale and maximum footprint of significant disturbance specified in Schedule F, Table 2 – Maximum significant disturbance are authorised to be undertaken at the location within the footprint prescribed in Schedule F, Table 2 – Maximum significant disturbance.	Proposed change to remove total scale and location is due to over regulation and prescriptiveness, due to the fact that its then limited by the maximum footprint and ESA limitation in Schedule F, Table 2 – Maximum significant disturbance (Table 2).
Schedule F – Protecting Biodiversity Values	Schedule F, Table 2 – Maximum significant disturbance	Remove: • Column 'Total scale'	Proposed change to remove total scale and location is due to over regulation and prescriptiveness, due to the fact that it's then limited by the maximum footprint and the ESA limitation in Table 2. Having prescriptive limits such as ha per

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			<p>PL will constrain development and force the need to seek EA amendments to go over the limit which maybe for reasons outside of Arrow's control, i.e., if land access forces a longer alignment. The inclusion of limitations in Table 2 creates additional compliance issue and conflict with the need to check against the authorised activity table, Schedule F, Table 1 and Schedule F, Table 3. The constraint per PL also don't support or incentivise an integrated approach to development by trying to reduce disturbance in another PL by co-locating disturbance in an adjacent PL i.e. disturbance in PL 305 might get 601 ha but saved 5 ha in PL 530, which would trigger an EA amendment to increase by 1 ha. It also does not provide flexibility from a development and execution standpoint by limiting disturbance per PL. As CCAs are negotiated there might be the need to pivot to develop another area and utilise the proposed disturbance limits elsewhere, which would not be authorised if its limited to PLs.</p>

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Schedule F – Protecting Biodiversity Values	Condition (Biodiversity 9) (a)	Add wording (in bold) to Condition (Biodiversity 9) (a) and delete crossed out wording. (a) records able to demonstrate compliance with conditions (Biodiversity 4), (Biodiversity 5), and (Biodiversity 8) and (Biodiversity 8a)	Administrative change. Update to align with inclusion of existing Table 2, and missing reference to Condition (Biodiversity 8a) in Condition (Biodiversity 9) (a).
Schedule F – Protecting Biodiversity Values	After condition (Biodiversity 9)	Add condition (Biodiversity 9a) (all wording): (Biodiversity 9a) Despite condition (Biodiversity 8) and (Biodiversity 8a), essential petroleum activities are permitted in Category B and Category C ESAs where there is significant residual impact authorised in Schedule F, Table 3- Significant residual impacts to prescribed environmental matters and where shapefiles (consistent with the DES Spatial Schema) of the impact can be provided to the administering authority upon request.	Proposed change is to provide a linkage to the authorised limit/ pool to be drawn down on through Table 2, and a despite clause to <i>Schedule F, Table 1 – Authorised petroleum activities in environmentally sensitive areas and their protection zones</i> (Table 1), to allow essential petroleum activities to occur in relevant ESA without the need to go through numerous EA amendments to authorise. These authorisations would also be linked to PEMs, offsets, and SRI assessments. The inclusion and linkage to the DES Spatial Schema is to include a loop back for DES compliance to check against the limits. i.e., by Arrow Energy providing spatial data consistent with Annual returns, ERC, and Plan of Operations. DES can then do periodic checks as to where disturbance has occurred in ESAs and have the limitations been set in Table 2 of the EA and PEMs

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			complied with. It then removes the need to provide GPS coordinates (which historically often only corner points), and an assessment where there are despite/exemptions provided for certain infrastructure as the EA provides for limitations in the ESA and PEMs table.
Schedule F – Protecting Biodiversity Values	After new Condition (Biodiversity 9a)	Change title to (add what's in bold and delete what is crossed-out): Planning for land disturbance – linear infrastructure significant residual impacts	Administrative change. For consistency regarding title structure of Schedule F – Protecting Biodiversity Values.
Schedule F – Protecting Biodiversity Values after title Planning for land disturbance – significant residual impacts (new)	Condition (Biodiversity 10)	Add wording to (in bold): (Biodiversity 10) Significant residual impacts to <u>prescribed environmental matters</u> (other than if the impacts were authorised by an existing authority issued before the commencement of the <i>Environmental Offsets Act 2014</i>) are not authorised under this environmental authority or the <i>Environmental Offsets Act 2014</i> unless the impact(s) is specified in Schedule F, Table 4 —Significant residual impacts to prescribed environmental matters	Administrative change. For consistency with SMC.
Schedule F – Protecting Biodiversity Values Planning for land disturbance – significant residual impacts (new)	Schedule F, Table 3 — Significant residual impacts to prescribed environmental matters	Remove Column 2: <ul style="list-style-type: none"> Location of impact 	Proposed change to remove location of impact from the table is due to over regulation and prescriptiveness, due to the fact that it's then limited by the maximum footprint in Table 2 and the ESA limitation in Table 1. Having prescriptive limits such as location of impact will constrain development and force the need to seek EA amendments to go over the limit which may be for

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			<p>reasons outside of Arrow Energy's control, e.g., if land access forces a longer alignment. The inclusion of location of impact creates an additional compliance issue and conflict with the need to check against <i>Schedule F, Table 1</i> and <i>Schedule F, Table 2</i>. The location of impact per PL also doesn't support or incentivise an integrated approach to development by trying to reduce disturbance in another PL by co-locating disturbance in an adjacent PL e.g., disturbance in RE 11.3.4 might occur in another PL not listed, but have an overall reduction of impact on that RE in a listed PL, however this would trigger an EA amendment to have another PL listed, but the PEMs isn't being increased. The location of impact also does not provide flexibility from a development and execution standpoint by limiting disturbance per PL. As CCAs are negotiated there might be the need to pivot to develop another area and utilise the proposed PEMs elsewhere, which would not be authorised if its limited to PLs.</p>

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		<p>Change the definition of staging from years per stage to number of wells to be drilled per stage (in bold).</p> <p><u>Column 4:</u> From: <ul style="list-style-type: none"> Maximum extent of impact – Stage 1 (Years 1 – 5 inclusive) To: <ul style="list-style-type: none"> Maximum extent of impact – Stage 1 (200 wells) </p> <p><u>Column 5:</u> From: <ul style="list-style-type: none"> Maximum extent of impact – Stage 2 (Years 6 – 10 inclusive) To: <ul style="list-style-type: none"> Maximum extent of impact – Stage 1 (250 wells) </p> <p><u>Column 6:</u> From: <ul style="list-style-type: none"> Maximum extent of impact – Stage 3 (Years 11 – 15 inclusive) To: <ul style="list-style-type: none"> Maximum extent of impact – Stage 1 (138 wells) </p> <p>Remove Column 7: <ul style="list-style-type: none"> Maximum extent of impact – Stage 4 (Years 16 – 20 inclusive) </p>	<p>Change the definition of the Project Stages from a 'year-based' approach to 'number of wells drilled per stage', as circumstances external to Arrow (e.g., worldwide pandemic, extended periods of wet weather, etc.) may cause the development to be delayed. Stages based on well count is also more reflective of disturbance.</p> <p>Proposal to remove Column 7 (i.e., Stage 4), as the total amount of wells as authorised by the SGP North EA (i.e., 588 wells) will be covered by three (3) stages.</p>
Schedule F – Protecting Biodiversity Values Planning for land disturbance – significant residual impacts (new)	Schedule F, Table 3 — Significant residual impacts to prescribed	Changes to Prescribed Environmental Matters (PEMs) table maximum disturbance numbers from biodiversity impact assessment provided in Appendix B (external consulting company) and detail of changes as provided in Appendix G (marked-up EA), i.e., specific changes to PEMs table numbers are provided in the marked-up EA.	To include impacts to biodiversity and changes to PEMs table due to additional activities (refer to Section 2.1). Refer to Section 5.4 and Appendix B for detailed

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	environmental matters		biodiversity impact assessment and to Appendix G for detail of maximum extent of impact to PEMs for the Project
Schedule F – Protecting Biodiversity Values Planning for land disturbance – significant residual impacts (new)	Condition (Biodiversity 12)	Change wording to (in bold) : (Biodiversity 12) An <u>environmental offset</u> made in accordance with the <i>Environmental Offsets Act 2014</i> and Queensland Environmental Offsets Policy, as amended from time to time, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in Schedule F, Table 3 — Significant residual impacts to prescribed environmental matters, unless a lesser extent of the impact has been approved in accordance with condition (Biodiversity 154).	Administrative change. To correct 'typo'.
Schedule G – Protecting Water Values			
Schedule G – Protecting Water Values – Activities in river improvement areas	Condition (Water 10)	Remove condition (Water 10) (Water 10) Measures must be taken to minimise negative impacts to, or reversal of, any river improvement works carried out in River Improvement Areas by Queensland's River Improvement Trusts.	Condition not applicable. The Project is not located within a River Improvement Area.
Schedule H - Rehabilitation			
Schedule H – Rehabilitation after Condition (Rehabilitation 1)	After Condition (Rehabilitation 1)	Add title: Transitional rehabilitation	Administrative change. For consistency regarding title structure of Schedule H – Rehabilitation.
Schedule H – Rehabilitation – Transitional rehabilitation (new)	Condition (Rehabilitation 2 (e) i.	Change wording to (in bold): (e) either: i. groundcover, that includes suitable native species of vegetation for the location and not a declared pest species, is growing; or	Administrative change. To be consistent with the SMC.
Schedule H – Rehabilitation – Continuing conditions	After Condition (Rehabilitation 5)	Remove the following wording: Rehabilitation reporting for relinquishment of part of an authority to prospect area under the <i>Petroleum and Gas (Production and Safety) Act 2004</i>	Administrative change. Relates to ATPs.

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Schedule J – Structures			
Schedule J - Structures	Before Condition (J1)	Add title: Consequence category assessment	Administrative change. For consistency regarding title structure of Schedule J – Structures
Schedule J – Structures Operation of a regulated structure	Before Condition (J5)	Change title to (in bold): Operation and maintenance of a regulated structure	Administrative change. To include 'maintenance' in consistency with Condition (J6) which mentions maintenance and is part of this section.
Schedule J – Structures Register of Regulated Structures	Condition (J16)	Change wording to (in bold): (J21) A Register of Regulated Structures must be established and maintained by the holder of this environmental authority for each regulated structure.	Administrative change. To add the wording ' <i>of this environmental authority</i> ' to the condition.
Schedule J – Structures Register of Regulated Structures	Condition (17)	Change wording to (in bold): (J22) The holder of this environmental authority must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.	Administrative change. To add the wording 'of this environmental authority' to the condition.
Schedule J – Structures Register of Regulated Structures	Condition (J19)	Change wording to (in bold): (J24) The holder of this environmental authority must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.	Administrative change. To add the wording 'of this environmental authority' to the condition.
Schedule K - Definitions			
Schedule K – Definitions Word or term	bed	Change wording to (in bold): of any waters, has the meaning in Schedule 19 of the <i>Environmental Protection Regulation 2019</i> and— (a) includes an area covered, permanently or intermittently, by tidal or non-tidal waters; but	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation and corresponding

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		(b) does not include land adjoining or adjacent to the bed that is from time to time covered by floodwater.	Schedule relevant to this definition.
	Category A Environmentally Sensitive Area	Change wording to (in bold): means any area listed in Schedule 19, Section 3 of the Environmental Protection Regulation 2019.	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation and corresponding Section relevant to this definition.
	Category B Environmentally Sensitive Area	Change wording to (in bold): means any area listed in Schedule 19, Section 3 of the Environmental Protection Regulation 2019.	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation and corresponding Section relevant to this definition.
	control measure	Change wording to (in bold): has the meaning in section 31(b) of the <i>Environmental Protection Regulation 2019</i> and means a device, equipment, structure, or management strategy used to prevent or control the release of a contaminant or waste to the environment.	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation and corresponding Schedule relevant to this definition.
	daily peak design capacity	Change wording to (in bold): for sewage treatment works, has the meaning in Schedule 2, section 63(4) of the <i>Environmental Protection Regulation 2019</i> as the higher equivalent person (EP) for the works calculated using each of the formulae found in the definition for EP.	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation.
	declared pest species	Add definition: means a species declared under the <i>Biosecurity Act 2014</i> and that are species that occur beyond their natural range and have the potential to cause significant adverse economic, environmental, and social impacts.	Administrative change. To provide a definition of <i>declared</i> pest species as stipulated in relevant applicable legislation.

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	ecologically dominant layer	<p>Change wording to (in bold):</p> <p>has the meaning in the <i>Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland</i> (Version 5.1 March 2020) and means the layer making the greatest contribution to the overall biomass of the site and the vegetation community (National Land and Water Resources Audit (NLWRA) 2001). This is also referred to as the ecologically dominant stratum or the predominant canopy in woody ecosystems.</p>	Administrative change. To provide reference to most up to date versions of documents.
	equivalent person(s) or EP	<p>Change wording to (in bold):</p> <p>has the meaning under section 3 of the Planning Guidelines For Water Supply and Sewerage, 2005, published by the Queensland Government. It is calculated in accordance with Schedule 2, Section 63(4) of the <i>Environmental Protection Regulation 2019</i> where:</p>	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation (2019).
	essential petroleum activities	<p>Add to the definition of essential petroleum activities (what is in bold and as per detail provided in Appendix G):</p> <ul style="list-style-type: none"> • well sites with slope considerations (>2% slope) for cut and fill earthworks and drainage: <ul style="list-style-type: none"> ○ for single well sites, not exceeding 1.5 hectares disturbance ○ for multi-well sites, not exceeding 2.5 hectares disturbance • well sites including a communication tower: <ul style="list-style-type: none"> ○ for single well sites, not exceeding 1.5 hectares disturbance ○ for multi-well sites, not exceeding 3.0 hectares disturbance • communication tower pads and collocated access tracks and fibre optic cable, not exceeding 1.0 hectares disturbance 	<p>Proposed change is to provide flexibility in the definition as to the area required when working on slopes to provide relevant space for safety and sediment and erosion controls for construction and operation of well pads. Due to the slope, adequate benching and setbacks are required where cut and fill to batters has occurred to manage safety and sediment and erosion control measures This is consistent with Arrows other EAs e.g., DXP EPPG00972513.</p> <p>It also explicitly authorises communication towers not exceeding 1 ha (same size as a well pad) to be defined as essential petroleum activities.</p>

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		<ul style="list-style-type: none"> gathering / flow pipelines from a well head to the initial compression facility and water transfer station/tanks/ponds temporary workspaces, necessary for the construction of other essential petroleum activities, which will not have a significant residual impact on any Matters of State Environmental Significance in accordance with the Environmental Offsets Act 2014. 	<p>Adding water transfer station and tanks as these form part of the infrastructure of the initial compression facility to provide clarity to allow gathering from water as well as gas. As currently it would not include gathering for water since it's not explicitly mentioned as only gas gathering goes to the initial compression facility with water from the well head going to a pond or tank for transfer into the water network.</p> <p>Inclusion of temporary workspaces into essential petroleum activities allows for workspaces to be constructed necessary for incidental activities where Arrow Energy can demonstrate there is no SRI to MSES without the need to seek an EA amendment. The proposed inclusion will negate the need to Arrow to continue to apply for EA amendments and despite clauses where it can comply with the EA but then also demonstrate that the proposed activities will not have an SRI and require further offsets.</p>
	predominant species	Change wording to (in bold):	<p>Administrative change.</p> <p>To update to the latest version of the document in reference.</p>

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		has the meaning in the <i>Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland</i> (Version 5.1 March 2020) and means a species that contributes most to the overall above-ground biomass of a particular stratum.	
	regional ecosystem	Change wording to (in bold): has the meaning in the <i>Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland</i> (Version 5.1 March 2020) and means a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform, and soil. Regional ecosystems of Queensland were originally described in Sattler and Williams (1999). The Regional Ecosystem Description Database (Queensland Herbarium 2013) is maintained by Queensland Herbarium and contains the current descriptions of regional ecosystems.	Administrative change. To update to the latest version of the document in reference.
	secondary treated class A standards	Remove definition.	Proposal is to move to specific discharge limits as proposed with the addition of Condition (Waste 17).
	secondary treated class B standards	Remove definition.	Proposal is to move to specific discharge limits as proposed with the addition of Condition (Waste 17).
	secondary treated class C standards	Remove definition.	Proposal is to move to specific discharge limits as proposed with the addition of Condition (Waste 17).
	Significantly disturbed or significant disturbance or significant disturbance to land areas	Change wording to (in bold): has the meaning in Schedule 12, section 4 of the <i>Environmental Protection Regulation 2008</i> . Land is significantly disturbed if— (a) it is contaminated land ; or (b) it has been disturbed and human intervention is needed to rehabilitate it – (i) to a condition required under the relevant environmental authority; or	Administrative change. Amendment of definition to correct 'typo' as per what is in Schedule 12, Section 4 of the EP Reg 2008. This definition is not in the EP Reg 2019.

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		(ii) if the environmental authority does not require the land to be rehabilitated to a particular condition—to the condition it was in immediately before the disturbance.	
	Suitably qualified third party	<p>Change wording to (in bold):</p> <p>means a person who:</p> <ul style="list-style-type: none"> a) has qualifications and experience relevant to performing the function including but not limited to: <ul style="list-style-type: none"> i. a bachelor's degree in science or engineering; and ii. 3 years' experience in undertaking soil contamination assessments; and b) is a member of at least one organisation prescribed in Schedule 14 of the <i>Environmental Protection Regulation 2019</i>; and c) not be an employee of, nor have a financial interest or any involvement which would lead to a conflict of interest with the holder(s) of the environmental authority. 	Administrative change. Minor administrative amendment to update to most recent and current version of the EP Regulation and corresponding Schedule relevant to this definition.

Appendix B. Biodiversity Impact Assessment (Attexo Consulting)

Appendix C. Air Quality Impact Assessment (SLR Consulting)

Appendix D. Noise Impact Assessment (SLR Consulting)

Appendix E. SGP Terrestrial Ecology Report (Ecosmart, 2017)

Appendix F. Coal Seam Gas (CSG) Water Management Plan

Appendix G. Draft EA (with marked-up changes)